A REVIEW OF CHRYSANTHEMUM, THE EASTERN QUEEN IN TRADITIONAL CHINESE MEDICINE WITH HEALING POWER IN MODERN PHARMACEUTICAL SCIENCES

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Abstract. Chrysanthemum is famous as the Queen of the East grown mainly in China and Japan. Chrysanthemum is the second most important plant in both the ornamental industry and traditional Chinese medicine. The most important chemical extracts of Chrysanthemum include flavonoids, betaine, choline and vitamin B1. Thirteen important compounds of chrysanthemum flowers are acacetin-7-0-beta-D-glucopyranoside, luteolin, luteolin-7-O-beta-D-glucopyranoside, acaciin, acacetin 7-0-(6$^{//}$-0-alpha-L-rhamnopyranosyl)-beta-sophoroside, 3-0-caffeoylquinic acid, syringaresinol 0-beta-D-glucopyranoside, 5,7-dihydroxychromone, uracil, p-gydroxybenzoic acid, 4-0-beta-D-glucopyranosyloxybenzoic acid, boscialin and blumenol A. The most outstanding health benefits of chrysanthemum tea are easing stress and anxiety, improving cardiovascular health, protect against oxidative damage, inhibit inflammation, support healthy immune function, improve eye health and lower risk for osteoporosis. In traditional Chinese medicine, chrysanthemum is a cold herb which helps dispel pathogenic heat, helps the liver, improves eyesight and aids detoxification. To conclude, treatment with natural Chinese herbal medicine especially chrysanthemum, non-synthetic drug is recommended for an organic life.
Keywords: *health benefits, Asian medicinal science, western pharmaceutical science, herbal medicine, silk road*

Introduction

Traditional Chinese medicine is a system of medicine based on acupuncture, acupressure, Chinese herbs, cupping, diet and moxibustion (Soleymani and Shahrajabian, 2012, 2018; Ogbaji et al., 2018; Shahrajabian et al., 2018, 2019a, b, c). Traditional medicine refers to health practices, knowledge, approaches and beliefs incorporating plants and herbs based on both ancient and modern pharmaceutical science (Sharajabian et al., 2019d, e, f, 2020). Chrysanthemum with high ornamental value is a one of the ten most popular traditional flowers in China and one of the most popular cut flowers in the world (Sun et al., 2011; Wang et al., 2014; Chung et al., 2018). Wang et al. (2014) stated that there are more than 20,000 chrysanthemum cultivars in the world and about 7,000 cultivars in China. The objective of this review is survey on some important modern and ancient pharmaceutical sciences of chrysanthemum.

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Materials and methods

All relevant papers in the English language of researchers from different countries were collected. The keywords of chrysanthemum, traditional Chinese medicine, traditional Asian medicine, modern pharmaceutical science, health benefits and western medicine were searched in Google Scholar, Scopus, Research Gate and PubMed.

Results and discussion

Chrysanthemum occurrence and cultivation

In Chinese culture, ancient Chinese scholars consider chrysanthemum as a symbol of nobility and integrity and long prized by ordinary people for its medicinal properties. Teixeria (2003) mentioned that, chrysanthemum is the world's second most economically important floricultural crop, following rose. In China, it is found most often in Zhejiang, Anhui, Henan and Sichuan provinces. Imtiaz et al. (2019) also noted that chrysanthemum is native to China and was first cultivated as a flowering herb back in the 15th century BC, and it was believed that this plant had the power of life. Chrysanthemum is famous as Queen of the East, and also known as autumn flower (Saicharan et al., 2017). In traditional Chinese medicine, chrysanthemum provides mildly cold energy, and it has special affinity to the energy channels that lead to the lungs, liver, spleen and kidneys. Chrysanthemum tea is an herbal infusion made from the dried flowers of the chrysanthemum plant in ancient China, and it was used as an herbal remedy in traditional Chinese medicine (TCM) as early as 1500 B.C. Its petals consumed in the form of a salad has the perception of causing longevity. *Chrysanthemum* commonly called as gul-e-daudi or golden flower autumn queen has been cultivated for more than 2000 years ago in Iran. It belongs to the family of Asteraceae, and it behaves both as an annual as well as perennial flowering crop (Kalia, 2015). It is the world's second most important floricultural crop only after Rose (Kalia, 2015). The National Chrysanthemum Society of Britain lists over 600 cultivars of this plant (Datta, 2013). Klie et al. (2014) has shown that chrysanthemum is a segmental allohexaploid with an ambiguous pattern of inheritance. Chrysanthemums require well-drained soil and full sunlight to grow and successfully bloom. Plants grown with less light will become weak, spindly and produce few flowers. Chrysanthemums are shallow rooted and do best if planted high, which means that frequent watering may be necessary during times of high heat and little rainfall. The best defense against adverse weather conditions is to provide good drainage so that water does not accumulate around the plants and promote ice formation. Cicek Atikmen et al. (2014) found that 12.5% fresh mushroom compost and 25% exhausted mushroom compost were the best ratios for cultivation of chrysanthemum. Chrysanthemum white rust (CWR) is one of the primary diseases on chrysanthemum which has been considered as a quarantine disease in many countries (Dong et al., 2018). List of some chrysanthemum varieties is presented in *Table 1*. Qualitative characters of 20 genotypes of chrysanthemum is shown in *Table 2*. Genotypes of *C. morifolium* is shown in *Table 3*. Performance of chrysanthemum genotypes for vegetative characters is presented in *Table 4*. Length of flowering, diameter of flowering stem, diameter of flower bud, diameter of most open inflorescence, plant height, and number of inflorescences per pot of chrysanthemum is presented in *Table 5*. Phytochemical characteristics evaluated in chrysanthemum plants (average of three cultivars) with and without application Si is shown in *Table 6*. Chukki

