대한한의학회지 제23권 제1호(2002년 3월)
J Korean Oriental Med 2002;23(1):61-66

원 저

甘味 한약재의 이화학적 특성에 관한 연구

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A Study on the Physicochemical Properties of a Sweet Flavor for Oriental Herbal Medicines

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목적 : 본 연구는 甘味의 작용에 관한 "甘補" 등의 이론적 바탕과 약물의 이화학적인 특성을 통해 약효를 어느 정도 예측하고자 하였다.

방법 : 韓藥材의 五味別 理化學的 특성을 구명하기 위하여 수소이온농도(pH), 200℃와 550℃에서의 질량감소량, 전기전도도, 가시부 및 자외부 흡수 spectrum의 전자전이에 따른 비율, TLC에 의한 주요 성분의 이동율(R_f value)과 낮은 성분의 이동율(R_f value)을 측정하였다.

결과 : 煎湯에 따른 수소이온농도(pH)의 평균은 5.24±0.56이었으며, 약재의 휘발 성분 및 수분 함유량은 288±125 ㎎이었고, 유기물함량의 평균은 867±116g이었으며, 전기전도도의 평균은 5.46±0.93S/cm이었으며, 가시부 및 자외부 흡수 spectrum의 전자전이에 따른 흡광도 비율($\pi \rightarrow \pi^*$/$n \rightarrow \pi^*$)의 평균은 3.043±0.679이었으며, TLC에 의한 주요 성분의 이동율(R_f value)의 평균은 0.553±0.317이었고, TLC에 의한 낮은 성분의 이동율(R_f' value)의 평균은 0.136±0.122이었다.

결론 : 藥材의 pH는 모두 7보다 낮은 약산성이었으며, 약재의 휘발 성분 및 수분 함유량은 대략 10~50%정도를 나타내었다. 유기물함량은 대략 80~95%정도를 나타내었다. 전기전도도를 통하여 山藥이나 甘草는 이온성 물질을 많이 포함하고 있으리라 추정된다. *(J Korean Oriental Med 2002;23(1):61-66)*

Key Words: sweet flavor, physicochemical properties, herbal medicine, pH, weight loss, TLC.

INTRODUCTION

A medicine is used to control physiological reaction strongly or weekly in the human body.

In a korean medicine, a doctor makes different diagnosis about disease, and then prescribes appropriate

· 접수 : 2001년 9월 29일 · 채택 : 11월 28일
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flavors of medicinal herb[1].

The flavor of medicine is not only the thing tasted by a taste cell in the mouth, but also have the physiological function controlling and balancing the human body. And it is closely related to the five parenchymatous viscera and six hollow viscera in the cure and prevention of a diseased body[1].

The sweet flavor has the function invigorating, harmonizing and relieving the body. Invigoration is tonifying action. Therefore the sweet flavor has been used as cure deficiency. For example, Ginseng Radix(人蔘) and Astragali Radix(黃芪) are used to invigorate the vital energy as the sweet and warm drugs. Adenophorae Radix(沙參), Liriopis Tuber(麥門冬) and Dendrobii Herba(石斛) are used to promote the production of the body fluid and to cure asthenia syndrome as sweet and cold drugs. Relieving and harmonizing the body mean the function regulating the middle-warmer, coordinating the action of various ingredients in a prescription and relieving spasm, pain and the toxicity of medicinal matters. For example, Glycyrrhizae Radix(甘草) has the functions of the regulation of the middle-warmer, reduction of the spasm and pain, moderation of extremely cold or dry property, and the removal of toxic substances. Therefore, it can cure gastric abdominal pain, muscular contraction of the extremities and food poisoning. Further, Glycyrrhizae Radix(甘草), Jujubae Fructus(大棗) and Mel(蜂蜜) are used to coordinate the actions of various ingredients and moderate extremely cold or dry property of a drug in a prescription mixed with many medicinal matters together.

