Study on the Quality Stability of Rose Effervescent Tablets and Evaluation of Antioxidant Activity

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Abstract

This paper experimentally evaluates stability and antioxidant properties of rose effervescent tablets; investigates the six-month stability of three batches of rose effervescent tablets sold in the market at room temperature. At the same time, 1,1-diphenyl-2-trinitrophenylhydrazine (DPPH) was used in antioxidant experiment to compare rose tea with the same concentration and thereby evaluate the antioxidant activity of rose effervescent tablets. The evaluation shows that the rose effervescent tablet prepared by this process is stable within 6 months, and the content of the six medicinal ingredients and various indicators detected in the effervescent tablet are relatively stable without significant changes. Rose effervescent tablets have better scavenging effect on DPPH free radicals than rose tea with the same concentration. It shows that the prepared rose effervescent tablets have relatively stable quality and the preparation process is feasible, which provides a reference for the follow-up long-term stability experiment of rose effervescent tablets and related health products.

Keywords: *rose, effervescent tablet, stability, antioxidant*

I. Introduction

Rose is the dried flower bud of Rosa rugosa Thunb. [1]. Native to China, it is a traditional Chinese medical and edible dual-purpose plant. The Chinese tradition believes that rose is good for liver and gallbladder, prevents evil spirits, softens the liver and wakes the stomach, supplements vital energy and invigorates the blood, which can also eliminate filth and prevent plague [2,3,4]. Modern pharmacological studies have found that rose has the effects of regulating endocrine, removing spots, moisturizing skin, anti-bacteria, anti-oxidant, improving immunity, anti-cancer, and lowering blood sugar [5-8]. In addition, roses are widely distributed and easy to grow, even in saline-alkali soils. So far, it is mainly distributed in China, Japan, Central Asia, Europe, Central America, etc. [9,10]. Internationally, it is mainly used to extract essential oils. The Damascus rose from Bulgaria has the largest content of essential oil, but roses from most origins are non-oil roses. Even for the transplanted Damascus rose, the essential oil content tends to decrease significantly [11-12]. In recent years, through research on the non-volatile components of roses, it is found that the non-volatile components in roses also have strong antioxidant and pharmacological effects [13-18]. If rose is used solely to extract essential oils, it will cause a lot of waste and limit the development and utilization of rose in most parts of the world [19].

As a new type of beverage, solid beverage effervescent tablets have good taste, which are easy to be accepted by children and the elderly, and easy to promote [20,21]. The development of rose solid beverage effervescent tablets can not only effectively avoid the waste of roses, but also better utilize its antioxidant properties to increase the economic added value of the product and facilitate promotion, which carries great application significance. The stability and antioxidant evaluation of rose effervescent tablets helps product process verification as a necessary condition for product development.

According to the guiding principles of the fourth part of the Chinese Pharmacopoeia 2020 edition, the stability of rose effervescent tablets was investigated for 6 months at room temperature, the stability of rose effervescent tablets was preliminarily investigated to demonstrate the feasibility of the preparation process and lay the foundation for further research and development of rose effervescent tablets.

1,1-Diphenyl-2-trinitrophenylhydrazine (DPPH) is a stable free radical in organic solvents. Its alcohol solution is purple and needs to be stored at low temperature and protected from light. It has a single electron, so it can accept an electron or hydrogen ion, which has maximum absorption at a wavelength of 517 nm [22]. With the presence of free radical scavenger, the single electron of DPPH free radical is captured to make its color lighter, and the absorbance value at the maximum light absorption wavelength decreases [23,24]. It is generally believed that both flavonoids and polyphenols have the effect of anti-DPPH free radicals [25,26]. In this study, the DPPH experimental method was established to compare the antioxidant activity of rose effervescent tablets and rose buds against DPPH free radicals.

The antioxidant evaluation of rose effervescent tablets can also further prove the development significance of rose effervescent tablets. Stability evaluation and antioxidant evaluation provide necessary reference for the development and utilization of health products such as rose effervescent tablets.

II. Instruments and reagents

2.1 Instruments

DFY-500 type Chinese medicine grinder (Wenling Linda Machinery Co., Ltd.); OLYMPUS SZ61 microscope (OLYMPUS, Japan); Direct16 Milli-Q ultrapure water meter (Millipore, USA); CPA225D type one-hundred-thousandth analytical balance (Sartorius, Germany). SB3 thin-layer spray pump (Shanghai Shuoguang Electronic Technology Co., Ltd.); ZF-20D dark box ultraviolet analyzer (Gongyi Yuhua Instrument Co., Ltd.); 101-2 type electro- thermostatic blast oven (Shanghai Dongxing Building Materials) ; SX2 integrated intelligent muffle furnace; Direct16 Milli-Q ultrapure water meter (Millipore, USA); CPA225D one-hundred-thousandth analytical balance (Sartorius, Germany); AL204 electronic balance (Mettler-Toledo Instruments(Shanghai) Co., Ltd);

T6 ultraviolet-visible spectrophotometer (Shanghai INESA Scientific Instruments Co., Ltd.); KQ-500B ultrasonic cleaning machine; Direct16 Milli-Q ultrapure water equipment (Millipore Corporation, USA); CPA225D one-hundred-thousandth analytical balance (Sartorius, Germany).

