Review

Antiviral medicinal plants found in Lanna traditional medicine

Jakaphun Julsrigival a,b,c,*, Panee Sirisa-ard c, Sarinya Julsrigival d, Nararat Akarchariya c

a Cluster of Excellence on Biodiversity Based Economics and Society (B.BES-CMU), Chiang Mai University, Chiang Mai 50200, Thailand
b Innovation Center for Holistic Health, Nutraceuticals and Cosmeceuticals, Faculty of Pharmacy, Chiang Mai University, Chiang Mai 50200, Thailand
c Medicinal Plant Innovation Center, Faculty of Pharmacy, Chiang Mai University, Chiang Mai 50200, Thailand
d Drug Section, Regional Medical Sciences Center 1 Chiang Mai, Department of Medical Sciences, Ministry of Public Health, Chiang Mai 50180, Thailand

A R T I C L E   I N F O
Article history:
Received 6 August 2021
Revised 5 September 2021
Accepted 8 September 2021
Available online 20 September 2021

Keywords:
antiviral activity
Lanna wisdom
traditional medicine

A B S T R A C T

Traditional medicine uses a multitude of plants to create medicinal formulations, some of which show antiviral properties that may be of benefit in treating emerging viral diseases, including Covid-19. Lanna, an ancient Kingdom in Northern Thailand, with a thriving culture that continues to this day and has a rich history of traditional medicine using local plants that is still practiced today. To find potential antiviral medicinal candidates, we examined ancient manuscripts, interviewed traditional healers practicing today, and inventoried current traditional medicines to catalogue 1400 medicinal formulations used in Lanna traditional medicine. We then narrowed this list to find those traditionally used to treat diseases that in their original use and descriptions most likely map to those we know today to be viral diseases. We identified the plants used in these formulations to create a list of 64 potential antiviral herbal candidates drawn from this ancient Lanna wisdom and matched these to the scientific literature to see which of these plants had already been shown to possess antiviral properties, generating a list of 64 potential antiviral medicinal candidates from Lanna traditional medicine worth further investigation for treating emerging viral diseases.

© 2021 Tianjin Press of Chinese Herbal Medicines. Published by ELSEVIER B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

Thai traditional medicines and pharmacopoeia are documented in traditional reference works and textbooks. Ethnomedicine or indigenous medicine continues to play an important role and is still being practiced throughout Thailand, including in the private sector and through local healers and monks. The knowledge and skills of traditional healers was not usually recorded or written but transferred from generation to generation, father to son and teacher to students. The healers and herbalists were usual the same people. The medicaments were usually compound medicines, characterized as having hot, cold, or equally hot and cold properties. The taste sensations of each herb are similar to the activities associated with the medicinal formulation. Hot property medicines

https://doi.org/10.1016/j.chmed.2021.09.006
1674-6384/© 2021 Tianjin Press of Chinese Herbal Medicines. Published by ELSEVIER B.V.
This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
are derived from herbs that produce heat in the body, such as fresh ginger (*Zingiber officinale* Roscoe). Ginger has a sweet-hot property and releases the air element. Consuming ginger warms the body and can relieve fever-related insomnia and flatulence. Cold property medicines, such as *Ficus racemosa* L, can reduce the heat in the body and relieve fever and flu. Some herbs, such as *Leucaena leucocephala* (Lam.) de Wit, contain equal parts of hot and cold properties; Medicines derived from these are used to stabilize and normalize the body temperature. The Royal Thai Government’s Department of Thai Traditional and Alternative Medicine, Ministry of Public Health restores and conserves traditional Thai medicine and knowledge, conducts pharmaceutical research of the traditional herbs, and promotes their use.

Lanna was an ancient kingdom in Northern Thailand, covering eight provinces–Chiang Mai, Chiang Rai, Phayao, Phrae, Nan, Lamphun, Lampang, and Mae Hong Son (Fig. 1). Chiang Mai was the center of the Lanna Kingdom. While the kingdom is gone, much of its culture remains in the people of the region. They retained a close relationship to nature and many of their traditional beliefs, which together provided continued support for traditional healers and the application of medicinal plants as used for centuries in treating those in the Lanna community.

Traditionally, two types of medicines, YaKae and YaTheep, are combined to treat these diseases. YaKae medicines help cure the patient while YaTheep medicines drive off the toxin or lessen the course of illness. If patients are treated with only YaTheep or YaKae medicine, it will take longer to recover, and the disease will recur sooner. The most common YaKae and YaTheep medicines that we found were referenced as Ya Kae Ha Ton and Ya Sri Munluang (Table 1).

