Review Article

iMedPub Journals
www.imedpub.com

Herbal Medicine: Open Access
ISSN 2472-0151

2020
Vol.6 No.1:3

DOI: 10.36648/2472-0151.6.1.100047

The Chemical Components and Pharmacological Functions of *Strobilanthes Cusia* (Nees) Kuntze

Ming-zhen Qin[1], Yu Liu[1], Wuwei Wu[1*], Thomas Oberhänsli[2], Qiyan Wang-Müller[2*]

[1]National Engineering Laboratory of Southwest Endangered Medicinal Resources Development, Guangxi Botanical Garden of Medicinal Plants, Nanning 530000, China

[2]Research Institute of Organic Agriculture FiBL, Ackerstrasse 113, CH-5070 Frick, Switzerland

Corresponding author 1: Wuwei Wu, National Engineering Laboratory of Southwest Endangered Medicinal Resources Development, Guangxi Botanical Garden of Medicinal Plants, 189 Changgang Road, Nanning 530000, China, Phone: +867712443036; E-mail: wuweiwu2013@163.com

Corresponding author 2: Qiyan Wang-Müller, Research Institute of Organic Agriculture FiBL, Ackerstrasse 113, CH-5070 Frick, Switzerland, Phone: +41628657292; E-mail: qiyan.wang-mueller@fibl.org

Received date: April 10, 2020; **Accepted date:** April 27, 2020; **Published date:** May 05, 2020

Citation: Qin MZ (2020) The Chemical Components and Pharmacological Functions of *Strobilanthes Cusia* (Nees) Kuntze. Herb Med Vol.6 No.1. DOI: 10.36648/2472-0151.6.1.100047.

Abstract

Strobilanthes cusia (Nees) Kuntze is a member of the *Acanthaceae* family, and widely used as an anti-inflammatory Traditional Chinese Medicine (TCM) in China since 1500's. As the development of the modern phytochemistry technologies, more and more compounds that have bioactivities were separated from the leaf, stem and root of *Strobilanthes cusia* (Nees) Kuntze. Through in vitro and in vivo experiments, people found many new functions of the extracts of this plant, such as antiviral, anti-bacterial and anticancer activities. Here we review the chemical components and pharmacological functions of *Strobilanthes cusia* (Nees) Kuntze, which may help people to understand this old TCM material and its new applications.

Keywords: Southern Ban-Lan-Gen; Traditional Chinese Medicine (TCM) application; Natural chemical components; Pharmacological activities; Anti-inflammatory; Antibacterial; Anticancer; Antiviral

Introduction

Strobilanthes cusia (Nees) Kuntze, also known as *Strobilanthes* balansae Lindau or *Baphicacanthus cusia* (Nees) Bremek, is a member of the *Acanthaceae* family. It is mainly distributed in tropics and subtropics area of Asian including India, Thailand, Vietnam and Southern China. This herbaceous plant is listed in the Chinese Pharmacopoeia as the typical species for "Southern Ban-Lan-Gen". The root and stem of this plant has been widely used as herbal traditional Chinese medicines (TCM) to treat the diseases of fever, inflammatory and sore throat.

According to the "Compendium of Materia Medica", which was published in 1578, the source plants of medicinal materials "Ban-Lan" has two types of plants: "Songlan, leaves are like white woad; Malan, leaves are like bitter selling, that is, Guo Pu's so-called big blue leaf, and the common so-called Ban-Lan". The Songlan is also known as "Northern Ban-Lan-Gen", which belongs to the *Brassicaceae* family, and its Latin name is *Isatis indigotica* Fort. The Malan is *Strobilanthes cusia* (Nees) Kuntze. These two types of herbs had both been used with the name of Ban-Lan-Gen for many years until 1995, when the Chinese Pharmacopoeia defined them separately as Northern and Southern Ban-Lan-Gen. Although share some common bioactive compounds such as indigo and indirubin, Northern and Southern Ban-Lan-Gen have very different profile of chemical components. Many papers had reviewed the chemical components and pharmacological functions of "Northern Ban-Lan-Gen": *Isatis indigotica* Fort [1-3]. In this review, we mainly focus on discussing the natural chemical components, pharmacological functions including anti-inflammatory, anti-bacterial, anticancer and antiviral, and applications of "Southern Ban-Lan-Gen", the plant species of *Strobilanthes cusia* (Nees) Kuntze.