2.2 Reagents

2.2.1 Reference substance: DPPH (1,1-di-phenyl-2-picryhydrazyl) reference substance; kaempferol (batch number B21126), quercetin (batch number B20527-20mg), geraniol (batch number: B21368), rutin (batch number: 20771). All were purchased from Shanghai Yuanye Bio-Technology Co., Ltd.

2.2.2 Rose effervescent tablets (self-made, batch number: 20200203, 20200204, 20200205, 20200206).

2.2.3 Other reagents: Shandong Pingyin Rose (purchased from Jinan Tianyuan Rose Products Development Co., Ltd., production date: 2018/12/03); purified water (prepared in the laboratory); glycerin; chloral hydrate; alcohol; hydrochloric acid (AR, batch number: 2018070719, Sanming Sanyuan Chemical Reagent Co., Ltd.); methanol (AR20180716 Sinopharm Chemical Reagent Co., Ltd.); 3% $AlCl_3$ ethanol color developer; thin layer chromatography silica gel G plate; purified water made by the laboratory (prepared by Direct16 Milli-Q ultrapure water instrument); other AR reagents and consumables: petroleum ether, ethyl acetate, toluene, formic acid, glass capillary, silica gel G plate, etc.

III. Methods and results

3.1 Preparation of rose effervescent tablets

3.1.1 Powdered rose medicinal materials were screened through No. 3 sieve. Extraction solvent was 80% ethanol, with material-liquid ratio 1:10. Ultrasonic extraction was performed with ice for 1 hour and repeated 3 times, filtered, combined with the extracts, concentrated under reduced pressure, so that 50g rose extract was concentrated to about 50 mL.

3.1.2 Rose spray dried powder was made by spray-drying of rose extract. The mixing design of spray-dried rose extract concentrate is as follows: solids in the concentrate account for 56.9%, microcrystalline cellulose accounted for 33.1%, dextrin and maltodextrin account for 0.05%. The spray drying parameters are selected as follows: the relative density after adding the mixture is 1.05, the spray temperature is 170 degrees, and the liquid feed rate is 500 mL/h.

3.1.3 Use powder to directly compress tablets, mix sucrose and lactose, citric acid and tartaric acid respectively by equal doubling method; then mix several excipients by equal doubling method, add acid and alkali separately, mix evenly, then press the tablet. An effervescent tablet with an average tablet weight of 1 g was prepared.

3.2 Investigation method in stability test

Three batches of self-made rose effervescent tablet samples (batch numbers: 2020203, 20200204, 20200205) were packaged in effervescent tablet bottles, and placed in natural room temperature for 6 months. Preliminary stability experiments were performed on them, respectively. Sampling and testing were conducted in the middle of January, February, March, April, May and June.

3.3 Investigation items and results

The preliminary stability study was carried out in accordance with the 9000 guidelines of the fourth part of Chinese Pharmacopoeia 2020 edition, 9001 experimental guidelines for the stability of raw materials and preparations.
Preparation stability investigation items: According to the quality control method of rose effervescent tablets established in the previous experiment, the properties, identification, inspection and content determination of three batches of rose effervescent tablets were performed.

3.3.1 Properties: This product is a light pink circular tablet with a diameter of 1cm and a smooth surface. The results are shown in Figure 1, Table 2, Table 3, and Table 4.

Figure 1 Photo of rose effervescent tablet

3.3.2 Thin layer identification
3.3.2.1 Identification of geraniol in effervescent tablets by thin layer chromatography
3.3.2.1.1 Preparation of reference solution

For geraniol reference substance, place 5 mg of geraniol reference substance in a centrifuge tube, add 2 mL of petroleum ether, cap, and weigh it. After shaking and deflating, perform ultrasonic processing in an ice bath for 30 min, add weight with petroleum ether. Prepare a reference substance solution containing 2.5 mg of geraniol per 1 mL and get it.