In the Lanna context, antiviral medicines typically use names associated with the wind and hot elements. The wind element is involved with the respiratory system. Several symptoms were mentioned, including Khikoo (asthma) and Khaang khare (severe asthma). The hot element is involved with fever, such as fever with toxic substances, which refers to fever accompanied by inflammation. Fever with cough means the prolonged fever effect to the lung. Other fevers are E-suk-e-sai (chicken pox), Ngu-sawad (herpes zoster), Phee kuer (skin rash scattered with pustules) and Hadd (measles rash). The traditional preparations were first documented on palm leaves (Fig. 2) and mulberry bark (Fig. 3).

This paper aimed to gather the formulations of antiviral medicaments used in traditional healing from a variety of sources in the Lanna region of Northern Thailand: palm leaf manuscripts, mulberry bark manuscripts, translations, researches, documents written by healers, interviews with folk healers, and an inventory of herbal plants and medicines in the region. In this study, we

---

**Table 1**

| Formula | Scientific names | Pharmaceutical parts |
|---------|------------------|----------------------|
| **YaKae** | **Ya Kae Ha Ton** | Roots or stems or leaves or aerial parts of a plant |
| **YaKae** | *Nyctocalos brunfelsiflora* Tejolm. & Binn. | Roots |
| **YaKae** | *Melothria affinis* King | Roots or stems or leaves or aerial parts of a plant |
| **YaKae** | *Inula cappa* (Buch.-Ham. ex D.Don) DC. | Roots or stems or leaves or aerial parts of a plant |
| **YaKae** | *Tinospora crispa* (L.) Hook. I. & Thomson | Stems |
| **YaKae** | *Tacca chantrieri* André | Roots |
| **YaKae** | *Momordica charantia* L. | Fruits |
| **YaKae** | *Cyperus rotundus* L. | Rhizome |
| **YaKae** | *Tinospora crispa* (L.) Hook. I. & Thomson | Stems |
| **YaKae** | *Vitex trifolia* L. | Fruits |
| **YaKae** | *Piper nigrum* L. | Fruits |
| **YaKae** | *Micromelum minutum* Wight & Arn. | Aerial parts of a plant |
| **YaKae** | *Eclipta prostrata* (L.) L. | Whole plants (except fruits) |
| **YaKae** | *Strychnos viridiflora* A.W. Hill. | Whole plants (except fruits) |
| **YaKae** | *Inula cappa* (Buch.-Ham. ex D.Don) DC. | Roots or leaves |
| **YaKae** | *Afzelia xylocarpa* (Kurz) Craib. | Stems or roots |

---

*Fig. 1.* A map of Thailand showing Lanna Kingdom shaded.

*Fig. 2.* A palm leaf manuscript (The document kept in Herbal Museum, Medicinal Plant Innovation Center, Faculty of Pharmacy, Chiang Mai University).
intensively searched the Thai traditional medicine references for traditional herbs and medicaments that might offer promise for treating viral diseases or their symptoms. From these preliminary studies, we found that traditional medicinal plants can treat viral diseases and may be of benefit in treating emerging infectious diseases, including Covid-19.

2. Antiviral medicinal plants in Lanna

We analyzed palm leaf and mulberry bark manuscripts from the eight-province Lanna region of Northern Thailand to find traditional medicinal formulas that might offer antiviral properties. We found and analyzed 1400 formulas, mapping their traditional uses to infections that are known today to be viral, such as influenza, several symptoms of toxic fever with or without cough, fever with asthma, chicken pox, herpes zoster, skin rashes with abscesses or pustules, and measles.

About 1400 formulas were selected and their constituent herbs were cross-referenced with current antiviral research to identify the pharmacological effects of these plants.

Table 2
Antiviral medicinal plants found in Lanna traditional medicine.