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et al. (2018) indicated that *Chrysanthemum indicum* flower has the potential for Congo red dye reduction from aqueous solution. A number of disease plague chrysanthemus, are Septoria Leaf Spot, Powdery Mildew and virus diseases such as mosaic and stunt or virus-like diseases such as aster yellows. A number of insects such as Aphids, Caterpillars, Leafhoppers, Leaminers, Plant Bugs and Spider Mites may hurt the crops. Chrysanthemums cultivars reveal amazing colours, shapes types of inflorescence and a varied growth (Carvalho-Zanao et al., 2012). Plants are generally raised through suckers and terminal cuttings. It has been said that micro propagation to be very efficient technique for the fast and disease free raising of *Chrysanthemum* plants (Kalia, 2015). Cojocariu et al. (2018) noted that knowing the particular architecture can improve the correct application of chrysanthemum culture technologies as properly positioning of the crops into the appropriate fertility plots, adequate application of fertilizers, and mechanical maintenance of chrysanthemum crops in order to protect the root system of the plants. Yasemin et al. (2017) reported that flower diameters, disc florets, number of flowers, shoot height, root collar thickness, root and shoot fresh weights were negatively affected in 150 and 200 mM NaCl treatments. Liu and Xiao (2018) reported that fourteen compounds were isolated and identified as stigmata-4-ene-3-one (1), calenduladiol-3β-O- palmitate (2), 16β,22α-dihydroxypseudotaraxasterol-3β-O-palmitate (3), α-amyrin (4), urs-12-ene-3β,16β-diol (5), 3β-hydroxyurs- 12-ene-11-one (6), arnidiol (7), maniladiol (8), 3β-hydroxyolean-12-ene-11-one (9), luteolin (10), apigenin (11), apigenin-7,4'- dimethyl ether (12), genkwanin (13), and 1-linoleic acid glycerate (14). Carvalho-Zanao et al. (2012) reported that silicon has promoted improvements both in quantitative and qualitative aspects when supplied to some ornamental species produced in these conditions. Lee and Van Iersel (2008) found that saline water may be more readily available and can have the added benefit of reduced plant height, which is an important quality characteristic for floriculture crops such as chrysanthemum. The effect of growth substrates over the nutrients of *chrysanthemum* plant is shown in *Table 7*. The effect of growth substrates over the nutrients of chrysanthemum plant is presented in *Table 8*. Germination rate of seeds is shown in *Table 9*. Kalia (2015) indicated that *Chrysanthemum* can be multiplied in large scale through micro propagation using right concentration of the auxins. She clearly indicates that the above problems can be minimized by micro propagation of *Chrysanthemum*.