3.3.2.1.2 Preparation of test solution

The rose effervescent tablet was ground into powder (screened through No. 3 sieve). 5g was accurately weighed into a 10mL measuring flask, added with 5mL petroleum ether, infiltrated, shaken, stoppered, added with ice and sonicated for 30 min, with 3~4 times' venting in the middle. After sonication, add petroleum ether to a constant volume, filter, and take the additional filtrate as the test solution.

3.3.2.1.3 Preparation of negative control solution

Take the rest of the auxiliary materials without rose spray-dried powder, and operate according to the same method as the preparation of rose effervescent tablets for test solution.

3.3.2.1.4 Identification of volatile components in effervescent tablets by thin layer chromatography

Take 10μL of each of the three batches of rose test solution, 5μL each of the geraniol reference solution, citronellol reference solution, and negative control solution, and test according to thin layer chromatography (Four General Principles 0502 in Chinese Pharmacopoeia 2020 Edition). Respectively dot on the same piece of silica gel G thin layer plate. Use the developing agent petroleum ether (60~90℃)-ethyl acetate (17:3), unfold, take out, and dry. Spray ethanol solution containing 3% aluminum trichloride, and inspect under 365nm ultraviolet light. The results showed that the test product chromatograms of the three batches of effervescent tablets displayed fluorescent spots of the same color at the corresponding positions where the reference substance geraniol has spots. There was no interference in the negative control, indicating that this method can be used in identification of geraniol in rose effervescent tablets. The thin layer chromatography is shown in Figure 2, Table 2, Table 3, and Table 4.

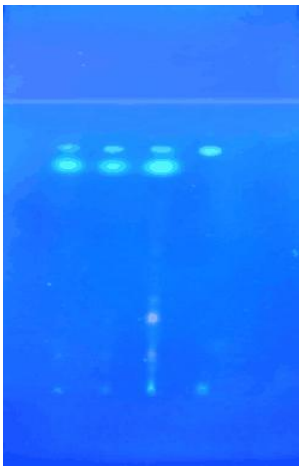


Figure 2 Thin-layer chromatogram of rose effervescent tablets
0 is negative reference solution; Oa is geraniol reference solution; 1~3 are rose effervescent tablet batch numbers 20200203, 20200204, 20200205

3.3.2.2 TLC identification of kaempferol and quercetin after hydrolysis of rose effervescent tablets

3.3.2.2.1 Preparation of reference solution

For quercetin reference solution, take an appropriate amount of quercetin reference substance, add methanol to prepare 0.5mg/mL reference solution, and get it.

For kaempferol reference solution, take an appropriate amount of kaempferol reference substance, add methanol to prepare 0.5mg/mL reference solution, and get it.

3.3.2.2.2 Preparation of test solution

Grind the rose effervescent tablet powder, screen it through No. 3 sieve, accurately weigh 2.5g, place it in a ground conical flask, add 50 mL of 80% methanol, add ice and sonicate for 30 min, then filter. The filtrate was steamed in a water bath until it had no alcohol taste. After adding 20mL of water for dissolution, add petroleum ether (30~60^{0}C) to wash twice, 20mL each time. Discard the petroleum ether, add 5mL of hydrochloric acid to the water layer, heat in the water bath for 1 h, take it out, and quickly cool. Add ethyl acetate for extraction and shake twice, 20 mL each time. Combine the ethyl acetate solutions, add 30 mL of water for extraction and wash, and discard the water layer. The ethyl acetate solution was evaporated to dryness, and the residue was dissolved in 1 mL of methanol as the test solution of the effervescent tablet.

In addition, 0.5g of rose spray-dried powder and 1g of Pingyin rose medicinal powder were used to prepare spray-dried test solution and Pingyin rose medicinal test solution in the same way.

3.3.2.2.3 Preparation of negative control solution

Operate according to the same method under "2.3.2.1.3".

3.3.2.2.4 Identification of kaempferol and quercetin by TLC

Take 2μL each of the kaempferol reference solution, quercetin reference solution, 5μL each of the Pingyin rose test solution, and the negative control solution, and place them on the same silica gel G thin-layer plate. According to thin-layer chromatography (Four General Principles 0502 of Chinese Pharmacopoeia 2020 Edition), use toluene-ethyl acetate-formic acid (10:8:1) as the developing agent, unfold, take out, and dry. Spray ethanol solution containing 3% aluminum trichloride, heat at 105^{0}C for a few minutes, and inspect under natural light. The results showed that in the chromatogram of the test substance, spots of the same color appeared at the corresponding positions where spots appeared on the reference substance. Then put it under the ultraviolet light (365nm) for inspection. In the chromatogram of the test substance, the fluorescent spots of the same color appeared at the corresponding position where spot appeared on the reference substance. The negative control had no interference. It suggested that this method can be used for the identification of rose effervescent tablets. The results are shown in Figure 3, Table 2, Table 3, and Table 4.