| Family names | Thai names | Scientific names | Pharmacological effects | References |
|--------------|------------|------------------|-------------------------|------------|
| Acanthaceae  | Pha Ya Yo (Burm.f.) Lindau | Clinacanthus nutans | Anti-Cyprinid herpesvirus 3 (IC50 of ethanolic extract was > 5 mg/mL, ED50 were 0.99, 0.78, 0.75 and 0.71 mg/mL at 1, 2, 3 and 4 h pre-infection) Anti-HSV type 1 activity (Subtoxic concentration of compounds 1, 2 and 3, IC50 were 1.96, 3.11 and 3.11 nmol/L) Anti HSV type 2 activity (Methanolic extract showed a low insignificant effect) Anti-Dengue virus (DENV-2, strain 16681) (Ethanol extract showed moderate activity, IC50 was 31.04 µg/mL) | Haetrakul et al., 2017; Sakdarat et al., 2009; Yoosook et al., 1999; Tu et al., 2014 |
| Acanthaceae  | Sang Ko Ra Ni Dong Wan Nam | Lepidagathis fasciculata (Retz.) Nees | – | – |
| Acoraceae    | Wan Nam | Acorus calamus L. | Anti-Dengue virus serotype 2 (DENV-2) NGC strain (Inhibition of methanolic extract was to 96.5%) Anti-HIV-1 reverse transcriptase activities (IC50 of hexane extract was 32.96 µg/mL) | Rosmalena et al., 2019; Silprasit et al., 2011 |
| Amaranthaceae | Ngon Kai Thai | Celosia argentea L. | – | – |
| Amaranthaceae | Sang Ko Ra Ni Dong Wan Nam | Celosia cristata (synonym) | Antiviral deoxyribonuclease and ribonuclease activity (CCP-27 showed DNase and RNase activity) | Begam et al., 2006 |
| Anacardiaceae | Ma Kok | Spondias pinnata (L. f.) Kurz | – | – |
| Apiaceae     | Bua Bok | Centella asiatica (L.) Urb. | Anti-Herpes simplex type-1 (HSV-1) and vesicular stomatitis (VSV) viruses (MIC of ethanolic extract against VSV was 0.1 mg/mL) Anti-Herpes simplex virus types 1 (HSV-1; KOS strain) and 2 (HSV-2; Baylor 186 strain) (ED50 were 362.40 and 298.84 µg/mL) | Ali et al., 1996; Yoosook et al., 2000 |
| Apocynaceae  | Sat Ta Ban | Alstonia scholaris (L.) R. Br. | Anti-Dengue type 2 (DENV2) and respiratory syncytial virus type A (RSV A) (The early phase of infections was inhibited by alstotides) Anti-Coxsackie B2, Polio virus, Herpes Simplex virus, and Hepatitis B virus (Water and alcohol extracts showed antiviral activity) | Nguyen et al., 2015; Antony et al., 2014 |
| Apocynaceae  | Klet Nak Ka Rat | Dischidia imbricata (Blume) Steud. | – | – |
| Apocynaceae  | Cha Em | Myriopoter extensus (Wight & Arn.) K. Schum. | – | – |
| Apocynaceae  | Khruea Khao | Parmeria laevigata (Juss.) Moldenke | – | – |
| Apocynaceae  | Muak Khao | Parmeria barbata (Blume) K.Schum. (synonym) | – | – |
| Apocynaceae  | Kha Yom Yai | Rauvolfia verticillata (Lour.) Baill. | – | – |
| Araceae      | Phak Nam | Lasia spinosa (L.) | – | – |
| Family names | Thai names | Scientific names | Pharmacological effects | References |
|-------------|------------|------------------|-------------------------|------------|