Chemical components

Strobilanthes cusia (Nees) Kuntze has been used as an antiviral, antibacterial herb for many years, and the efforts to find out its active components had started as early as in 1970's. As more and more people devoted to the study, many chemicals were identified in *Strobilanthes cusia* (Nees) Kuntze, including alkaloids, glycosides, sterols, pentacyclic triterpenoids, flavonoids, organic acids, anthraquinones and polysaccharide.

Alkaloids: The alkaloids from *Strobilanthes cusia* (Nees) Kuntze include indoles, quinazolones and some other alkaloids. The most frequent reported indoles from *Strobilanthes cusia* (Nees) Kuntze are Indirubin and indigo, which were found in the root, stem and leaf of this plants [4,5]. Indigo is widely used in food, medicine and industrial dyeing, and indirubin has many pharmacological activities, for example, it can be used in the treatment of chronic myeloid leukemia (CML) and psoriasis [6,7]. The Quinazolone alkaloids from *Strobilanthes cusia* (Nees)

Kuntze include 4 (3H)-quinazolone and 2,4, (1H, 3H)-quinazolone, etc. [8]. At present, there are 17 kinds of alkaloids had been identified in *Strobilanthes cusia* (Nees) Kuntze, and they were summarized in Table 1 [9-14].

Table 1: Alkaloids isolated from *Strobilanthes cusia* (Nees) Kuntze.

No.	Compounds	Ref.
1	indirubin	5
2	indigotin	5
3	trptanthrin	8
4	4(3H)-quinazolinone	8
5	2 ,4,(1H,3H)-benzoyleneurea	8
6	2-methyl-4(H)-quinazolinone	8
7	indican	9
8	1H-indole-3-carboxylic acid	10
9	3-(2'-methyl-butyric acid methyl ester)-1H-indole	10
10	2-benzoxazolinone	11
11	2-hydroxy-1,4-benzoxazin-3-one	11
12	(2R)-2-O-β-D-glucopyranosyl-2H-1,4-benzoxazin-3(4H)-one	12
13	(2R)-2-O-β-D-glucopyranosyl-4-hydroxy-2H-1,4-benzoxazin-3(4H)-one	12
14	baphicacanthin A	13
15	baphicacanthin B	13
16	(2R) -2-O-β-D- glucopyranosyl-5-hydroxy-2-1,4-benzoxazin-3(4H)-one	14
17	7-chloro-(2R)-2-O-β-D-glucopyranosyl-2H-1,4-benzoxazin-3(4H)-one	14

Glycosides: Many phenylpropanoid glycosides, lignans and their glycoside derivatives were found in *Strobilanthes cusia* (Nees) Kuntze. Xiao et.al had isolated a variety of glycosides from the root of *Strobilanthes cusia* (Nees) Kuntze with methanol extraction [14]. Many of those extracts, such as akoside, isoakoside, carrageenin, alloflavin and (+)-clove-o-β-d-glucoside, had good antioxidant activities. The glycosides found in *Strobilanthes cusia* (Nees) Kuntze were summarized in Table 2 [12,14-16].

Table 2: Glycosides isolated from *Strobilanthes cusia* (Nees) Kuntze.

No.	Compounds	Ref.
18	Uridine	12
19	pinoresinol-4-O-β-D-apiosyl-(1→2)-β-D-glucopyranoside	12
20	Isoacteoside	14
21	Martynoside	14
22	Isomartynoside	14
23	Verbasoside	14
24	β-phenylethoxy-β-D-glucopyranoside	14
25	1,2-O-[2S-(3,4-dihydroxyphenyl)-l,2-ethanediyl]-3-O-a-L-rhamnopyranosyl-6-O-caffeoyl-β-D-glucopyranoside	14
26	2-(3,4-dihydroxyphenyl)ethyl-(6-O-ethyl)-β-D-glucopyranoside	14
27	(+)-syringaresinol	14
28	(-)-episyringaresinol	14
29	(+)-syringaresinol-O-β-D-glncopyranoside	14
30	5',5"-dimethoxy-4"-hydroxy-2,4,6,8-diepoxylingan-4'-O-β-D-glucopyranoside	14
31	Eleutheroside E	14
32	(+)-lyoniresinol-3a-O-β-apiofura-nosyl-(1 → 2)-β-D-glucopyranoside	15
33	cusianoside A	15
34	cusianoside B	15
35	(+)-5,5'-dimethoxy-9-O-β-D-glucopyranosyl lariciresinol	15
36	(+)-9-O-β-D-glucopyra-nosyl lyoniresinol	15
37	(+)-5,5'-dimethoxy-9-O-β-D-glu-copyranosyl secoisolariciresinol	15
38	Acteoside	15
39	[(2-(3,4-dihydroxyphenylethyl))-3-O-a-L-rhamnopyranosyl-(1→4)-(4-O-caffeoyl)-β-D-glucopyranoside]	16
40	adenosine	16