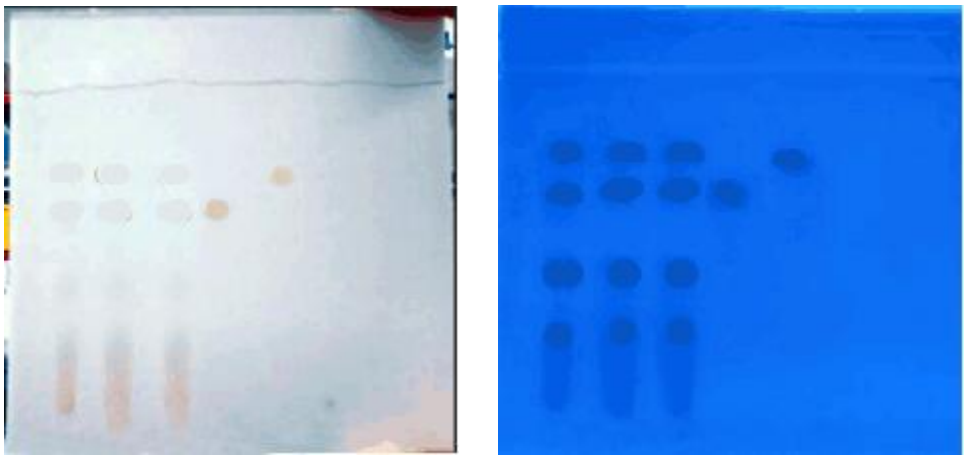


Figure 3 Thin layer identification of rose effervescent tablets

0 is negative control solution; Oa is quercetin reference solution; Ob is kaempferol reference solution; 1~3 are rose effervescent tablet batch numbers 20200203, 20200204, 20200205

3.3.3 Inspection

3.3.3.1 Tablet weight variation

Refer to inspection method of tablet weight variation under Four General Rules for Tablets in "Chinese Pharmacopoeia" 2020 Edition.

Take 20 tablets of this product and accurately weigh them to obtain the average tablet weight. Then, accurately weigh the weight of each tablet, and compare the weight of each tablet with the average tablet weight. The experimental results show that the weight variation of the finished product is less than ±5%, which meets the weight variation regulations. The results are shown in Table 2, Table 3, and Table 4.

3.3.3.2 Disintegration time limit
Refer to 0921 Disintegration Time Limit Inspection Method in the Fourth Part of "Chinese Pharmacopoeia" 2020 edition.

Take 10 tablets of this product and place them in a 250 mL beaker with 200 mL of water at water temperature of 37 ℃. There were many bubbles overflowing. Check the time for the effervescent tablet to disperse in the water without agglomerated particles when no more gas escaped. Record the time, calculate the average value at 159s, and set it as the disintegration time of the effervescent tablet. Experimental results showed that all tablets disintegrated within 5 min, which meets the requirements for disintegration of effervescent tablets. The results are shown in Table 2, Table 3, and Table 4.

3.3.3.3 pH value determination
Take 10 rose effervescent tablets, grind them, and place them in a 250mL beaker, add water (37±1)℃, 200mL, shake for 10min, and determine according to the (Four General Principles 0713 of "Chinese Pharmacopoeia" 2020 Edition). The experimental results showed that the pH was 7.5～8.5, which was weakly alkaline and met the requirements. The results are shown in Table 2, Table 3, and Table 4.

3.3.3.4 Friability
In accordance with the specific content of Item 0923 in the Four General Principles of Chinese Pharmacopoeia 2020 edition, the friability of rose effervescent tablets was checked. Take 10 rose effervescent tablets, blow off the surface foam, accurately weigh them, and place them in the friability tester. Take it out after 100 rotations, blow off the surface powder and weigh it accurately. Calculate lost weight. The experimental results showed that the weight loss measured by the experiment was 0.23%, and no broken, cracked, or fractured tablets were detected, which met the requirements of friability. The results are shown in Table 2, Table 3, Table 4.

3.3.4 Assay
3.3.4.1 Solution preparation
3.3.4.1.1 Reference solution
It is the same as "2.1 Solution Preparation 2.1.1 Reference Solution in Section 3, Chapter 1".

3.3.4.1.2 Negative reference solution
Take the rest of the auxiliary materials without spray-dried rose powder for the preparation of effervescent tablets, and operate according to the same method for the preparation of rose effervescent tablets and the test solution.