A sweet flavor generally has the function moistening the lung, eliminating the phlegm and loosening the bowel to relieve constipation[2]. For example, Trichosanthis Semen(瓜蔞) and Fritillariae Cirrhosae Bulbus(貝母) are used to moisten the lung and eliminate the phlegm. Cannabis Semen(火麻仁) and Mel(蜂蜜) are used to loosen the bowel to relieve constipation.

A sweet flavor has abilities relaxing muscle and tendons, restoring hunger and fatigue, loosing the bowels, making origination, moving upward, invigorating the vital energy, removing toxic substance, abirritating the symptom and promoting the production of the body fluid to quench thirst in the human body[1].

Five kinds of flavor of medicinal herbs and their ingredients have close relationships with the effect of a medicine. So it is predicted that a medicine of sweet flavor contains anyone of carbohydrate, derivative and protein, and has the functions of nutrition, robustness, urination, heart stimulant and promotion of breast milk[3,4].

A study of the physicochemical properties about five kinds of flavors of medicinal herbs has been made by Zhao[5] who investigated the relationships between five kinds of flavors and their ingredients and then found sweet flavors had correlation with sugars, by Li[6] who described the component ratio of herbal medicines and attributive channels comparatively, by Wang[7] who studied about the relationship between five kinds of flavors and the inorganic components and reported the medicine of sweet flavor contained a high percentage of lithium.

It is possible to predict and define the effect of herbal medicines throughout the theoretical basis and physicochemical property. To find the method predicting the effect of medicines, the writer chose the medicines having conventional properties of sweet flavors, which is mentioned in The Standard Explanatory Note of Herbal Medicine in the Korean Pharmacozpoeia and the Others[8], and studied the physicochemical measuring method about sweet flavors and drew significant conclusions.

MATERIALS AND METHODS

1. Materials

Herbal medicines were selected by The Standard

Explanatory Note of Herbal Medicine in the Korean Pharmacopoeia and the Others[8]. They were bought in Kyung-dong market(Jeji-dong, Dongdaemungu, Seoul), carefully selected by sensory test for good quality, pulverized the size of 20 meshes and below and then used for this experiments(Table 1).

The reagents prepared were Acetone and $CHCl_3$ (99%, Samchunsa, Korea), methanol(100%, J. T. Baker Inc., U.S.A), dichloromethane(99%, Matsunoen Chemical Inc., Japan), ethyl-acetate(99.5%, Kanto Chemical Inc., Japan). Aluminium sheets for analysis of TLC were used as silica gel 60 F245 and silica gel 60(Merck Inc., Germany).

The apparatus used for analysis were pH meter of Model 750P(Istek Inc., Korea), UV-Visible spectrophotometer of Cary 50 probe(Varian, U.S.A.), stirrer/hot plate of PC-420(Corning, U.S.A.), furnace of Model 62700(Thermolyne Inc., U.S.A.), ohmmeter of Fluke 83(John fluke mfg., U.S.A.), UV light of ENF-240C(Spectoline Inc., U.S.A.), grinder of RT-08(Rong tsong Inc., Taiwan).

2. Methods

Since herbal medicines have been clinically used as water extracts, each sample was extracted by boiling down both exact 1.00g of a herbal medicine and 10 ml of distilled water for 2 hours, and then cooled in normal temperature for 1 hour to measure pH and electric conductivity.

To measure the weight loss, two samples of 1.00g of each herbal medicine were put in a vaporization dish. One was heated at 200℃ for 2 hours, and the other at 550℃ for 15 minutes.

For electric conductivity, two plates of Cu which had 1 cm^2 of area and the 1 cm of the space with each other were prepared.

To measure UV-spectrum, water extracts were prepared by boiling down with 0,5g of herbal medicine and 10mL of distilled water, filtrated and diluted as one sixtieth to get a appropriate range of absorbance.

To spot on TLC plate, each sample was extracted with 1.00 g of a herbal medicine and 20 mL of methanol for 2 hours in a close bottle, evaporated in a open plate, and melted mixed liquid with 2 :1 : 0.5 ratio (V/V) of dichloromethane : methanol : ethyl acetate. The spreading solvent was mixed liquid with 3 : 3 : 1 : 1 ratio (V/V) of dichloromethane : butanol : methanol : distilled water. The position of ingredients was determined by optical test and UV light. R_f was the ratio for the spot of the deepest and widest color, R_f' was the ratio for the lowest spot.