Sterols: Several sterols were found in the roots, leaves and fruits of *Strobilanthes cusia* (Nees) Kuntze, and they were reported having many physiological effects, such as antioxidation, immune regulation, cholesterol reduction, on human. Wu et al. had extracted stigmasterol-5,22-diene-3 β, 7 β-diol and stigmasterol-5,22-diene-3 β, 7 α-diol from *Strobilanthes cusia* (Nees) Kuntze with petroleum ether, and found that they have some antitumor activity [17]. The sterols isolated form *Strobilanthes cusia* (Nees) Kuntze were summarized in Table 3.

Table 3: Sterols isolated from *Strobilanthes cusia* (Nees) Kuntze.

No.	Compounds	Ref.
41	β-daucosterol	14
42	spinasterol-3-O-β-D-glucopyranoside	16
43	stigmasterol-3-O-β-D-glucopyranoside	16
44	stigmasta-5,22-diene-3β,7β-diol	17
45	stigmasta-5,22-diene-3β,7a-diol	17
46	β-sitosterol	18

Pentacyclic triterpenoids: Chen et.al had extracted lupanone, lupinol and betulin, all of which were soluble in organic matter and insoluble in water, and identified as pentacyclic triterpenoids, from *Strobilanthes cusia* (Nees) Kuntze in 1987 [18]. However, not too many pentacyclic triterpenoids are identified since then. At present, only four pentacyclic

triterpenoids were found from *Strobilanthes cusia* (Nees) Kuntze , and they were summarized in Table 4 [18,19].

Table 4: Pentacyclic triterpenoids isolated from *Strobilanthes cusia* (Nees) Kuntze.

No.	Compounds	Ref.
47	lupenone	18
48	lupeol	18
49	betulin	18
50	2,3-dihydroxy-12-oleanen-28-oic acid	19

Other compounds: Many other compounds such as flavonoids, organic acids, anthrones, sugars and amides were found in *Strobilanthes cusia* (Nees) Kuntze. Wu et.al had isolated 5,7,4 '-trihydroxy-6-oxyflavone and 3', 4 ', 5,7-tetrahydroxydihydroflavonol from the root of *Strobilanthes cusia* (Nees) Kuntze in 2005, and these are the first reported flavonoids obtained from the plant of *Acanthaceae* family [10]. All other compounds isolated form *Strobilanthes cusia* (Nees) Kuntze were summarized in Table 5 [10,11,14,16,19-21].

Table 5: Other compounds isolated from *Strobilanthes cusia* (Nees) Kuntze.

No.	Compounds	Ref.
70	5,7,4'-trihydroxy-6-methoxyflavone	10
71	3',4',5,7-quadrihydroxy-flavanonols	10
72	4-hydroxy-3-methoxybenzoic acid	11
73	lauric acid	19
74	11,12-dihydroxy-7,9-octadecadienoic acid	19
75	sucrose	16
76	polysaccharide	20
77	Chrysophanol	21
78	monobutyl phthalate	14
79	dibutyl phthalate	14
80	Nicotinamide	14
81	Squalene	14

Pharmacological activities

Many ancient TCM books had recorded that "Ban-Lan-Gen" has the functions of " detoxification, cooling blood and eliminating swelling ", and modern researches show that *Strobilanthes cusia* (Nees) Kuntze has many pharmacological functions with anti-inflammatory, anti-bacterial, anti-tumor and anti-virus activities.