3.3.4.1.3 Test solution
Take 20 rose effervescent tablets, weigh the average tablet weight, grind, accurately weigh about 2.50g of tablet powder, add 50mL 80% methanol, and weigh. After ultrasonication in an ice bath for 1 h, wipe off the water on the glassware wall, place it at room temperature, make up the weight with 80% methanol, filter, and take the subsequent filtrate to get it.

3.3.4.2 Chromatographic conditions and system suitability test
Chromatographic column: COSMOSIL C18 chromatographic column (250 mm × 4.6 mm, 5 μm). Mobile phase:

methanol (A)-0.2% formic acid (D) solution, gradient elution, injection volume 10μL, flow rate 1mL/min. Detection wavelength, gallic acid 274nm. Others are 254nm. The gradient elution program is shown in Table 1. The peaks of gallic acid, rutin, hyperoside, isoquercitrin, quercitrin, and quercetin have a good resolution of R>1.5 under the specified chromatographic conditions, and the number of theoretical plates is not less than 3000 when calculated based on gallic acid.

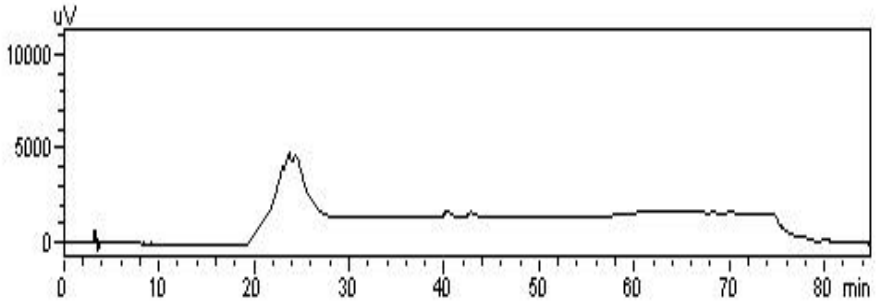
Table 1 Gradient elution program

Time	Methanol (A)	0.2% formic acid (D)
0～10min	3%	97%
10～15min	3%～4%	97%～96%
15～20min	4%～40%	96%～60%
20～55min	40%～50%	60%～50%
55～61min	50%～55%	50%～45%
61～71min	55%	45%
71～75min	55%～3%	45%～97%
75～85min	3%	97%

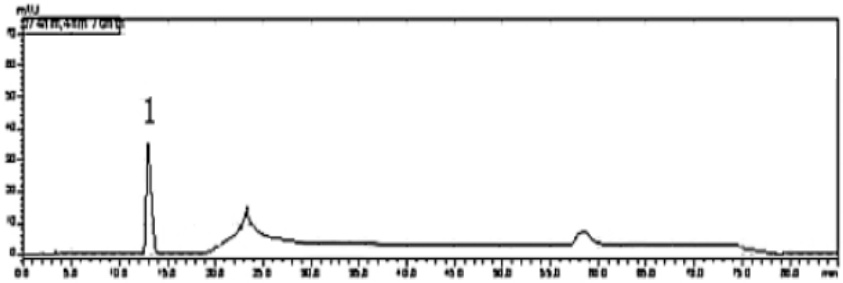
3.3.4.3 Methodological investigation

3.3.4.3.1 Specificity experiment

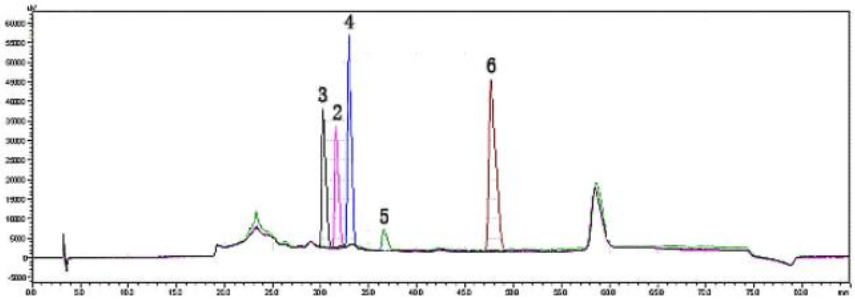
Precisely absorb 10 μL each of the reference solution, the test solution and the negative control solution, and inject them into the liquid chromatograph. The experimental results showed that the chromatographic peaks were well separated and the negative control had no interference. The results are shown in Figure 4, Table 2. Table 3, Table 4.