Table 1. *List of some chrysanthemum varieties (Kumar et al., 2014)*

Cultivars	Cultivars
Kanchil	Pusa Anmol
Glumohr	Yellow Bangla
Shayamal	Sharad Mala
Sadwin Yellow	Star White
White Andaman	TERI
Aparjita	Poornima White
Sadbhawna	Waters May
Flirt	Beauty
Neelima	Jubilee
White Prolific	Maghi Orange
Ravikiran	Maghi White
Birbal Sahni	Maghi Yellow
Shukla	Kalvin Orange

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Yellow Charm	Diana
Pink Cloud	Pankaj
Kajole	Kalvin Pink
Gaity	Sonali Tara
Geetanjali	Mother Teressa
Star Pink	Pinked White
Korean Small	Gajra
Yellow Star	Santa Dine
Ajay	Red Shringar
Meghavi	Shwet Shringar
Yellow Gold	White Anemone
Lalpari	Mahatma Gandhi
Red Gold	Raja Orange
Vasantika	Tokyo Soldier
Kundan	Korean Small
Kargil	Kalvin Yellow
Shanti	Greenish White
Taichen Queen	Ajay
Star Yellow	Texas Gold
Snowball	Yellow Reflex
President Viger	Golden Yellow
Jayanti	Red D spoon
Dolly Orange	Annual Chrysanthemum
Liliput	Annual Chrysanthemum
FDL	

Table 2. *Qualitative characters of 20 genotypes of chrysanthemum (Prakash et al., 2018)*

Genotypes	Flower colour	Disc colour	Type of flower
Thai Chin Queen	Orange	*	Double
Pusa arunoday	Pink	Yellow	Double
Yellow charm	Yellow	Yellow	Semi-double
Pusa sona	Yellow	Yellow	Semi-double
Pusa centenary	Yellow	*	Double
Pusa aditya	Yellow with orange center	Orange	Semi-double
Sunny	Blood red	*	Double
Pusa kesari	Saffron	*	Double
Sadbhavana	Dark orange	Yellow	Semi-double
Lalith	White	*	Double
Ajay	Pink	*	Double
Pusa Chitraksha	Deep magenta	Yellow	Semi-double
Basanthi	Yellow	Yellow	Semi-double
Ramlal dada	Yellow	*	Single
Haldighati	Dark yellow	*	Double
Star white	White	*	Double
Lal pari	Red	Yellow	Semi-double
Jaya	White	*	Double
Ajay orange	Orange	*	Double
Lilyput	Yellow	*	Double

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Table 3. *Genotypes of C. morifolium (Kaur et al., 2018)*

Plant tag no.	Genotypes name	Color	Plant tag no.	Genotypes name	Color
V1	Aparajita	Yellow	V9	Celtic	Green
V2	Fortune	White	V10	Paiwer-W	White
V3	Anastasia	White	V11	HF-164	Yellow Purple
V4	Charlia	Purple Yellow	V12	Paladov Dark	Orange
V5	Vanilla Sorbet	Cream	V13	Tocovar-6	Red
V6	Paladov Sunny	Yellow	V14	Papaya	Orange
V7	White Double	White	V15	Cologne	White
V8	Braca Splendid	Magenta			

Table 4. *Performance of chrysanthemum genotypes for vegetative characters (Kaur et al., 2018)*

Population No.	Genotypes	Plant spread (cm)	No. of branches per plant	No. of leaves per plant	No. of flowers per stem	No. of flowers per cut flower	Flower size (cm)
V1	Aparajita	26.06	13.66	156.33	4.73	55.44	3.73
V2	Fortune	31.86	15.06	140.93	5.46	60.34	5.73
V3	Anastasia	17.86	7.53	51.00	4.33	27.33	5.43
V4	Charlia	22.40	18.46	252.73	4.46	52.38	3.28
V5	Vanilla Sorbet	12.13	10.06	73.93	2.60	23.80	3.92
V6	Paladov Sunny	16.26	11.26	82.13	2.86	31.74	2.59
V7	White Double	23.80	13.26	156.00	4.26	46.16	5.71
V8	Braca Splendid	21.26	9.46	75.40	3.53	34.13	5.15
V9	Celtic	21.00	6.20	57.46	4.26	26.11	3.04
V10	Paiwer-W	23.66	9.33	98.33	4.60	43.93	5.11
V11	HF-164	20.93	8.06	72.00	2.93	21.74	5.13
V12	Paladov Dark	13.66	6.00	34.66	2.20	20.53	4.58
V13	Tocovar-6	23.00	12.00	145.40	3.13	38.87	5.05
V14	Papaya	19.40	10.13	99.46	3.06	38.88	5.21
V15	Cologne	18.73	9.40	77.86	2.13	19.78	4.93
C.D. at 5% level of significance		3.63	3.29	5.58	1.56	1.99	0.17

Table 5. *Length of flowering (LFS), diameter of flowering stem (DFS), diameter of flower bud (DFB), diameter of most open inflorescence (DI), plant height (PH), and number of inflorescences per pot (NI) of chrysanthemum cultivar (Carvalho-Zanao et al., 2012)*