Anti-inflammatory: People had found that *Strobilanthes cusia* (Nees) Kuntze has anti-inflammatory activities and can enhance the mouse immune system. Tao et al. reported that injection of the water extracts of *Strobilanthes cusia* (Nees) Kuntze into the mouse can inhibit auricle inflammation induced by xylene, and increase the permeability of capillary [22]. Luo et al. found that *Strobilanthes cusia* (Nees) Kuntze can significantly alleviate the ear swelling induced by xylene injection in mice, reduce the weight of granuloma in rats, and improve the spleen and thymus index in mice [23].

Zhou et al. found that oleoresin acetate from *Strobilanthes cusia* (Nees) Kuntze can block NF-κ B signal pathway, and down regulating the expression of inflammatory factors induced by influenza A virus (IAV). IL-17 is a cell factor that induces inflammation [24]. It was found that indirubin and tryptophan can significantly reduce the expression of IL-17, suggesting that indirubin and tryptophan have anti-inflammatory activities [25]. In addition, many benzodiazinone derivatives were found in *Strobilanthes cusia* (Nees) Kuntze, and those benzodiazinone derivatives were found to be able to inhibit the inflammatory response through reducing the release of histamine [12,13].

Anti-bacterial: *Strobilanthes cusia* (Nees) Kuntze extract has a broad-spectrum anti-bacterial effect, and its inhibitory effect on Staphylococcus aureus and Escherichia coli is stronger than that of *Isatis indigotica* Fort extract [10]. Wei et al. found that *Strobilanthes cusia* (Nees) Kuntze extract can enhance the inhibitory effect of lincomycin on Staphylococcus aureus, Escherichia coli and Bacillus subtilis [26]. Tryptamine and indole derivatives may be the main components of *Strobilanthes cusia* (Nees) Kuntze that responsible for its antibacterial function, for example, Kataoka et al. found that tryptamine can significantly inhibit the growth of Helicobacter pylori in a dose-dependent manner both in vitro and in vivo [27]. Wei et al. found that n '-β-D-glucopyranosyl indirubin from *Strobilanthes cusia* (Nees) Kuntze had some antibacterial activity against *Staphylococcus aureus* [25]. In addition, indirubin was also reported to be able to inhibit the growth of Staphylococcus aureus and Staphylococcus epidermidis, with the minimum inhibitory concentrations of 12.5 mg/L and 25 mg/L respectively [28].

Sterols from *Strobilanthes cusia* (Nees) Kuntze, such as stigmasterol and β - sitosterol, also have good inhibitory effects on the inhibition of Agrobacterium, Escherichia coli, Staphylococcus and Bacillus subtilis [29]. Chrysophanol was found to have very strong anti-inflammatory effect, for example, the commonly used anti-bacterial and anti-inflammatory agents ferrofluid tincture and Mongolian prescription "TRSDL" all contain chrysophanol as the active component [30,31]. So, the chrysophanol from *Strobilanthes cusia* (Nees) Kuntze may also contribute to its anti-bacterial effect.

Antitumor: Many researchers had found that *Strobilanthes cusia* (Nees) Kuntze has the antitumor effect. Xiao et.al reported that akoside, a phenylethanolic glycoside isolated from *Strobilanthes cusia* (Nees) Kuntze, can significantly inhibit the growth of tumor cell line CB3 with IC50 at 2.26 ± 0.22 μ mol/L [14]. Indirubin was found to inhibit the growth of a variety of human tumor cells form liver, lymphoid, cervical and leukemia [32]. Zhang et al. showed that indirubin can inhibit the growth of human glioblastoma cell U251 by down regulating the expression of Bcl-2 gene [33]. Tryptophan is also an important active antitumor component from *Strobilanthes cusia* (Nees) Kuntze. It can inhibit the proliferation of hepatoma cell BEL-7402 and ovarian carcinoma cell A2780, induce tumor differentiation,

reduce telomerase activity and reverse the tumor transformation [34]. Ren had studied the effects of chrysophanol on the growth of breast cancer cells, and found that chrysophanol can affect the cell cycle and proliferation of breast cancer cells through inhibiting the phosphorylation of NF - κ B, reducing the downstream gene expressions regulated by NF-κ B/Bcl-2 signal pathway, thus promote the apoptosis of breast cancer cells [35].