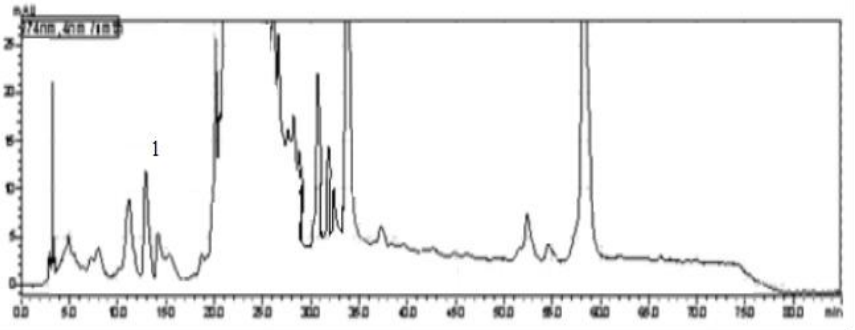
Negative control solution



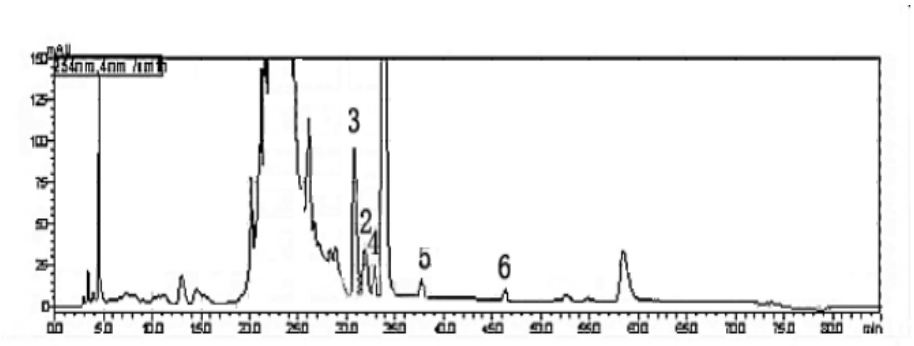
Gallic acid reference substance



5 kinds of flavonoid reference substances



HPLC chart at 274nm of effervescent tablet



HPLC chart at 254nm of effervescent table

Figure 4 HPLC chromatogram of rose effervescent tablets

According to the experimental results, the test results of the three batches of rose effervescent tablets are in compliance with the relevant regulations under the 9000 guidelines of the fourth part of Chinese Pharmacopoeia 2015 edition, 9001 experimental guidelines for the stability of raw materials and preparations.

Table 2 Preliminary stability test results of rose effervescent tablets (batch number: 20200203)

Inspection item		Test time/month						
		0	1	2	3	4	5	6
Properties	This product is light pink circular tablet, 1cm in diameter, with smooth surface.	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations
Identification	Geraniol spots should be detected	Detected	Detected	Detected	Detected	Detected	Detected	Detected
	Quercetin and kaempferol spots should be detected	Detected	Detected	Detected	Detected	Detected	Detected	Detected

	For disintegration time limit, disintegration should be complete within 5 min.	159s	162s	166s	170s	175s	179s	182s
Examination	Weight difference should be less than ±5%.	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations
	The pH should be 7.5～8.5 and weakly alkaline.	8	8	7.9	8	7.8	7.8	7.9
	The friability should be less than 0.8%.	0.39%	0.40%	0.39%	0.38%	0.40%	0.39%	0.41%
Content determination/μg/g	Gallic acid	805.68	803.14	790.76	783.30	775.84	763.09	760.07
	Rutin	1601.95	1593.90	1593.90	1577.8	1569.75	1563.37	1553.65
	Hyperoside	1224.09	1218.0	1205.8	1204.3	1181.35	1173.27	1139.41
	Isoquercitrin	122.43	121.37	117.81	115.21	113.17	112.07	109.22
	Quercitrin	35.56	35.17	34.21	33.99	33.97	33.12	32.39
	Quercetin	1.29	1.28	1.28	1.25	1.23	1.18	1.17

Table 3 Preliminary stability test results of rose effervescent tablets (batch number: 20200204)

Inspection item		Test time/month						
		0	1	2	3	4	5	6
Properties	This product is light pink circular tablet, 1cm in diameter, with smooth surface.	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations
Identification	Geraniol spots should be detected	Detected	Detected	Detected	Detected	Detected	Detected	Detected
	Quercetin and kaempferol spots should be detected	Detected	Detected	Detected	Detected	Detected	Detected	Detected
	For disintegration time limit, disintegration should be complete within 5 min.	158s	162s	165s	168s	173s	178s	181s
Examination	Weight difference should be less than ±5%.	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations
	The pH should be 7.5～8.5 and weakly alkaline.	8.2	8	8.1	8.1	7.8	7.9	7.9