All results were expressed as mean±standard error.

Table 1. The Herbal Medicines Used in the Experiments

Flavor	Herbal Medicine Name
Sweet (甘味)	*Adenophorae Radix*(沙參, AdR)
	Astragali Radix(黃芪, AsR)
	Biotae Semen(柏子仁, BiS)
	Dioscoreae Rhizoma(山藥, DiR)
	Glycyrrhizae Radix(甘草, GlR)
	Jujubae Fructus(大棗, JuF)
	Longan Arillus(龍眼肉, LoA)
	Lycii Fructus(枸杞子, LyF)
	Lycii Radicis Cortex(地骨皮, LyC)
	Mori Radicis Cortex(桑白皮, MoC)
	Plantaginis Semen(車前子, PlS)
	Polygonati Rhizoma(黃精, PoR)
	Rehmanniae Preparata Radix(熟地黃, ReR)
	Typhae Pollen(蒲黃, TyP)

Table 2. The Values of pH for the Water Extracts of Herbal Medicines

Flavor	pH (Z)					
Sweet	**5.24 ± 0.56** *					
	AdR	4.64	(-1.07)	LyC	5.85	(1.10)
	AsR	5.66	(0.76)	LyF	4.88	(-0.64)
	BiS	5.39	(0.27)	MoC	5.16	(-0.14)
	DiR	5.49	(0.45)	PlS	5.88	(1.15)
	GlR	5.44	(0.36)	PoR	4.47	(-1.37)
	JuF	5.15	(-0.15)	ReR	4.36	(-1.57)
	LoA	4.76	(-0.85)	TyP	6.18	(1.69)

See the Table 1 for the abbreviation of herbal medicines.
* Mean ± Standard Error.

And standard normal distribution was used for comparison and analysis of results to reduce the error caused by difference of experimental methods.

RESULTS AND DISCUSSIONS

1. pH measurement

pH meter were used for this experiment. It is known that liquid is acid in pH 7 and below at 25℃. And acid liquid contains some of acetic and sulfonic radicals, salts of double bond or conjugation, nonmetallic compounds and so on[9].

Rehmanniae Preparata Radix(ReR) had the lowest value of 4.36 and Typhae Pollen(TyP) had the highest value of 6.18 in pH measurement. The mean of pH was 5.24±0.56. The standardized value of Mori Radicis Cortex(MoC), -0.14 was the closest to zero, that of Typhae Pollen(TyP), 1.69 was the furthest(Table 2). All herbal medicines of sweet flavor were in acid conditions of pH 7 and below.

2. The measurement of weight losses

The weight loss was measured to investigate the water content and volatile components in the condition of heating at 200℃. The weight loss was the lowest as 310 mg/g in Typhae Pollen(TyP) and the highest as 491 mg/g in Jujubae Fructus(JuF). The mean and standard error of weight loss was 288± 125 mg/g. The standardized value of Glycyrrhiza Radix(GiR), -0.105 was the closest to zero, that of Jujubae Fructus(JuF), 1.619 was the furthest(Table 3).

All herbal medicine of sweet flavor had the weight loss in the range of 10 and 50 %.

The weight loss was measured to find the contents of water and organics, and possibility of decomposition at 550 ℃10).

The weight loss presented as the lowest value, 471mg/g in Typhae Pollen(TyP) and the

highest one, 920mg/g in Rehmanniae Preparata Radix(ReR). Mean and standard error was 846±116 mg/g. Standardized value showed the closest to zero as -0.052 in Longan Arillus(LoA), the furthest as -3.240 in Typhae Pollen(TyP)(Table 4). The weight loss was in the range of 80 and 95 percentage except Astragali Radix(AsR).

3. The measurement of electric conductivities of water extracts

Electric conductivities were measured to find the ionic strength, which was the ability to carry the current[11].