Cultivar	PH (cm)	DI (cm)	LFS (cm)	DFS (cm)	DFB (cm)	NI (unit/pot)
Coral Charm	55.35a	5.15c	44.94a	44.94a	0.99a	22.50c
White Reagan	56.31a	6.87b	45.09a	45.09a	1.01a	29.17a
Indianapolis	48.67b	7.81a	41.10a	41.10a	1.16a	24.50b
CV (%)	6.42	3.85	6.51	6.51	6.34	15.15

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Table 6. *Phytochemical characteristics evaluated in chrysanthemum plants as a function of the application of Si (average of three cultivars) (Carvalho-Zanao et al., 2012)*

Variables	Without Si	With Si	CV (%)
Length of flowering stem (cm)	39.99a	39.22a	7.42
Diameter of flowering stem (cm)	0.38a	0.37a	6.51
Diameter of flower bud (cm)	1.00a	1.03a	6.34
Diameter of the most open inflorescence (cm)	6.65a	6.58a	3.85
Height of plant (cm)	48.73a	49.45a	6.42
Number of inflorescences per pot	25.11a	25.67a	15.15
Production of root dry matter (g)	2.88a	2.87a	20.60
Production of leaf dry matter (g)	7.36a	6.86a	14.49
Production of stems dry matter (g)	11.36a	11.50a	15.57
Production of inflorescence dry matter (g)	7.62a	7.49a	19.58
Production of dry matter of the shoots (g)	26.34a	25.84a	11.16
Cycle (days)	88.54a	88.50a	7.55
Shelf life (days)	26.89a	27.00a	6.21

Averages followed by distinct letters different significantly among each other by Turkey's test, $p < 0.05$

Table 7. *The effect of growth substrates over the nutrients of chrysanthemum plant (Cicek Atikmen et al., 2014)*

Growth substrates	Total N (%)	Total P (%)	Total K (%)	Total Na (ppm)	Total Ca (%)
100% P	4.04^{ns}	1.07A	6.36^{ns}	695^{ns}	1.81E
12.5% FMC + 87.5% P	3.90	0.79CD	7.14	513	2.01CDE
25% FMC + 75% P	3.84	0.87BC	6.81	581	1.86DE
50% FMC + 50% P	3.62	0.66D	6.55	739	2.48AB
12.5% FMC + 25% Perlite + 62.5% P	3.98	0.80CD	6.68	705	2.07BCD
25% FMC + 25% Perlite + 50% P	3.83	0.79CD	7.27	607	2.31ABC
50% FMC + 25% Perlite + 25% P	3.75	0.84BCD	7.20	597	2.44AB
12.5% EMC + 87.5% P	3.71	0.93ABC	6.82	784	2.25ABCD
25%EMC + 75% P	3.91	0.95ABC	6.70	619	2.19ABCDE
50% EMC + 50% P	3.81	0.93ABC	6.83	526	2.57A
12.5% EMC + 25% Perlite + 62.5% P	3.80	1.07A	7.05	614	2.57A
25% EMC + 25% Perlite + 50% P	3.91	1.09A	6.75	599	2.26ABCD
50% EMC + 25% Perlite + 25% P	3.84	1.00A	7.20	579	2.34ABC

ns: non-significant, $p < 0.01$. P = Peat, FMC = Fresh MC, EMC = Exhausted MC

Table 8. *The effect of growth substrates over the nutrients of chrysanthemum plant (Cicek Atikmen et al., 2014)*

Growth substrates	Total Mg (%)	Total Fe (ppm)	Total Mn (ppm)	Total Zn (ppm)	Total Cu (ppm)
100% P	1.00A	701A	96BC	144BC	17A
12.5% FMC + 87.5% P	0.86CD	405CD	88BC	166B	14BC
25% FMC + 75% P	0.84D	354D	103BC	100C	15ABC
50% FMC + 50% P	0.94ABC	306D	136A	49D	14C
12.5% FMC + 25% Perlite + 62.5% P	0.90BCD	463BCD	90BC	48D	15ABC
25% FMC + 25% Perlite + 50% P	0.92ABCD	505BCD	86.29C	156B	14C
50% FMC + 25% Perlite + 25% P	0.95ABC	464BCD	118AB	224A	16ABC
12.5% EMC + 87.5%P	0.95ABC	566ABC	101BC	175B	16ABC
25%EMC + 75%P	0.92ABCD	659AB	92BC	156B	16ABC
50% EMC + 50% P	0.95ABC	702A	81C	161B	14C
12.5% EMC + 25% Perlite + 62.5%P	0.98AB	495BCD	99BC	160B	15ABC
25% EMC + 25% Perlite + 50% P	0.97AB	466BCD	81C	155B	16ABC
50% EMC + 25% Perlite + 25%P	1.01A	474BCD	93BC	170B	17AB

ns: non-significant, $p < 0.01$. P = Peat, FMC = Fresh MC, EMC = Exhausted MC

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Table 9. *Germination rate of seeds (Wang et al., 2014)*

