

# The Immunological Significance of Medicinal Plants in Disease Control and Prevention in Humans

Fakhri S. Alajeeli<sup>1</sup>, Abdullah Salim Al-Karawi<sup>2</sup>, Mustafa M. Ali<sup>3</sup><sup>\*</sup>

<sup>1</sup>Al-Hadi University College, Department of Medical laboratory Technologies, 10011, Baghdad/ Iraq.

<sup>2</sup>Department of Biology, College of Science, Mustansiriyah University, Baghdad, Iraq.

<sup>3</sup>Amsterdam University, college of human physiology, Netherland.

\*Corresponding Author: Mustafa M. Ali

DOI: <https://doi.org/10.55145/ajbms.2023.1.2.003>

Received May 2023; Accepted July 2023; Available online July 2023

**ABSTRACT:** This abstract provides a review highlighting the significant role of medicinal plants in the treatment of various diseases globally. To explore this, a questionnaire was conducted in Baghdad to inquire whether individuals resorted to using medicinal plants when experiencing illness. The objective was to gain insights into the efficacy of medicinal plants when used as a form of treatment. Findings from studies conducted worldwide consistently indicate that medicinal plants are widely utilized due to their positive outcomes and cost-effectiveness compared to chemical drugs. Furthermore, ongoing research on the effects of medicinal plants has resulted in the development of novel therapies for numerous chronic ailments, including Parkinson's disease, diabetes, hypertension, peptic ulcers, IBS syndrome, and other acute and chronic conditions.

**Keywords:** medicinal plants, plant extracts, inflammation, COVID-19



## 1. INTRODUCTION

A variety of diseases can now be treated or prevented with the help of medicinal plants. Each plant contains several vital components that can be utilized in the medical industry and used to create various types of drugs [1]. Several underdeveloped or even developed nations use herbal medicine to maintain human well-being, treat specific diseases like coughs, and maintain individual health conditions. Echinacea, garlic, ginger, ginkgo, ginseng, and other plants are among these [2]. The use of medications grew over time. Direct use of therapeutic plants still seems to have found a place in contemporary medicine today [3]. The pharmaceutical drug industry, founded mainly on active principles, is necessary for modern drugs [4].

Recently, there has been an increasing focus on the potential therapeutic benefits of medicinal plant extracts in reducing inflammation. Inflammation is crucial in many chronic diseases, such as arthritis, cardiovascular disease, and cancer. Studies have demonstrated the anti-inflammatory properties of various medicinal plants and their extracts. For example, curcumin derived from turmeric has been shown to possess potent anti-inflammatory effects by inhibiting vital inflammatory pathways [5]. Similarly, *Boswellia serrata* extract has been found to inhibit pro-inflammatory enzymes and cytokines, thereby reducing inflammation in conditions like osteoarthritis [6, 7].

Furthermore, amidst the ongoing COVID-19 pandemic, there has been growing interest in exploring the potential antiviral properties of certain medicinal plants. Preliminary research suggests that plant compounds like quercetin in onions and EGCG in green tea may exhibit antiviral activity against respiratory viruses, including coronaviruses [8].

These findings highlight the immense therapeutic potential of medicinal plants and their extracts in combating inflammation-related disorders and potentially offering antiviral effects against viral infections.

## 2. Immunomodulatory Effects of Volatile Oils, Turmeric, and Curcumin

### 2.1. Volatile Oils

Volatile oils, also known as essential oils, have potential immunomodulatory effects. These oils are derived from medicinal plants and contain bioactive compounds that positively influence the immune system. They exhibit antimicrobial, antiviral, and anti-inflammatory properties, supporting the immune response against pathogens. Volatile oils stimulate the production and activity of immune cells, enhancing overall immune function. Incorporating these oils into healthcare practices may bolster immunity and promote human disease control and prevention [9].

### 2.2. Turmeric Powder

Turmeric powder, derived from the *Curcuma longa* plant's root, shows potential immunomodulatory properties. The active compound in turmeric, curcumin, has been extensively studied for its anti-inflammatory and antioxidant effects. These properties contribute to its positive impact on the immune system by regulating immune cell function and modulating inflammatory responses. Curcumin's antioxidant activity protects immune cells from oxidative damage, supporting their optimal functioning. Including turmeric powder in dietary habits may benefit immune health and improve disease control and prevention [10].

### 2.3. Curcumin

Curcumin is the main bioactive compound in turmeric, with extensive research on its immunomodulatory effects. It possesses anti-inflammatory, antioxidant, and antimicrobial properties that contribute to its impact on the immune system. Curcumin can modulate various immune response components by regulating inflammatory pathways and immune cell function. It inhibits pro-inflammatory molecule production while stimulating anti-inflammatory cytokines. The antioxidant activity of curcumin helps protect immune cells from oxidative damage and supports proper functioning. Research suggests curcumin positively influences immune health by promoting a balanced immune response and contributing to human disease control and prevention [11].