| Arecales | Mak | Arecaceae | Areca catechu L. | Anti-Human immunodeficiency virus (HIV-1) integrase activity (IC₅₀ of ethanolic and water extracts were 3.2 and 15.7 μg/mL) | Bunluepuech & Tewtrakul, 2011 |
| Asparagaceae | Chan Daeng | Dracaena cochinchinensis (Lour.) S.C.Chen | Anti-Human immunodeficiency virus (HIV-1) integrase activity (IC₅₀ of ethanolic extract was 3.2 and 15.7 mg/mL) | – |
| Bignoniaceae | Pip | Millingtonia hortensis L.f. | Anti-Human immunodeficiency virus (HIV-1) integrase activity (IC₅₀ of ethanolic and water extracts were 3.2 and 15.7 mg/mL) | Suedee et al., 2014; Akanitapichat et al., 2005 |
| Burseraceae | Ma Kok Kluean | Canarium subulatum Guillaum. | Anti-Herpes simplex type-1 (HSV-1) (IC₅₀ of b-amyrin and cubebin were 234 and 280 mmol/L) | Sritularak et al., 2013 |
| Convolvulaceae | Bai Ra Bat | Argyreia nervosa (Burm. f.) Bojer | Anti-HIV activity (Ethanolic extract showed anti-HIV activity of syncytium reduction assay > 80% and EC₅₀ was 11.87 μg/mL) | Sareedenchai et al., 2014; Woradulayapinij et al., 2005 |
| Costaceae | Ueang Mai Na | Chelocostus speciosus (J.Koenig) C.D.Specht | – | – |
| Orchidaceae | Kam Pu Lut | Tradescantia zebrina var. zebrina | – | – |
| Cucurbitaceae | Phak Tam Lueng | Coccinia grandis (L.) Voigt | – | – |
| Cyperaceae | Ya Hao Mu | Cyperus rotundus L. | Anti-Hepatitis A, Herpes simplex type 1, and Cossackie viruses (Antiviral activities of oil were 7.98, 14.21 and 8.79%) Anti-hepatitis B virus (HBV) (IC₅₀ of ethyl acetate, n-butanol and aqueous fractions were 46.2, 94.8, and 107.8 μg/mL) Anti-Herpes simplex-1 virus (HSV), poliomyelitis-1 virus (POLIO) and vesicular stomatitis virus (VSV) (Hydro-alcoholic extract showed virucidal effect against HSV) | Samra et al., 2020; Parvez et al., 2019; Soltan & Zaki, 2009 |
| Euphorbiaceae | Di Mi | Claoxyln parviflorum A.Juss. | – | – |
| Euphorbiaceae | Phang Khi Yai | Croton crassifolius Geiseler | – | – |
| Euphorbiaceae | Som Chao Kham Saet | Euphorbia tortilis Rottler ex Ainslie | Anti Sindbis (SINV), human polio virus 1 (POLO), and Herpes simplex virus 1 (HSV) (MIC of methanolic extracts were 200, 50, and 25 μg/mL) | Taylor et al., 1996 |
| Fabaceae | Nam Khi Raet | Acacia pennata (L.) Wild. | – | – |
| Fabaceae | Kra Dai Ling Fang | Bauhinia scandens L. | – | – |
| Fabaceae | Fang | Coesalpinia sappan L. | Anti-Influenza viral activity (Influenza viruses A/PR/8/34 (H1N1), B/ Jiangsu/10/2003, and Influenza virus A/Guangdong/243/72 (H3N2) (IC₅₀ of 3-deoxysappanchalcone and sappanchalcone against influenza virus (H3N2) were 1.06 and 2.06 μg/mL) Anti-Influenza virus (A/PR/8/34 (H1N1), B/ Jiangsu/10/2003, and Influenza virus A/Guangdong/243/72 (H3N2) (IC₅₀ of 3-deoxysappanchalcone and sappanchalcone against influenza virus (H3N2) were 1.06 and 2.06 μg/mL) Anti-Porcine reproductive and respiratory syndrome virus (PRRSV) (Anti-PRRSV agents were coumarin, byakangelicin, and flavonoids) | Liu et al., 2009; Arjin et al., 2021 |