The electric conductivity was the lowest as 1.553 S/cm in Astragali Radix(AsR) and the highest as 2.646 S/cm in Dioscoreae Rhizoma(DiR). The mean and

Table 3. The Weight Losses of Herbal Medicines Dried at 200℃

Flavor	Weight Loss at 200 ℃ (Z) (unit : mg/g)					
Sweet	**288 ± 125 ***					
	AdR	387	(0.789)	LyC	227	(-0.488)
	AsR	216	(-0.576)	LyF	377	(0.709)
	BiS	167	(-0.967)	MoC	165	(-0.983)
	DiR	220	(-0.544)	PlS	154	(-1.071)
	GlR	258	(-0.241)	PoR	386	(0.781)
	JuF	491	(1.619)	ReR	389	(0.805)
	LoA	476	(1.499)	TyP	121	(-1.334)

See Table 1 for the abbreviation of herbal medicines.
* Mean ± Standard Error.

Table 4. The Weight Losses of Herbal Medicines Volatilized at 550℃

Flavor	Weight Loss at 550℃ (Z) (unit : mg/g)					
Sweet	**846 ± 116 ***					
	AdR	868	(0.182)	LyC	758	(-0.766)
	AsR	904	(0.492)	LyF	831	(-0.137)
	BiS	883	(0.311)	MoC	883	(0.311)
	DiR	886	(0.337)	PlS	884	(0.320)
	GlR	913	(0.569)	PoR	884	(0.320)
	JuF	919	(0.621)	ReR	920	(0.630)
	LoA	853	(0.052)	TyP	471	(-3.240)

See Table 1 for the abbreviation of herbal medicines.
* Mean ± Standard Error.

standard error of weight loss was 1.890±0.372 S/cm. The standardized value of Mori Radicis Cortex(MoC), -0.283 was the closest to zero, that of Dioscoreae Rhizoma(DiR), 2.027 was the furthest(Table 5). It is suggested that Dioscoreae Rhizoma(DiR) and Glycyrrhizae Radix(GlR) contain the more ionic compounds than others.

4. The measurement of UV-Visible spectrum

Absorbance of each herbal medicine was measured to investigate chemical concentrations using UV-Visible spectrometer. Electro-wavelength is absorbed passing substances. Specially, the absorbance of ultraviolet and visible rays happens to substances having the electron dropped easily(π or n electron)[11].

From this experiment, n→π^* was found in the range of 272 and 333nm, π→π^* in the range of 204 and 270nm. The ratio of absorbance(π→π^*/n→π^*) was the lowest as 1.411 in Glycyrrhizae Radix(GlR) and the highest as 4.02 in Lycii Radicis Cortex(LyC). The mean of ratio was 3.043±0.679. The standardized value of Typhae Pollen(TyP), -0.081 was the closest to zero, that of Glycyrrhizae Radix(GlR), -2.401 was the furthest(Table 6).

5. Thin layer chromatography of herbal medicines

1) The retention factor of major components (R_f value)

TLC analysis was conducted for classification of components. The R_f presented as the lowest value 0.041 in Astragali Radix(AsR) and the highest one, 0.979 in Rehmanniae Preparata Radix(ReR). Mean and standard error was 0.553±0.317. The standardized value showed the closest to zero as -0.059 in Plantaginis Semen(PlS), the furthest as -1.731 in Jujubae Fructus(Table 7).

2) The retention factor of the component measured at the lowest area (R_f' value)

The R_f' was the lowest as 0.024 in Longan Arillus(LoA) and the highest as 0.467 in Biotae Semen(BiS). The mean of weight loss was 0.136± 0.122 S/cm. The standardized value of Typhae Pollen(TyP), -0.083 was the closest to zero, that of Biotae Semen(BiS), 2.722 was the furthest(Table 8).