## 3. Uses of plants from different countries

The World Health Organization (WHO) estimates that 80% of the global population relies on natural resources for healthcare, primarily plants and plant extracts. Ayurveda, Traditional Chinese Medicine (TCM), Unani, and biomedicine are traditional medicinal systems that comprise thousands of medications created from secondary metabolites of various plant sections, like ethnomedicine. More than 400 plants and traditional medicines are used in India to produce the Ayurveda, Siddha, and Unani medicinal systems, with about 25% of the plants coming from temperate and 75% from tropical forests. India, divided into phytogeographical zones with over 45000 different plant species and traditional communities, is one of the world's 4 biodiversity hotspots [12].

## 4. VALUE OF MEDICAL PLANTS

Alternative medicine is the practice of employing plants for therapeutic purposes (AM). Nearly every culture, particularly Western and Asian, has employed AM. Regrettably, most people today still think that the only reliable and efficient medication is the one with a dosage form [13]. Even though numerous tablets and capsules, like paclitaxel, digoxin, and aspirin, are used daily and derived from plants. Our forefathers used plants and herbs to flavor and preserve food, alleviate headaches, and even prevent diseases like epidemics in the past [14]. Human groups have shared knowledge of these plants' therapeutic powers through the ages. Produced active chemicals [15].

## 5. MEDICINAL PLANT ANTI-SALMONELLA IN INDONESIA

These are typical Indonesian plants that can be utilized as herbal treatments for typhoid cases among the 32 types of plants researched. Most of the antibacterial activity was evaluated utilizing the MIC (Minimum Inhibitor Concentration) test system based on the size of the inhibition zone on the supplied medium [16]. Some herb research also compares the antibacterial activity of antibiotics used in pharmacotherapy to treat typhoid. According to a recent study from Indonesia, *Salmonella typhi* infection in Balb/c mice could be significantly reduced by using an extract from Mayana leaves (*Coleus scutellaroides*. L). The outcome demonstrated a distinctive pattern of TLR-4 expression. TLR-4 mRNA expression was reduced in the manna leaf extract treatment group.

With a mix of antibiotics [17]. Turmeric, Due to its numerous advantageous features, treating inflammation, irritation, digestion, and antiseptic, has been widely utilized in traditional medicine in India, Pakistan, and Bangladesh. According to old Ayurveda, the turmeric plant is a valuable natural antibacterial, antiseptic, anti-inflammatory, and painkiller. It was also frequently used to enhance intestinal flora, aid digestion, and heal skin irritations. It has also been employed as an antiseptic for cuts, bums, and bruises in South Asia [18]. Nevertheless, dried turmeric rhizomes and Table 2, displaying the biological activity of turmeric, have documented many other advantageous qualities. It contains

antifungal, antibacterial, antiparasitic, antimutagen, antimicrobial, and renal properties, as well as those for allergies, arthritis, Alzheimer's disease, and other chronic and difficult-to-cure conditions [19].

**Table 1. - Compound Extracts and Their Biological Activities**

Compound extract	Biological activity
1. Turmeric powder	Antitumor, Anti protozoan Anti-inflammatory and Wound healing
2. Methyl curcumin	Anti-protozoan.
3. Desmethoxycurcumin and Bisdemethoxycurcumin	Antioxidant.
4. Volatile oil	Anti-inflammatory. Antibacterial, Antifungal.
5. Curcumin	Antibacterial, Anti protozoan. Antiviral. Antitumor and Antioxidant.

## 6. GINGER USES ANTI-ULCER AND ANTICHOLINERGIC.

Because of its antioxidant capabilities, ginger protects the gastric mucosa from various substances that can induce ulcers. Prostaglandin has been demonstrated to have a housekeeping and gastro-protective function by maintaining stomach mucosal integrity, which has many advantages and disadvantages. Ginger exhibits potent antiemetic properties by promoting intestinal motility and blocking serotonin receptors. According to certain reports, ginger stimulates GIT15 5-hydroxytryptamine receptors while antagonistic 5-hydroxy cholinergic and anti-histaminic receptors in the periphery [20].

## 7. ANDROGRAPHIC PANICULATE USE FOR CORONA VIRUS

Because of its flavor, *Andrographis paniculate* is sometimes called the "king of bitters" and is known as "Fah Talai Jone" in Thai. The plant's leaves and shoots are utilized to create pharmaceuticals [21]. The leaves are ground up and combined with honey, according to traditional Thai medicine, to treat the flu and sore throat. Researchers looked into herbs' advantages again as a result of the severe acute respiratory illness coronavirus-2 [22]. To validate the outcomes of molecular docking, they first looked at an in-silico model. It became clear as a result that Fah Talai Jone's ability to predict the binding structure of the SARS-CoV-2 Mpro, S-spike protein, ACE2 receptor, RdRp, and N protein RNA-binding domain allows for successful virus suppression [23].