(continued on next page)
| Family names | Thai names | Scientific names | Pharmacological effects | References |
|--------------|------------|------------------|-------------------------|------------|
| Fabaceae     | Thua Rae   | Cajanus cajan (L.) Millsp. | Anti-Herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2) ([IC50 of ethanol extract against HSV-1 and HSV-2 were 0.022 and 0.1 μg/mL] Anti-Measles virus (MV) (Hot-water and ethanol extracts showed anti-MV properties) | Zu et al., 2010; Nwodo et al., 2011 |
| Fabaceae     | Thua Phra  | Canavalia ensiformis (L.) DC. | Anti-Newcastle disease virus (60 mg/100 mL of water extract inhibited replication of Newcastle disease virus) Anti-Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Glycyrrhizin inhibited SARS-CoV-2 replication at 0.5 and 1 mg/mL) Anti-Human immunodeficiency virus (HIV) and Herpes simplex virus (HSV) (EC50 of alkaline (pH12.0) extract against HIV-infected cells was 54.1 μg/mL and EC50 of isoliquiritin against HSV-infected were 0.84 and 0.14 μg/mL) Anti-Japanese encephalitis virus strains (JEV), West Nile virus strains, Sindbis, Adenoviruses, and Coxackie viruses (The ammonium salt of GA inhibited plaque formation of JEV at 1000 μg/mL) Anti-influenza A/H1N1/pdm09 virus (Selectivity index of glycyrrhizic acid conjugates with aromatic amino acids methyl esters (phenylalanine and tyrosine) and s-benzylcysteine were 61, 38, and 71) | Omer et al., 2014; Sand et al., 2021; Fukuchi et al., 2016; Badam, 1997; Baltina et al., 2015 |
| Fabaceae     | Cha Em Thet | Glycyrrhiza glabra L. | Anti-Severe acute respiratory syndrome coronavirus (SARS-CoV-2), in silico (19-Nortestosterone, mesterolone, oleanolic acid, rutin, and ursolic acid showed a low binding energy in MPro, HR1, and NF-κB) | Purwanti et al., 2021 |
| Fabaceae     | Thua Paep  | Lablab purpureus (L.) Sweet | Anti-Severe acute respiratory syndromecoronavirus (SARS-CoV-2), in silico (19-Nortestosterone, mesterolone, oleanolic acid, rutin, and ursolic acid showed a low binding energy in MPro, HR1, and NF-κB) | Akanitapichat et al., 2005 |
| Fabaceae     | Thua Phu   | Psophocarpus tetragonolobus (L.) DC. | Anti-Herpes simplex virus type 1 ([IC50 of dichloromethane–methanol and methanolic extracts were 24, and 30 μg/mL) | Akanitapichat et al., 2005 |
| Lecythidaceae | Kra Don    | Careya arborea Roxb. | -- | -- |
| Lecythidaceae | Kra Don    | Careya sphaerica Roxb. (synonym) | Anti-Herpes simplex virus type 1 ([IC50 of dichloromethane–methanol and methanolic extracts were 24, and 30 μg/mL) | Akanitapichat et al., 2005 |
| Marsileaceae | Phak Waen  | Marsilea crenata C. Presl | -- | -- |
| Menispermaceae | Thao Ya   | Tiliacora triandra Diels | -- | -- |
| Moraceae     | Ma Duea Plong | Ficus hispida L.f. | -- | -- |
| Orchidaceae  | Phaen Din Yen | Nervilia concolor (Blume) Schltr. | -- | -- |
| Orchidaceae  | Phaen Din Yen | Nervilia aragouna Gaudich. (synonym) | -- | -- |
| Pandanaceae  | Lam Chiak | Pandanus utilis Bory | -- | -- |
| Pandanaceae  | Lam Chiak | Pandanus odoratissimus Jacq. (synonym) | -- | -- |
| Passifloraceae | Phak Sap  | Adenia viridiflora Craib | -- | -- |
| Phyllanthaceae | Phak Wan Ban | Securinega leucopyrus (Willd.) Müll.Arg. | -- | -- |
| Phyllanthaceae | Phak Wan Ban | Saururus androgynum (L.) Merr. | -- | -- |
| Phyllanthaceae | Phak Wan Ban | Phyllanthus reticulatus Poir. | -- | -- |
| Phyllanthaceae | Phak Wan Ban | Piper retrofractum Vahl | Anti-Mosquito-borne dengue virus (DENV) (Virucidal activity of ethanol extract against DENV2 was 84.93%) | Klawikkan et al., 2011 |
| Piperaceae    | Di Pli     | Piper chaba Hunter (synonym) | -- | -- |
| Primulaceae  | Cham       | Ardisia attenuata Wall. ex A.DC. | -- | -- |
those for which findings have reported antiviral activity. Sixty-four medicinal plants in Thai names with a scientific name were selected and reviewed for their antiviral properties. Synonym names were included for analysis. The medicinal plants we found belonged to the following families (number per family): Acanthaceae (2), Acocraccae (1), Amaranthaceae (2), Anacardiaceae (1), Apioaceae (1), Apocynaceae (6), Araceae (1), Arecaaceae (1), Asparagaceae (2), Bignonieae (1), Burseraceae (2), Celastraceae (1), Commelinaceae (2), Compositae (2), Convolvulaceae (1), Costaceae (1), Cucurbitaceae (2), Cyperaceae (1), Euphorbiaceae (5), Fabaceae (9), Lecythiseae (2), Marsileaceae (1), Menispermacae (1), Moraceae (2), Orchidaceae (3), Pandanaceae (2), Passifloraceae (1), Phyllanthaceae (4), Piperaceae (2), Primulaceae (3), Proteaceae (1), Rhamnaceae (1), Rubiaceae (3), Rutaceae (1), Salvadoraceae (1), Solanaceae (2), Stemonaceae (1), Vitaceae (1), and Zingiberaceae (2).