Antiviral: *Strobilanthes cusia* (Nees) Kuntze has been used to treat influenza, pneumonia and other viral diseases in China for many years, for examples, it has been used to treat viral pneumonia, cough and asthma, and it was also reported to be used in treating herpes simplex virus induced keratitis [36,37] .

Many studies have shown that *Strobilanthes cusia* (Nees) Kuntze has antiviral effects. Qin et al. found that *Strobilanthes cusia* (Nees) Kuntze extracts can inactivate the influenza A virus through chicken embryo culture experiment [38]. Luo et al. studied the antiviral effects of *Strobilanthes cusia* (Nees) Kuntze using influenza virus FM1 mice model and herpes simplex virus rabbit model, and the results showed that *Strobilanthes cusia* (Nees) Kuntze could significantly prolong the average survival days and lower the death rate of influenza A virus infected mice, and reduce the degree of keratitis in herpes simplex virus infected rabbits [39]. In addition, it showed that extracts of *Strobilanthes cusia* (Nees) Kuntze had high anti TMV activity, and 20-50 μg/ml of *Strobilanthes cusia* (Nees) Kuntze extract significantly inhibits the expression of TMV coat protein [40,41].

Some compounds separated from *Strobilanthes cusia* (Nees) Kuntze were also proved to have antiviral activities. It is found that lectin from *Strobilanthes cusia* (Nees) Kuntze has the hemagglutination activity and can prevent influenza virus from infecting cells [42]. The *Strobilanthes* A and 2 (H)-benzoxazolone from *Strobilanthes cusia* (Nees) Kuntze can also inhibit the influenza A virus with IC50 of (29.2 ± 5.8) μ mol/L and (46.0 ± 8.4) μ mol/L, respectively. In addition, 4 (3H)-quinazolone from *Strobilanthes cusia* (Nees) Kuntze can also lower the infectivity of influenza virus and Coxsackie virus, while promote the proliferation rate of spleen cell and lymphocyte [43].

Medicinal applications

Strobilanthes cusia (Nees) Kuntze is widely used in many TCM products that were effectiveness at relieving pain, eliminating inflammation and detoxification. For example, " Southern banlangen preparation" is commonly used in treating mumps, pharyngitis, mastitis and furuncles diseases. " Children antipyretic suppository", a *Strobilanthes cusia* (Nees) Kuntze based prescription, can relieve children's fever, sore throat, phlegm and cough. In addition, *Strobilanthes cusia* (Nees) Kuntze has also been used in the breeding industry as antibiotic substitutes to improve animal immunity and prevent animal diseases. Lin et.al had invented an animal feed additive, which containing *Strobilanthes cusia* (Nees) Kuntze as the major ingredient, to improve the pig immunity and reduce the illness and mortality rate of pigs [44,45].

Conclusion

As a traditional Chinese medicine ingredient, *Strobilanthes cusia* (Nees) Kuntze plays an important role in disease prevention. In many areas of South China and South Asia, *Strobilanthes cusia* (Nees) Kuntze is one of the most frequently used TCM in cold and fever treatment, and will have more prospect applications and a greater market potential in the near future. However, more comprehensive and in-depth exploration of *Strobilanthes cusia* (Nees) Kuntze is needed to identify more chemical components, dig out the mechanism under its pharmaceutical effects, especially the targets and pathway of the effective components. We believe these researches will give *Strobilanthes cusia* (Nees) Kuntze a greater opportunity for the drug development and market application.

Acknowledgements

This work was financially supported by Guangxi R&D project of medical and health technology (grant number S201529) and Guangxi science and technology program (grant number AD17292003).

Conflict of Interest

The authors declare no financial or commercial conflict of interest.