## 8. GARLIC FOR ORDINARY FLU

Garlic has long been used as a herbal remedy for treating colds, flu, bronchitis, and asthma. Moreover, it treats respiratory infections [24]. It is typically used as an antiseptic for phlegm and asthma to treat bronchial illnesses. Moreover, it has uses as an anthelmintic, diaphoretic, and antihypertensive [25].

Warnings: The juice and oil irritate the conjunctiva and mucous membrane. Also, eating a lot of garlic can make you more likely to experience bleeding following surgery. Aside from that, consuming fresh garlic on an empty stomach might result in heartburn, nausea, vomiting, and diarrhea [26].

## 9. CHAMOMILLA ANTI-MICROBIAL ACTIVITY

According to studies, chamomile has anti-microbial capabilities due to bisabolol. Both Gram-positive and Gram-negative bacteria are resistant to it. investigated the antibacterial potential. With a blade, cuts were made that later became infected with *Pseudomonas aeruginosa* strains [27]. The effects of chamomile and tetracycline ointments were then compared. Compared to the antibiotic group, it was discovered that the chamomile treatment group had faster wound healing times (5.3 days) (6.3 days). Any microbial infection that develops from biofilm is frequently very difficult to treat [28]. Highly organized microbial cells that surround themselves in a self-made extracellular matrix are called biofilms. They are to blame for the bacterial or fungal resistance that is so hard to eliminate. Moreover, studies have shown that chamomile has the power to destroy biofilms [29]

## 10. CINNAMOM USE FOR DIABETES

With 350 million people worldwide suffering from it, diabetes is the primary cause of morbidity and mortality globally. With the research of their reaction with acarbose, cinnamon species (four types) were observed to have an inhibiting effect on the digestive enzyme glucosidase and pancreatic amylase [30]. It was determined that maltase, sucrose, and pancreatic amylase were all inhibited by all four types of cinnamon research. The strongest and most effective inhibitor of intestinal maltase activity was a kind of cinnamon known as Thai cassia extract. Cinnamon has a lot of vitamins and antioxidants, both of which have a positive impact on fat metabolism. ettle for women's health as an expectorant and for bleeding, urinary tract infections and hormone antioxidants, and vitamins, which can also have a secondary impact on fat metabolism [31]. The health of women can be greatly enhanced by drinking nettle leaf tea. Nettle is a well-liked herb for women's health because it has historically been used to enhance milk supply. Urinary

tract infections are more common in women than in men [32]. Nettle is a diuretic that aids in the removal of more toxins linked to UTIs in women. The astringent qualities of stinging nettle may lessen cramps and bloating associated with menstruation. Unsurprisingly, nettle has been used in pregnancy teas for a long time to provide nutritional support because it contains so many nutrients. Nettle can benefit women ready for menopause by regulating the body's hormonal changes. Urinary tract infections are more common in women than in men. Nettle is a diuretic that aids in removing more toxins linked to UTIs. As a coagulant, nettle helps women stop bleeding [33]. Nettle Helps with healthy skin and bone. Stinging nettle's antihistamine, anti-inflammatory, and antibacterial qualities aid in treating acne and other skin conditions. The amino acids, proteins, flavonoids, and bone-building elements iron, calcium, magnesium, potassium, and zinc are abundant in stinging nettle [25]. Vitamins and minerals found in nettles can support strong bones. One of the best sources of vitamin K is stinging nettle. Vitamin K encourages osteogenic activity, maintaining bone health (the production and strengthening of bone). Stinging nettle contains large amounts of the element borax, which is utilized to keep the body's calcium levels healthy. Stinging nettles that are high in boron can postpone the start of osteoporosis [34]. Cocoa for pressure the biggest risk factors for the development of cardiovascular disease are hypertension and hypertension. Products from cocoa beans, such as cocoa powder and dark chocolate, include varying levels of naturally occurring polyphenols, particularly flavanols like epicatechin. It has been suggested that consuming flavanol-rich cocoa goods and preexisting BP have an antagonistic connection. Nitric oxide synthesis is boosted due to flavanols' ability to inhibit the angiotensin-converting enzyme (ACE) and activate nitric oxide synthase. Vasodilation and a drop in blood pressure are linked to the generation of nitric oxide [35].

### 11. Method

In November 2022, an anonymous cross-sectional survey was conducted online using a stratified random sampling method on an online survey in Baghdad. Provides online questionnaire design and survey functions for enterprises, research institutions, and individuals. The sample database covers over 116 respondents

with confirmed personal information, allowing for an authentic, diverse, and representative sample. The target population in the present study was adults living in Baghdad; thus, a random sample procedure was stratified by age. The study was approved by Al-Hadi university college.