Previous studies have shown that 24 Lanna medicinal plants had antiviral activities (Table 2). Medicinal plants that have potential antiviral activities include Clinacanthus nutans (Burm.F.) Lindau, Blumea balsamifera (L.) DC., Caesalpinia sappan L., and Glycyrrhiza glabra L.

C. nutans, Pha Ya Yo, belongs to the family Acanthaceae. In Thailand, this plant has been used to treat skin ailments. Leaves of C. nutans are extracted with ethanol and used to prepare topical formulations to treat Herpes simplex virus and Varicella-zoster virus. The plant has been tested for several anti-viral properties, including anti-Cyprinid herpesvirus 3, anti-HSV type 1 activity, anti-HSV type 2 activity, and anti-Dengue virus (Haetrakul et al., 2017; Sakdarat et al., 2009; Yoosook et al., 1999; Tu et al., 2014). Chlorophyll derivatives (phaeophytins) were extracted from leaves of C. nutans and showed anti-Herpes simplex virus type 1 (HSV-1) activities at subtoxic concentrations. These compounds could prevent the entry of the virus into cells (Sakdarat et al., 2009).

B. balsamifera, Compositae, Nat Yai, has been used widely in Thai traditional medicine, including as a carminative, for relieving sinusitis pain, and preparing bath water for mothers after giving birth. The main compounds have been identified, and include essential oil, steroids, flavonoids, and coumarin (Ruangrunsi et al., 1985). Many anti-viral properties have been tested, including anti-HIV-1 integrase activity and anti-Zika virus (ZIKV). Antibacterial and antifungal activities against Bacillus cereus, Staphylococcus

| Family names | Thai names | Scientific names | Pharmacological effects | References |
|--------------|------------|----------------|------------------------|------------|
| Primulaceae  | Kam Lang   | Ardisia villosa Roth. | Anti-Herpes simplex virus type 1 (HSV-1), Poliovirus type 1, and Measles virus | Lipipun et al., 2003 |
| Primulaceae  | Chang      | Ardisia vestita Wall. (synonym) | | |
| Proteaceae   | Mueat      | Helicia nilagirica Bedd. | | |
| Rhamnaceae   | Rang       | Ventilago denticulata Wild. | Anti-Herpes simplex virus type 1 (HSV-1), Poliovirus type 1, and Measles virus | Lipipun et al., 2003 |
| Rubiaceae    | Kra Gian   | Cerisoides turgida | | |
| Rubiaceae    | Chan Tha Na | Tarenna hoaensis Pit. | | |
| Rutaceae     | Kao        | Magnolia paniculata (L.) Jack | Anti-A/duck/ Egypt/ Q5569D/2012(H5N1) virus | Baker, Ibrahim, Kandeil, & Baz, 2017 |
| Salvadoraceae | Nam        | Azima sarmentosa (Blume) Benthi. & Hook.f. | | |
| Solanaceae   | Dap Yang   | Solanum erianthum D. Don | Anti-Hepatitis B virus (HBV) | Chou et al., 2012 |
| Solanaceae   | Tong Tang  | Solanum spirale Roxb. | | |
| Stemonaceae  | Non Tai    | Stemona tuberosa Lour. | Anti-Herpes simplex viruses HSV type 1 and type 2 (TI value of ethanolic extract against HSV-1 was 41.30 and TI value of aqueous extract against HSV-2 was 3.64) | Chaliewchalad et al., 2013 |
| Vitaceae     | Khueang    | Leuca rubra Blume ex Spreng. | | |
| Zingiberaceae| Kra Wan    | Elettaria cardamomum (L.) Maton | Activity and expression of Matrix metalloproteinase (MMP-2, MMP-9), and Tissue inhibitor of metalloproteinases (TIMP-1, TIMP-2) (Aqueous extract inhibited the activities and expression of MMP-2 and MMP-9) | Sharma et al., 2015; Chang et al., 2013; Hayati et al., 2021; Kaushik et al., 2020 |
| Zingiberaceae| Khing      | Zingiber officinale Roscoe | Anti-Human respiratory syncytial virus (HRSV) (Fresh ginger inhibited HRSV-induced plaque formation in HEp-2 and AS49) | |

(continued)
The chemical compounds have been extracted from Caesalpinia sappan L., including brazilin, braziliin, protosappanin A, 3-deoxysappanachone, sappanchalcone, and rhamnetin. These compounds showed activities against neuraminidase (NA) inhibitory activity (anti-Influenza viral activities) (Liu et al., 2009). C. sappan, Fabaceae, is distributed throughout Southeast Asia, Africa, and America. Its size was small to medium. The heartwood of C. sappan has been used to treat inflammatory disease, arthritis, and cancer. Other biological activities of this plant have also been investigated, including antioxidant activities and its protective effects against DNA damage (Saenjum et al., 2010).

Licorice, Glycyrrhiza glabra L., has been used as a traditional medicine, particularly as an expectorant to treat sore throats and coughs. The licorice plant has a sweet taste due to glycyrrhizin and its derivatives. It has been tested for its anti-viral properties against several viruses, including Newcastle disease virus, SARS-CoV-2, human immunodeficiency virus (HIV), Herpes simplex virus (HSV), Japanese encephalitis virus (JEV), West Nile virus, Sindbis, adenoviruses, Coxsackie viruses, and Influenza A/H1N1/pdm09 virus. Moreover, licorice extract has been shown to inhibit Candida albicans, Lactobacillus casei, and Lactobacillus acidophilus (Sirlun et al., 2018).

3. Conclusion

We analyzed over one thousand traditional formulations made from various medicinal plants to find those that might offer antivi-
ral properties. Previous scientific research supported the antiviral properties of many of these formulations. As some of the docu-
ments studied were over 100 years old, we were unable to identify some of the plants referenced, as old names could not always be matched to their scientific names. Only a few of the plants we identified based on their traditional uses as possibly offering antiviral properties have been investigated both in vitro and in vivo. Further studies are needed to identify their active compo-

aureus, Candida albicans, and Enterobacter cloacae have been reported (Sakee et al., 2011).