Cultivars	Seed germination rate (%)
QX-081	0
QX-006	0
QX-003	0
Q10-33-2	66.7 ± 8.3
Nannongxiangbin	0
Nannonghongcheng	57.1 ± 6.5
QX-001	66.7 ± 4.7
Nannongjinhe	27.5 ± 4.5
Q10-33-1	23.9 ± 4.3

Values given are mean ± standard deviation

Medicinal uses and potential health benefits in traditional and modern medicine industry

In traditional Chinese medicine (TCM), chrysanthemum flowers are plants that belong to the Cool/Acrid herbs that release the exterior category. Herbs which release the exterior aim to treat the early stages of diseases that affect the upper respiratory tract, the eyes, the ears, the nose, the throat or the skin. In some Eastern cultures, chrysanthemums are also a symbol of good luck, wealth, happiness, and longevity. In Chinese medicine, chrysanthemums are a versatile herb called Ju Hua. In Chinese traditional medicine, Ju Hua is considered to be a fragrant, cool, and light herb. Also, it is used for cooling heat in the liver channel, especially when it manifests as dry, red or painful eyes. Yang et al. (2019) discovered that the *Chrysanthemum morifolium* flower is widely used in China and Japan as a food, beverage, and medicine for many diseases. Chrysanthemum tea is naturally caffeine-free which makes it a great alternative to drinks containing caffeine like black tea and coffee. It has been reported that *Chrysanthemum morifolium* has many antioxidant activities including resisting fatigue, improving the function of cardiovascular system, and lowering the levels of serum lipid (Wang and Xiao, 2013; Yu et al., 2013). The healing benefits of *Chrysanthemum morifolium* are closely related to the composition and content of phenolic compounds (Liu et al., 2013), and apigenin-7-O-glucoside is one of the most active phenolic compounds in chrysanthemum flowers (Wang et al., 2018). Sassi et al. (2008) found that chrysanthemum acts as an antibiotic against a variety of pathogens. Marongiu et al. (2009) reported that the extract of a fresh plant can be applied to skin infections. Liang Yu et al. (2010) and Michalowska and Lema-Ruminska (2018) reported that chrysanthemums have many health-promoting properties used in medicine. Bose et al. (2003) found that chrysanthemum s boiled roots were used as a headache remedy, young sprouts and petals were eaten as salad and leaves were brewed for a festive drink. Chrysanthemum has aesthetic values, antigenotoxic, antioxidative and antimutagenic properties. 13 different types of Chrysanthemums are: Single blooms, Quilled blooms, Spider blooms, Anemone, Pompons, Decorative blooms, Reflex and Incurve blooms, Reflex mums, Brush or Thistle Chrysanthemums, Unclassified, Spoon mums, Cushion mums and Miscellaneous mums. Terpenes concentrations used for sensory analyses is shown in *Table 10*. Compounds identified from Chrysanthemum morifolium Huangju by UHPLC-Q-TOF-MS is presented in *Table 11*. Antioxidant activities of apigenin-7-

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O-glucoside, apihenon and glucose is shown in *Table 12*. The chemical compositions of Chrysanthemum essential oil (CHEO) is presented in *Table 13*. Essential oil composition of *Chrysanthemum cinerariifolium* is shown in *Table 14*. Some health benefits of chrysanthemums are for allergies, hypertension (high blood pressure0, tightening of the chest, anxiety, skin conditions such as boils, vertigo, eyes that are inflamed, headaches, sore throats, colds and tinnitus. The health benefits of chrysanthemum is shown in *Table 15*. The most important health benefits of chrysanthemum tea is presented in *Table 16*. Samples and origins of the studies *Chrysanthemum morifolium* tea from China is shown in *Table 17*. Common traditional Chinese medicine formulas in which chrysanthemum flowers are used is shown in *Table 18*.