	The friability should be less than 0.8%.	0.40%	0.40%	0.39%	0.39%	0.41%	0.41%	0.42%
Content determination/μg/g	Gallic acid	808.73	806.36	804.97	800.11	797.13	791.29	787.31
	Rutin	1605.31	1603.21	1602.97	1597.98	1595.21	1592.13	1589.07
	Hyperoside	1225.17	1222.60	1221.13	1218.79	1213.97	1211.15	1210.58
	Isoquercitrin	125.79	122.31	121.97	119.78	117.31	115.71	113.22
	Quercitrin	37.21	36.91	36.37	34.82	34.13	33.59	32.89
	Quercetin	1.33	1.30	1.28	1.17	1.13	1.11	1.03

Table 4 Preliminary stability test results of rose effervescent tablets (batch number: 20200205)

Inspection item		Test time/month						
		0	1	2	3	4	5	6
Properties	This product is light pink circular tablet, 1cm in diameter, with smooth surface.	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations
Identification	Geraniol spots should be detected	Detected	Detected	Detected	Detected	Detected	Detected	Detected
	Quercetin and kaempferol spots should be detected	Detected	Detected	Detected	Detected	Detected	Detected	Detected
Examination	For disintegration time limit, disintegration should be complete within 5 min.	161s	163s	167s	170s	173s	180s	184s
	Weight difference should be less than ±5%.	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations	In compliance with regulations
	The pH should be 7.5～8.5 and weakly alkaline.	7.9	8	8.1	7.9	7.8	7.9	7.8
	The friability should be less than 0.8%.	0.38%	0.39%	0.38%	0.40%	0.41%	0.41%	0.43%
Content determination/μg/g	Gallic acid	807.31	805.73	803.22	801.21	798.78	796.31	793.73
	Rutin	1603.79	1601.91	1598.13	1596.61	1593.43	1592.17	1590.11
	Hyperoside	1221.97	1220.13	1218.99	1216.13	1213.97	1210.75	1203.88
	Isoquercitrin	124.39	123.77	121.91	120.31	119.75	117.33	116.12
	Quercitrin	36.89	36.01	35.31	35.17	34.97	34.73	34.01
	Quercetin	1.33	1.30	1.30	1.27	1.23	1.23	1.19

3.4 Evaluation of antioxidant activity of rose effervescent tablets

3.4.1 Solution preparation DPPH solution preparation: accurately weigh 9.9 mg of DPPH reference substance and place it into 100 mL measuring flask, and add absolute ethanol to prepare DPPH absolute ethanol solution with a concentration of 0.25 mmol/L.

The rose test solution was prepared with 19-year rose powder (screened through No. 3 sieve), added with water and decocted for 15 min to increase the weight, and prepared into solution according to the proportion of 0.2%, 0.3%, 0.4%, 0.5%, 1.0%, 2.0%, 5.0%.

Preparation of test solution of rose effervescent tablets: Convert in accordance with the proportion of rose solids contained in the effervescent tablet (1 effervescent tablet is equivalent to 0.5g rose buds), and directly dissolve it in 37±1℃ water to prepare a series of rose effervescent tablet test solution with the same solubility.

3.4.2 DPPH experiment analysis

Take 2 mL samples of different concentrations and mix them evenly with 2 mL DPPH solution, react for 30 min in the dark, and measure the absorbance value A of the experimental group at 517 nm. Mix the ethanol and the test solution as the experimental control group to determine the absorbance value A_0. Take the mixture of deionized water and DPPH as the blank solution, measure the absorbance value A_1, eliminate the absorbance of the deionized water before the measurement, and the measured A_1 value was 1.179.

According to the literature [21-22], the following formula is used to calculate the DPPH free radical scavenging ability:

$$\text{DPPH free radical scavenging rate } SR(\%) = [1-(A - A_0)/A_1] \times 100\%$$

Where, A_0 is the control group with mixture of ethanol and the test solution; A_1 is the control group with mixture of deionized water and DPPH ethanol solution; A is the absorbance value of the experimental group. The experimental results showed that the effervescent tablets with the same concentration as the dried rose buds have significantly higher antioxidant activity than rose decoction, and both rose effervescent tablets and rose decoction have a significantly higher scavenging rate when the concentration is about 1.0%~2.0%. The rise is relatively stable afterwards. The scavenging rate of rose effervescent tablets is as high as 95.00% in the experiment, and it has a better scavenging effect on DPPH free radicals, reflecting strong antioxidant capacity. The results are shown in Table 5 and Figure 5.