Badam, L. (1997). Ammonium salt of glycyrrhizic acid as an antiviral. The National Medical Journal of India, 10(2), 98.
Baker, D. H. A., Ibrahim, E. A., Kandeel, A., & Baz, F. K. E. (2017). Steroids bioactivity of suppressing feedlot. L. and Murray, 25 pages. L. International. Journal of Pharmaceutical Sciences, 9, 102–103.
Baltina, L. A., Zarubova, V. V., Baltina, L. A., Orshanskaya, I. A., Fairishwina, A. I., Korytina, O. L. & Yunosov, M. S. (2015). Glycyrrhizinic acid derivatives as influenza A/H1N1 virus inhibitors. Bioorganic & Medicinal Chemistry Letters, 25(6), 1742–1746.
Begam, M., Narwal, S., Roy, S., Kumar, S., Lodha, M. L., & Kapoor, H. C. (2006). An antiviral protein having deoxynucleosyme and nucleosyme activity from leaves of the post-flowering stage of Celaostia cristata. Biochemistry (Moscow), 71 (51), 544–548.
Bununquep, K., & Tewtrakul, S. (2011). Anti-HIV-1 integration activity from Chinese medicinal plants in laboratory prepa-

References

Akanitachipt, P., Wangmaneerat, A., & Teerawatnasuk, N. (2005). Anti-herpes simplex virus type 1 activity of local Northeastern plants. Thai Journal of Pharmaceutical Sciences, 29(3–4), 137–145.
Ali, A., Mackeen, M. M., El-Sharkawy, S. H., Hamid, J. A., Ismail, N. H., Ahmad, F. B. H., & Lajis, N. H. (1996). Antiviral and cytotoxic activities of some plants used in Malaysian indigenous medicine. Pertanika Journal of Tropical Agricultural Science, 19(2), 129–136.
Anthony, M., Mishra, C. S., & Thakankani, V. (2014). Evaluation of active fraction from plant extracts of Alstonia scholaris for its in-vitro and in-vivo antiviral activity. Journal of Pharmaceutical Sciences, 6, 775–781.
Arjir, C., Hongxiongsong, S., Prinprakor, K., Seel-Audom, M., Ruksirawanch, W., Sutan, K., & Sirigarm, K. (2021). Effect of ethanol Caesalpinia sappan fraction on in vitro antiviral activity against porcine reproductive and respiratory syndrome virus. Veterinary Sciences, 8(6), 106, 1–14.

Badam, L. (1997). Ammonium salt of glycyrrhizic acid as an antiviral. The National Medical Journal of India, 10(2), 98.
Baker, D. H. A., Ibrahim, E. A., Kandeel, A., & Baz, F. K. E. (2017). Steroids bioactivity of suppressing feedlot. L. and Murray, 25 pages. L. International. Journal of Pharmaceutical Sciences, 9, 102–103.
Baltina, L. A., Zarubova, V. V., Baltina, L. A., Orshanskaya, I. A., Fairishwina, A. I., Korytina, O. L. & Yunosov, M. S. (2015). Glycyrrhizinic acid derivatives as influenza A/H1N1 virus inhibitors. Bioorganic & Medicinal Chemistry Letters, 25(6), 1742–1746.
Begam, M., Narwal, S., Roy, S., Kumar, S., Lodha, M. L., & Kapoor, H. C. (2006). An antiviral protein having deoxynucleosyme and nucleosyme activity from leaves of the post-flowering stage of Celaostia cristata. Biochemistry (Moscow), 71 (51), 544–548.
Bununquep, K., & Tewtrakul, S. (2011). Anti-HIV-1 integration activity from Chinese medicinal plants in laboratory prepa-

3. Conclusion

We analyzed over one thousand traditional formulations made from various medicinal plants to find those that might offer antivi-
ral properties. Previous scientific research supported the antiviral properties of many of these formulations. As some of the docu-
ments studied were over 100 years old, we were unable to identify some of the plants referenced, as old names could not always be matched to their scientific names. Only a few of the plants we identified based on their traditional uses as possibly offering antiviral properties have been investigated both in vitro and in vivo. Further studies are needed to identify their active compo-

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This study was supported by the Medicinal Plant Innovation Center, Faculty of Pharmacy, Chiang Mai University. Figures were drawn and photographed by Kritsaya Chaithathawatana, Faculty of Pharmacy, Chiang Mai University.
Sakdarat, S., Shuyprom, A., Pientong, C., Ekalaksananan, T., & Thongchai, S. (2009). Bioactive constituents from the leaves of Clinacanthus nutans Lindau. Bioorganic & Medicinal Chemistry, 17(5), 1857–1860.

Sakoe, U., Maneerat, S., Cushnie, T. P. T., & De-eknamkul, W. (2011). Antimicrobial activity of Blumea balsamifera (L.) DC. extracts and essential oil. Natural Product Research, 25(19), 1849–1856.