References

1. Chen M, Gan L, Lin S, et al. (2012) Alkaloids from the root of Isatis indigotica. J Nat Prod 75: 1167-1176.
2. Ho YL, Chang YS (2002) Studies on the antinociceptive, anti-inflammatory and anti pyretic effects of Isatis indigotica root. Phytomed 9: 419-424.
3. Wang XL, Chen MH, Wang F, et al. (2013) Chemical constituents from root of Isatis indigotica. Zhongguo Zhong Yao Za Zhi 38: 1172-1182.
4. Liang W, Bi Y (1990) Determination of indirubin and indigo in the roots, stems and leaves of Baphicacanthus cusia. Chinese Trad Pat Med 12: 31-32.
5. Zhang Y, Zhu Y, Jian C, Chen X, Pei L (2018) Identification of three species commonly known as "daqingye" by internal leaf anatomy and high-performance liquid chromatography analyses. Acta Societ Botan Polon 87: 35-75.
6. Nam S, et al. (2012) Indirubin derivatives induce apoptosis of chronic myelogenous leukemia cells via inhibition of Stat5 signaling. Mol Oncol 6: 276-283.
7. Luo X (1982) Study on the therapeutic effect and principle of indirubin in the treatment of psoriasis. Chinese J Dermatol 15: 157-160.
8. Cao M (2015) Study on the equivalence of radix and stem of Baphicacanthus cusia (Nees) Bremek. Guangzhou University of Chinese Medicine, Guangzhou.
9. Li L, Qiao C (1992) Direct determination of indole glycoside in Baphicacanthus cusia by HPLC. Chinese J Pharm Anal 12: 302-303.