Table 10. *Terpenes concentrations used for sensory analyses (Niu et al., 2018)*

Terpenes	Concentration (mg/L)
α-pinene	3083
Camphene	2780
β-pinene	355
β-myrcene	787
α-phellandrene	523
dl-limonene	8192
Cis-ocimene	53
α-terpinolen	7566
Caryophyllene	775
β-farnesene	243
Germacrene B	985
Alcohols	
Linalool	2974
D-fenchyl alcohol	1178
Eudesmol	1177
Borneol	183
Isoborneol	3065
4-terpineol	866

Table 11. *Compounds identified from Chrysanthemum morifolium Huangju by UHPLC-Q-TOF-MS (Wang et al., 2018)*

No.	RT	Formula	$[M-H]^-$	Score	MS/MS	Identification
1	4.833	C16H18O9	353.08785	97.69	191.05644, 248.97382, 112.98560	Chlorogenic acid
2	11.442	C21H20O11	447.09376	87.93	285.03972	Luteolin-7-O-glucoside
3	17.242	C25H24O11	515.12035	95.93	353.08736, 179.03450, 173.04544, 135.04501, 191.05577	3,5-dicafeoylquinic acid
4	19.575	C25H24O12	431.09920	95.44	268.03810, 269.04341	Apigenin-7-O-Glucoide
5	21.275	C21H18O11	445.07743	79.28	269.04514, 113.02422	Apigenin-7-O-glucuronide
6	22.208	C24H22O14	533.09396	94.85	489.10472, 285.04009	Luteolin-7-O-6″-malonylglucoside
7	32.767	C15H10O5	269.04627	94.96	117.03469, 151.00383, 149.02439	Apigenin

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Table 12. *Antioxidant activities of apigenin-7-O-glucoside, apihenon and glucose (Wang et al., 2018)*

±	ABTS (EC_{50})	DPPH (EC_{50})	FI (EC_{50})
Apigenin-7-O-glucoside	5.49 ± 0.74^{a}	/	/
Apigenin	0.68 ± 0.01^{b}	/	/
Glucose	/	/	/
BHT	0.17 ± 0.00^{b}	0.41 ± 0.01^{a}	/
Ascorbic acid	0.12 ± 0.00^{b}	0.11 ± 0.00^{b}	/
Rutin	0.52 ± 0.10^{b}	0.52 ± 0.07^{a}	/
EDTA	/	/	0.32 ± 0.03

Each value is expressed as the mean ± standard deviation (n = 3). Means with different letters with in a column are significantly different ($p < 0.01$). ABTS and DPPH, effective concentration at which 50% of radicals are scavenged (mg/mL); FI, ferrous ion chelating power; effective concentration at which 50% of ferrous ions are chelated (mg/mL). Positive controls were: BHT, ascorbic acid, rutin and EDTA. / , no data obtained from the EC_{50} model Y = 100 / (1 + 10^((LogEC50-C)*HillSlope))

Table 13. *The chemical compositions of chrysanthemum essential oil (CHEO) (Lin et al., 2019)*

Composition	Proportion (%)	Composition	Proportion (%)
Borneol	19.55 ± 0.031	α-Curcumene	1.25 ± 0.021
B-Slinene	16.25 ± 0.052	Eucalyptol	1.11 ± 0.013
Camphor	13.48 ± 0.021	Pentanoic acid	1.05 ± 0.018
Guaia-3,9-diene	5.26 ± 0.019	Butanoic acid, 3-methyl-,1,7,7-trimethylbicyclo[2.2.1]hept-2-yl ester	1.0 ± 0.007
Hexaoxa-cycloocatdecane	4.16 ± 0.012	1,4,7,10,13,16-Hexaoxacyclooctadecane	0.92 ± 0.011
Cyclopropa-naphthalene	2.69 ± 0.015	3-Cyclohexene-1-methanol, alpha., alpha., 4-trimethyl	0.92 ± 0.003
1,4,7,10,13,16-Hexaoxacycloocladecane	2.33 ± 0.004	1-Phenyl-2-propanol	0.63 ± 0.011
3-ethylidence-1-methylcyclopentene	1.88 ± 0.008	Octaethylene glycol	0.56 ± 0.042
Tetramethyl-undeca-2,6,9-trien-8-one	1.42 ± 0.014	3,6,9,12,15-Pentaoxanonadecan-1-ol	0.27 ± 0.026

Table 14. *Essential oil composition of Chrysanthemum cinerariifolium (Shrestha et al., 2014)*