Samra, R. M., Soliman, A. F., Zaki, A. A., El-Gendy, A. N., Hassan, M. A., & Zaghloul, A. M. (2020). Chemical composition, antiviral and cytotoxic activities of essential oil from Cyperus rotundus Growing in Egypt: Evidence from chemometrics analysis. Journal of Essential Oil Bearing Plants, 23(4), 648–659.

Sand, L. V. D., Bormann, M., Alt, M., Schipper, L., Heilingloh, C. S., Steinmann, E., ... Krawczyk, A. (2021). Glycyrrhizin effectively inhibits SARS-CoV-2 replication by inhibiting the viral main protease. Viruses, 13(4), 609, 1–10.

Sareedenchai, V., Wiwat, C., Wongsinkongman, P., & Soonthornchareonnon, N. (2014). In vitro testing of anti-HIV and antioxidative activities of Argyreia nervosa (Burm.f) Bojor Leaves. Mahidol University. Journal of Pharmaceutical Sciences, 41(4), 47–53.

Sharma, B. K., Kinzing, D. C., & Ramos, J. D. (2015). Zingiber officinale Roscoe aqueous extract modulates matrixmetalloproteinases and tissue inhibitors of metalloproteinases expressions in Dengue virus-infected cells: Implications for prevention of vascular permeability. Tropical Journal of Pharmaceutical Research, 14(8), 1371–1381.

Silprasit, K., Seetaha, S., Pongsaranakul, P., Hannongbua, S., & Choowongkorn, K. (2011). Anti-HIV-1 reverse transcriptase activities of hexane extracts from some Asian medicinal plants. Journal of Medicinal Plants Research, 5(19), 4899–4906.

Siinun, S., Sivamaruthi, B. S., Kesika, P., Pengkumrith, N., Tuntisuwanono, N., Chaisayut, K., & Chaisayut, C. (2018). Development and stability evaluation of vaginal suppository containing Chyphyrhiza glabra L. For the treatment of Candida albicans infection. Asian Journal of Pharmaceutical and Clinical Research, 11(7), 205. https://doi.org/10.22159/ajpcr.2018.v11i7.25927.

Soltan, M. M., & Zaki, A. K. (2009). Antiviral screening of forty-two Egyptian medicinal plants. Journal of Ethnopharmacology, 126(1), 102–107.

Sriritalaruk, B., Boonplod, N., Lippun, Y., & Likhitwitsayawid, K. (2013). Chemical constituents of Conarai subulatum and their anti-herpetic and DPPH free radical scavenging properties. Records of Natural Products, 7(2), 129–132.

Sudee, A., Tewtrakul, S., & Panichayupakaranant, P. (2014). Anti-HIV-1 integrase activity of Minusopus elengi leaf extracts. Pharmaceutical Biology, 52(1), 58–61.

Taylor, R. S. L., Hudson, J. B., Manandhar, N. P., & Towers, G. H. N. (1996). Antiviral activities of medicinal plants of southern Nepal. Journal of Ethnopharmacology, 54(2), 97–104.

Tu, S. F., Liu, R., Cheng, Y. B., Hsu, Y. M., Du, Y. C., El-Shazly, M., & Chang, F. R. (2014). Chemical constituents and bioactivities of Clinacanthus nutans aerial parts. Molecules, 19(12), 20382–20390.

Vista, F. E. S., Dalmacio, L. M. M., Corales, L. G. M., Salem, G. M., Galula, J. U., & Chao, D. Y. (2020). Antiviral effect of crude aqueous extracts from ten Philippine medicinal plants against Zika virus. Acta Medica Philippina, 54(2), 195–202.

Woradulayapinij, W., Soonthornchareonnon, N., & Wiwat, C. (2005). In vitro HIV type 1 reverse transcriptase inhibitory activities of Thai medicinal plants and Canna indica L. rhizomes. Journal of Ethnopharmacology, 101(1-3), 84–89.

Yooosook, C., Bunyapraphatsara, N., Boonnyakiat, Y., & Kantasuk, C. (2000). Anti-herpes simplex virus activities of crude water extracts of Thai medicinal plants. Phytotherapy, 6(6), 411–415.

Yooosook, C., Panpisutchai, Y., Chaichana, S., Santisuk, T., & Neutrakul, V. (1999). Evaluation of anti-HSV-2 activities of Barleria lupulina and Clinacanthus nutans. Journal of Ethnopharmacology, 67(2), 179–187.

Zu, Y., Fu, Y., Wang, W., Wu, N., Liu, W., Kong, Y., & Reichling, J. (2010). Comparative study on the antitherpetic activity of aqueous and ethanolic extracts derived from Cajanus cajan (L.) Millsp. Forsch Komplementmed, 17(1), 15–20.