Table 5 Investigation results of DPPH scavenging by the sample

Calculated by rose concentration/%	Rose			Rose Effervescent Tablets		
	A	A0	scavenging rate/%	A	A0	scavenging rate/%
0.2	0.604	0.018	50.30	0.432	0.009	64.12
0.3	0.499	0.033	60.22	0.292	0.016	76.59
0.4	0.469	0.04	63.61	0.264	0.026	79.81
0.5	0.434	0.05	67.43	0.210	0.03	84.73
1	0.445	0.102	70.89	0.228	0.098	88.97
2	0.525	0.217	73.88	0.303	0.21	92.11
5	0.914	0.626	75.57	0.670	0.611	95.00

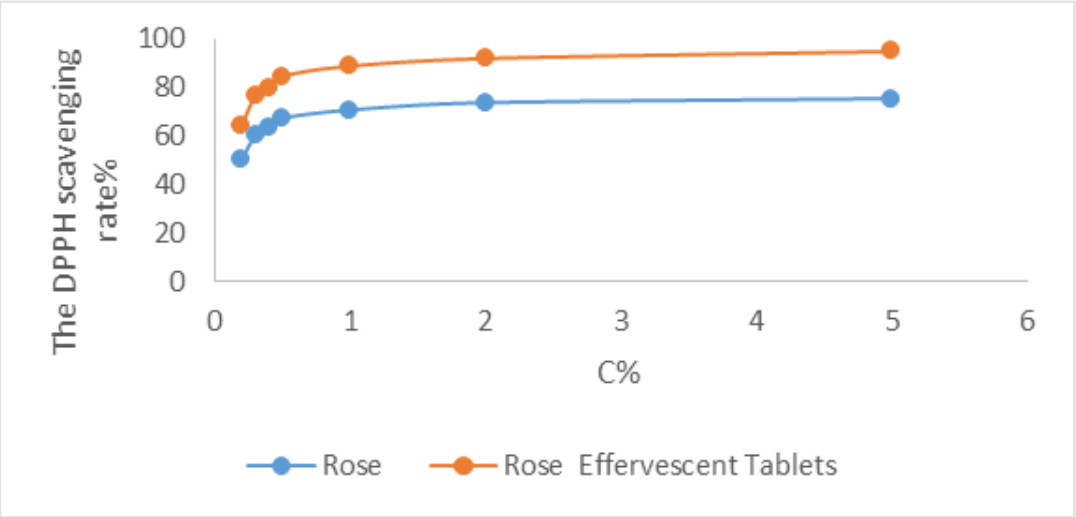


Figure 5 The DPPH scavenging rate of rose effervescent tablets and dried rose buds

IV. Discussion of results

The preliminary stability test results of three batches of rose effervescent tablets show that the prepared rose effervescent tablets are stable within 6 months, and the content of the six medicinal ingredients and various indicators tested in the effervescent tablets are relatively stable without significant changes. It suggests that the preparation process is relatively stable, which can be used as a reference basis for further evaluation of the quality stability and packaging of rose effervescent tablets.

Studies have shown that the antioxidant activity of rose effervescent tablets is significantly superior to that of rose decoction of the same proportion. For the reason, it may be that effervescent tablets are produced with 80% ethanol to extract more antioxidant polyphenols, flavonoids, and the water solubility of these components in dried rose flowers is lower than that of alcohol. This result also suggests that the technological process of the experimental design is reasonable. The rose effervescent tablets produced by the process optimization are not only easy to compress and carry, but also easier to be accepted by the public as a beverage. At the same time, the antioxidant activity is also higher and superior to that of rose medicinal material. Therefore, rose effervescent tablets can exert a stronger effect than pure rose medicinal materials.

In addition, polyphenols and flavonoids are important medicinal ingredients in roses, which have the effects of whitening, anti-aging, inhibiting cancer, and regulating the three highs. These ingredients can be prepared and processed into effervescent tablets through optimized technology to further improve the regulation of the preparation on human immunity.

This experiment initially investigated the quality stability of rose effervescent tablets at room temperature in six months. The results suggest that the quality of rose effervescent tablets prepared according to the optimal process in this study is relatively stable and the process is feasible, which can provide a reference basis for the subsequent further development of health products such as rose effervescent tablets, etc.

V. Conclusion

This experiment preliminarily compared the in vitro antioxidant activity of simulated rose effervescent tablets and traditional rose tea solution. The DPPH free radical scavenging rate was compared with rose of the same proportion. The DPPH scavenging rate of rose effervescent tablets is obviously stronger than that of roses, which may be due to higher content of alcohol extracts in antioxidant polyphenols, flavonoids, and polysaccharides. It

suggests that the rose effervescent tablets prepared by the optimized process in this research have stronger antioxidant activity than rose medicinal materials. After made into effervescent tablets, the effective ingredients of rose are extracted at a high rate, which means practical significance and good application prospect for development of rose health products.

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