Table 5. The Electric Conductivities for the Water Extracts of Herbal Medicines

Flavor	Electric Conductivity (Z) (unit : S/cm)				
Sweet	**1.891 ± 0.372 ***				
	AdR	1.655	(-0.632)	LyC	2.146 (0.685)
	AsR	1.552	(-0.908)	LyF	1.656 (-0.632)
	BiS	1.587	(-0.816)	MoC	1.786 (-0.283)
	DiR	2.645	(2.027)	PlS	1.783 (-0.291)
	GlR	2.571	(1.826)	PoR	1.634 (-0.690)
	JuF	2.173	(0.760)	ReR	1.600 (-0.782)
	LoA	1.587	(-0.816)	TyP	2.096 (0.552)

See Table 1 for the abbreviation of herbal medicines.
* Mean ± Standard Error.

Table 6. The Absorbance Ratios of n→π^* to π→π^* Measured by UV-Visible Spectrometer for Herbal Medicines

Flavor	Absorbance Ratio (Z)				
Sweet	**3.043 ± 0.679 ***				
	AdR	3.341	(0.439)	LyC	4.026 (1.447)
	AsR	3.776	(1.078)	LyF	-
	BiS	3.463	(0.618)	MoC	3.213 (0.250)
	DiR	-		PlS	2.688 (-0.522)
	GlR	1.411	(-2.402)	PoR	3.193 (0.220)
	JuF	3.105	(0.091)	ReR	2.371 (-0.990)
	LoA	2.944	(-0.146)	TyP	2.988 (-0.082)

See Table 1 for the abbreviation of herbal medicines.
* Mean ± Standard Error.

Table 7. The Retention Factors of the Major Components Measured by TLC for Herbal Medicines

Flavor	R_f (Z)				
Sweet	**0.554 ± 0.317 ***				
	AdR	0.103	(-1.424)	LyC	0.317 (-0.747)
	AsR	0.587	(0.105)	LyF	0.205 (-1.102)
	BiS	0.689	(0.427)	MoC	0.762 (0.657)
	DiR	0.308	(-0.777)	PlS	0.535 (-0.059)
	GlR	0.932	(1.194)	PoR	0.739 (0.585)
	JuF	0.042	(-1.617)	ReR	0.979 (1.342)
	LoA	0.976	(1.334)	TyP	0.580 (0.083)

See Table 1 for the abbreviation of herbal medicines.
* Mean ± Standard Error.

Table 8. The Retention Factors of the Component Measured at the Lowest Area by TLC for Herbal Medicines

Flavor	R_f' (Z)					
Sweet	**0.136 ± 0.122** *					
	AdR	0.103	(-0.271)	LyC	0.098	(-0.312)
	AsR	0.174	(0.315)	LyF	0.205	(0.567)
	BiS	0.467	(2.722)	MoC	0.095	(-0.331)
	DiR	0.308	(1.415)	PlS	0.060	(-0.621)
	GlR	0.091	(-0.367)	PoR	0.065	(-0.578)
	JuF	0.042	(-0.772)	ReR	0.043	(-0.765)
	LoA	0.024	(-0.919)	TyP	0.125	(-0.083)

See Table 1 for the abbreviation of herbal medicines.
* Mean ± Standard Error,

CONCLUSION

This study was conducted to investigate the physicochemical properties of sweet flavors of oriental herbal medicines.

The results were as follows:

1. All water extracts of sweet flavors were in acid condition of pH 7 and below, and the mean and standard error of them was 5.24±0.56.

2. The water content and volatile components of each herbal medicine was in the range of 10 and 50 percentage with the mean and standard error, 288±125 mg/g as the result of heating experiment at 200℃. And the water and organic content was in the range of 80 and 95 percentage with the mean and standard error, 867±116 mg/g at 550℃.

3. The mean and standard error of electric conductivities was 5.46±0.93 S/cm. And it is found that Dioscoreae Rhizoma and Glycyrrhizae Radix contained more ionic compounds than others.

4. The mean and standard error of absorbance ratio by transition of electron was 3.043±0.679.

5. The mean and standard error of retention factors for major components was 0.553±0.317, and that of retention factor for the component measured at the lowest area was 0.136±0.122.

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