RI	Compound	%	RI	Compound	%
809	2-Hexanol	0.8	1217	Trans-Carveol	0.4
854	(2E)-Hexenal	0.4	1225	Neoiso-Dihydrocarveol	0.3
856	(3Z)-Hexenol	2.3	1261	Cis-Chrysanthenyl acetate	0.5
890	2-Hexen-1-ol	0.3	1270	Unidentified	1.4
891	n-Hexanol	1.0	1311	(Z)-Patchenol	0.9
941	α-Pinene	0.2	1315	Unidentified	1.9
981	1-Octen-3-ol	1.5	1356	Eugenol	0.5
992	Dehydro-1,8-cineole	0.4	1419	(E)-Caryophyllene	0.9
994	6-Methyl-5-hepten-2-ol	0.2	1458	(E)-β-Farnesene	0.4
996	3-Octanol	0.2	1477	Trans-Cadina-1(6),4-diene	0.2

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1016	α-Terpinene	0.3	1481	ϒ-Muurolene	4.6
1024	p-Cymene	0.2	1484	ar-Curcumene	0.3
1028	Limonene	0.2	1497	α-Zingiberene	1.0
1030	1,8-Cineole	2.4	1516	cis-Dihydroagarofuran	0.7
1032	Benzyl alcohol	0.2	1525	δ-Cadinene	1.7
1043	Phenylacetaldehyde	0.4	1534	Italicene Ether	0.3
1066	Cis-Sabinene hydrate	0.4	1550	Unidentified	1.0
1097	Trans-Sabinene hydrate	0.7	1552	Unidentified	0.9
1100	Linalool	0.2	1559	Unidentified	1.2
1103	Filifolone	2.3	1565	(E)-Nerolidol	0.3
1105	Hotrienol	1.1	1576	Germacrene D-4-ol	1.4
1112	2-Phenylethyl alcohol	1.2	1581	ar-Turmerol	0.5
1120	Isophorone	1.0	1583	Caryophyllene oxide	2.1
1125	Chrysanthenone	7.6	1601	Viridiflorol	2.2
1138	trans-Pinocarveol	3.3	1609	Humulene epoxide II	0.2
1144	Camphor	11.0	1628	1-epi-Cubenol	1.1
1162	Cis-Chrysanthenol	4.4	1631	Caryophylla-4(12),8(13)-dien-5α-ol	0.8
1165	Borneol	3.5	1633	Caryophylla-4(12),8(13)-dien-5β-ol	1.9
1166	δ-Terpineol	0.4	1642	τ-Muurolol	2.7
1173	Cis-Pinocamphone	0.2	1646	α-Muurolol (= Torreyol)	0.5
1176	Terpinen-4-ol	3.6	1651	β-Eudesmol	0.4
1190	α-Terpineol	1.2	1655	α-Cadinol	4.8
1193	Methyl salicylate	1.3	1686	Caryophylla-4(15)5,10(14)-trien-1α-ol	0.8
1195	Myrtenol	1.0	1691	Shyobunol	3.4
1202	Nopol	0.4	1737	Oplopalone	1.2
1207	Verbenone	0.5	1954	Hexadecanoic acid	0.3
1208	Trans-3(10)-Caren-2-ol	0.2	2108	(E)-Phytol	0.2
				Total identified	93.7

Table 15. *The health benefits of chrysanthemum*

1-	Increase the metabolism in the body, which can help people to lose weight, improve circulation, regulate hormone levels, and even improve neurotransmitter activity
2-	Prevent certain chronic illnesses, in part because it helps fight free radicals, prevents cellular mutations, and protects body against numerous illnesses which cause by free radicals
3-	Improve vision. Chrysanthemum tea can also improve eyesight, and also can protect against diseases such as cataracts, macular, degeneration, neuropathy and even blurry vision
4-	It may help to improve bone density and even prevent osteoporosis. This is due to its many naturally occurring minerals, including calcium and magnesium
5-	It may boost immune system because of its high levels of Vitamin C and A
6-	It may help unclog arteries and improve overall heart health
7-	It may help alleviate varicose veins
8-	Help ease digestive issues, eliminating a lot of digestive problems and keeping body in less pain with fewer stomach problems
9-	It may help alleviate dryness and itchiness in the eyes
10-	Rejuvenate the brain and alert the senses
11-	Detoxify the liver, making body healthier overall, as well as make the cholesterol numbers lower
12-	It may help alleviate pimples, acne, and other skin problems
13-	It may lower body temperature, and can help relieve the pain
14-	It may help feeling better without the nasty side effects that chemical medicines may have, particularly prescription

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Table 16. *The most important health benefits of chrysanthemum tea*

1-	Anti-inflammatory
2-	Increase immune system
3-	Strengthens bones
4-	Prevents chronic diseases
5-	Improve eyesight
6-	Increase metabolic rate
7-	Maintains cardiovascular health
8-	Relaxes nerves
9-	Treats cough and cold
10-	Detoxifies body