10. Wu Y (2005) Basic pharmaceutical researches on Radix isatidis and Rhizoma et Radix Baphicacanthis cusiae. Kunming Medical University, Kunming.
11. Gao G, He Y, He L, Zhang Y (2001) Nitrogen-containing heterocycles in the roots of Baphicacanthus cusia: 2-benzoxazolinone and 2-hydroxy-1,4-benzoxazin-3-one. J Chinese Med 12: 41-49.
12. Wei H, Wu p, Wei X, Yashikawa M (2005) Glycosides from the roots of Baphicacanthus cusia. J Trop Subtrop Bot 13: 171-174.
13. Feng Q, Zhu G, Gao W, et al. (2016) Two New Alkaloids from the Roots of Baphicacanthus cusia. Chem Pharm Bull 64: 1505-1508.
14. Xiao C (2018) Study on the chemical constituents of anti-influenza virus isolated from the roots of Baphicacanthus cusia (Nees) Bremek from Guizhou provinc. Guizhou University, Guizhou.
15. Tanaka T, Ikeda T, Kaku M, et al. (2004) A new lignan glycoside and phenylethanoid glycosides from strobilanthes cusia bremek. Chem pharma bullet 52: 1242-1245.
16. Pei Y (2007) Pharmaceutical studies on isatis indigotica fort and Baphicacathus cusia (Nees) Bremek. Heilongjiang Univ Chinese Med, Haerbin.
17. Wu Y (2005) Study on the chemical constituents in the roots of Baphicacanthus cusia. Chinese Trad Herb Drugs 36: 982-983.
18. Chen R, Lu Z, Guan D, Chen G, Li X (1987) Study on the chemical constituents in the roots of Baphicacanthus cusia. Chinese Trad Herb Drug 18: 8-10.
19. Wang W (2008) Study on chemical constituents and resources of five medical plant. Kunming Institute of Botany, Chinese Academy of Sciences, Kunming.
20. Du J, Wang B, Zhang Z, Li S, Wang K (2016) Extraction, characterization and bioactivities of novel purified polysaccharides from Baphicacanthis Cusiae Rhizoma et Radix. Int J Biolog Macromol 93: 879-888.
21. Chen R, Jiang S (1990) Isolation and identification of chrysophanol from the roots of Baphicacanthus cusia. J Chinese Med Mat 13: 29-30.
22. Tao G, Tan Y (2002) Study on pharmacodynamics of injection of Baphicacanthus cusia Rhizoma et. Radix Guangdong Pharm J 12: 38-40.
23. Luo X, Du T, chen Y, Zhang D, Zhao Z, et al. (2011) Comparative study on antipyretic effects, anti-inflammation, immunoregulation of Radix isatidis grown in different regions of Guangdong province. J New Chinese Med 43: 113-116.
24. Zhou B, Yang Z, Feng Q, et al. (2017) Aurantiamide acetate from baphicacanthus cusia root exhibits anti-inflammatory and anti-viral effects via inhibition of the NF-kappaB signaling pathway in Influenza A virus-infected cells. J Ethnopharmacol, 199: 60-67.
25. Lee C, Wang C, Hu H, et al. (2019) Indole alkaloids indigodoles A–C from aerial parts of Strobilanthes cusia in the traditional Chinese medicine Qing Dai have anti-IL-17 properties. Phytochemist 162: 39-46.
26. Wei Y (2010) Effects of Baphicacanthus cusia (Nees) Bremek extract on the antibacterial activity of lincomycin in vitro. J Anhui Agri Sci 38: 2927-2928.
27. Kataoka M, Hirata K, Kunikata T, et al. (2001) Antibacterial action of tryptanthrin and kaempferol, isolated from the indigo plant (Polygonum tinctorium Lour.) against Helicobacter pylori-infected Mongolian gerbils. J Gastroenterol 36: 5-9.
28. Ponnusamy K, Ramasamy M, Savarimuthu I, Paulraj MG (2010) Indirubin potentiates ciprofloxacin activity in the NorA efflux pump of Staphylococcus aureus. Scandinavian J Infec Disea 42: 500-505.
29. Wen X (2012) Studies on chemical constituents and biological activity of Abrus mollis. Guangxi University, Nanning.
30. Meng Q, Zhao L, Qin L, Qu S, Zhang s, et al. (2017) Determination of contents of emodin and chrysophanol in rumex patiential.var.callosus processing with rice vinegar by HPLC. Ginseng Res 29: 46-48.
31. NaRen G, Wang C, Aori G (2012) Extraction and identification of the antimicrobial compound of chrysophanol from Mongolian medicine of TRSDL. Chinese J Preven Veter Med 34: 926-928.
32. Wu Q, Ge Z, Gao Y, zhang L (2008) Inhibitory effect of indirubin on growth of some cancer cells and its mechanism. Tianjin J Trad Chinese Med 25: 59-62.
33. Zhang T, Yi H, Wang B, Wang Z, Ning Z, et al. (2017) Inhibitory effects of indirubin on glioblastoma U251 cell proliferation and Bcl-2 expression. J Hubei Univ Sci Technol 31: 465-467.
34. Liang Y, Hou H, Li D, Qin J, Qiu L, et al. (2000) Studies on in vitro anticancer activity of tryptanthrin B. Chinese Trad Herb Drug 31: 531-533.
35. Ren L (2018) Studies on the effect and mechanism of chrysophanol on cell cycle and apoptosis of breast cancer. Liaoning University of traditional Chinese Medicine, Shenyang.
36. State Administration of Traditional Chinese Medicine (1999) Chinese materia medica. Shanghai Science and Technology Publishing House, Shanghai.
37. Dai M, You Y (1995) Radix isatidis and vitamin C in the treatment of herpes simplex keratitis. Strait Pharmaceut J 7: 51-52.
38. Qin H, Shi B, Li S, Fan X, Song D, et al. (2009) Comparing research in antiviral action of Rhizoma et Radix Baphicacanthis cusiae and Radix isatidis against influenza A virus. Chinese Arch Trad Chinese Med 27: 168-169.
39. Luo X, Du T, Zhang D, Hong D, chen Y (2011) Study on pharmacological functions of Radix isatidis grown in different regions. J Trad Chinese Med Pharmacol 17: 66-69.
40. Waqar I, Muhammad Q, Ali N, Muhammad T, Chen S, et al. (2018) Management of Tobacco Mosaic Virus through Natural Metabolites. Rec Nat Prod 12: 403-415.
41. Chen Y, Ru B, Zhuo Y, Li J, Chen J, et al. (2018) Screening and inhibitory effects of plant extracts against Tobacco mosaic virus (TMV). J Plant Protect 45: 463-469.
42. Hu X, Cheng J, Liu S, Zuo X (2001) Experimental study on the relationship between the titer of Baphicacanthus cusia agglutinin and inhibition of influenza virus. Acta Univ Trad Med Sin Pharmacol Shanghai15: 56-57.
43. Li L, Dong T (1994) Study on the quality control of Folium isatidis and its preparation. Acta Pharmaceutica Sinica 29: 128-131.
44. Lin J, Ma E, Lin T (2017) The preparation and application of traditional Chinese medicine feed additive for improving immunity of pigs In Office, C.I.P. edn. China.
45. Xuan X (2008) Present situation and future forecast of Baphicacanthus cusia. Mod Chinese Med 10: 42-43.