Table 17. *Samples and origins of the studies Chrysanthemum morifolium tea from China (Wang et al., 2019)*

Samples	Company	Origins
C. morigolium Gongju	Beijing Tongrentang Health Pharmaceutical Industry Co., Ltd	Huangshan city, Anhui province
C. morifolium Hangbaiju	Beijing Tongrentang Health Pharmaceutical Industry Co., Ltd	Tongxiang city, Zhejiang Province
C. morifolium Taiju	Beijing Zhang Yiyuan Jinqiao Tea Co., Ltd.	Zhongwei city, Ningxia Hui Autonomous Region
C. morifolium Boju	Bozhou Zhongyitang Chinese Medicinal Materials Sales Co., Ltd.	Bozhou city, Anhui Province
C. morifolium Chuju	Anhui Jutai Chuju Herb Science and Technology Co., Ltd.	Chuzhou city, Anhui Province
C. morifolium Huangju	Huangshan Dingxiangwu Ecological Agriculture Development Co., Ltd.	Shangrao city, Jiangxi Province

Table 18. *Common TCM formulas in which chrysanthemum flowers are used*

1-	For hypertension combine chrysanthemum flowers with dangelions and honeysuckle flowers
2-	For improving vision, relieving tinnitus and headaches combine chrysanthemum flowers with goji berries
3-	For exterior wind-heat with symptoms of headache, colds, sore throat combine chrysanthemum flowers with wild mint, platycodon roots, and greater burdock fruits
4-	For high blood pressure combine chrysanthemum flowers with gambir stems and thorns, cassia seeds and white peony roots
5-	For liver and kidney Yin deficiency combine chrysanthemum flowers with glossy privet fruits and goji berries
6-	For external wind heat with fever, sore throat, chills and red eyes combine chrysanthemum flowers with mulberry leaves, forsythia fruits, wild mint and platycodon roots
7-	For deficient kidney and liver Yin patterns with symptoms such as dizziness, vertigo, blurred vision, headache and hypertension combine chrysanthemum flowers with heal-all spikes, gambir stems and thorns and Baikal skullcap roots
8-	For wind-heat headache combine chrysanthemum flowers with angelica roots and Szechuan lovage roots
9-	For liver or wind-heat with red and painful eyes combine chrysanthemum flowers with cassia seeds and mulberry leaves

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Conclusions

Chrysanthemum is the second most important plants in both ornamental industry and traditional Chinese medicine. Chrysanthemums, often called mums or chrysanths (family *Asteraceae*, genus *Chrysanthemum*), are one of the most important crops in the flower industry. Chrysanthemum is both a source of beautification and high medicinal characteristics. In some Eastern cultures, chrysanthemums are also a symbol of good luck, wealth, happiness, and longevity. In Chinese medicine, chrysanthemums are a versatile herb called Ju Hua. In Chinese traditional medicine, Ju Hua is considered to be a fragrant, cool, and light herb. Also, it is used for cooling heat in the liver channel, especially when it manifests as dry, red or painful eyes. It has tremendously diverse in morphologies including flower shapes, sizes, colors and plant architecture. Thirteen important compounds of chrysanthemum flowers are acacetin-7-0-beta-D-glucopyranoside, luteolin, luteolin-7-O-beta-D-glucopyranoside, acaciin, acacetin 7-0-($6^{//}$-0-alpha-L-rhamnopyranosyl)-beta-sophoroside, 3-0-caffeoylquinic acid, syringaresinol 0-beta-D-glucopyranoside, 5,7-dihydroxychromone, uracil, p-gydroxybenzoic acid, 4-0-beta-D-glucopyranosyloxybenzoic acid, boscialin and blumenol A. Some health benefits of chrysanthemums are for allergies, hypertension (high blood pressure0, tightening of the chest, anxiety, skin conditions such as boils, vertigo, eyes that are inflamed, headaches, sore throats, colds and tinnitus. In traditional Chinese medicine, chrysanthemum is a cold herb which helps dispel pathogenic heat, helps the liver, improves eyesight and aids detoxification. In TCM, chrysanthemum tea has been used for varicose veins, atherosclerosis, acne, influenza, sore throat, fever, angina (Chest pain), common cold symptoms, high blood pressure, inflammation, HIV/AIDS, dizziness and type 2 diabetes. Integrative use of modern agriculture and science of traditional Chinese herbs with new technologies will play an important role in sustainable agriculture and food systems. More clinical researches are necessary to uncover the numerous substances and their impacts on chrysanthemum that contribute to public health.

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