**Table 2. - Characteristics of Study Participants and Respondents' Attitudes towards Natural Health Products**

Variable	N (%)
<b>Gender</b>	
Male	32 (27.6) %
Female	84 (72.4) %
<b>Age</b>	
20-39	110 (94.8) %
40-59	5 (4.3) %
≤ 60	1 (0.9) %
<b>Level of education</b>	
School	10 (8.6) %
Bachelor	101 (87.1) %
Higher degree	5 (4.3) %
<b>Monthly income</b>	
<500,000	82 (70.7) %
500,000 – 1000,000	25 (21.6) %
>1000,000	9 (7.8) %
<b>Do you suffer from chronic disease?</b>	
Yes	100 (86.2) %
No	16 (13.8) %
<b>Are natural health products (herbs) used as therapeutic alternatives?</b>	
Yes	55 (47.4) %
No	61 (52.6) %
<b>Do you think these products are safe because they are made from natural sources?</b>	
Yes	92 (79.3) %
No	24 (20.7) %
<b>Do you think these products are better than medicines?</b>	

Yes	44 (37.9) %
No	72 (62.1) %
<b>Do you consult your doctor or pharmacist before using these products?</b>	
Yes	62 (53.4)%

## Funding

No funding received for this work

## ACKNOWLEDGEMENT

We thank Mustansiriyah University in Baghdad/Iraq (<http://uomustansiriyah.edu.iq>) for its support to achievement this work. Also, we would like to express our gratitude to Al-Hadi University for their support in facilitating the completion of this work.

## CONFLICTS OF INTEREST

The authors declare no conflict of interest

## REFERENCES

- [1] N. H. Rakotoarivelo *et al.*, "Medicinal plants used to treat the most frequent diseases encountered in Ambalabe rural community, Eastern Madagascar," *Journal of ethnobiology and ethnomedicine*, vol. 11, pp. 1-16, 2015.
- [2] H. Yuan, Q. Ma, L. Ye, and G. Piao, "The traditional medicine and modern medicine from natural products," *Molecules*, vol. 21, no. 5, p. 559, 2016.
- [3] A. H. Mohammed, "Importance of medicinal plants," *Research in Pharmacy and Health Sciences*, vol. 5, no. 2, pp. 124-125, 2019.
- [4] J. M. Munita and C. A. Arias, "Mechanisms of antibiotic resistance," *Virulence mechanisms of bacterial pathogens*, pp. 481-511, 2016.
- [5] H. E. Khoo, A. Azlan, S. T. Tang, and S. M. Lim, "Anthocyanidins and anthocyanins: Colored pigments as food, pharmaceutical ingredients, and the potential health benefits," *Food & nutrition research*, vol. 61, no. 1, p. 1361779, 2017.
- [6] B. Gayathri, N. Manjula, K. Vinaykumar, B. Lakshmi, and A. Balakrishnan, "Pure compound from *Boswellia serrata* extract exhibits anti-inflammatory property in human PBMCs and mouse macrophages through inhibition of TNF $\alpha$ , IL-1 $\beta$ , NO and MAP kinases," *International immunopharmacology*, vol. 7, no. 4, pp. 473-482, 2007.
- [7] N. S. S. Siddhu *et al.*, "Pro-inflammatory cytokine molecules from *Boswellia serrata* suppresses lipopolysaccharides induced inflammation demonstrated in an in-vivo zebrafish larval model," *Molecular Biology Reports*, vol. 49, no. 8, pp. 7425-7435, 2022.
- [8] Q. M. S. Jamal, "Antiviral Potential of Plants against COVID-19 during Outbreaks-An Update," (in eng), *Int J Mol Sci*, vol. 23, no. 21, Nov 5 2022, doi: 10.3390/ijms232113564.
- [9] M. Korinek *et al.*, "Anti-Inflammatory and Antimicrobial Volatile Oils: Fennel and Cumin Inhibit Neutrophilic Inflammation via Regulating Calcium and MAPKs," (in eng), *Front Pharmacol*, vol. 12, p. 674095, 2021, doi: 10.3389/fphar.2021.674095.
- [10] J. Sharifi-Rad *et al.*, "Turmeric and Its Major Compound Curcumin on Health: Bioactive Effects and Safety Profiles for Food, Pharmaceutical, Biotechnological and Medicinal Applications," (in eng), *Front Pharmacol*, vol. 11, p. 01021, 2020, doi: 10.3389/fphar.2020.01021.
- [11] A. Allegra, G. Mirabile, R. Ettari, G. Pioggia, and S. Gangemi, "The Impact of Curcumin on Immune Response: An Immunomodulatory Strategy to Treat Sepsis," (in eng), *Int J Mol Sci*, vol. 23, no. 23, Nov 25 2022, doi: 10.3390/ijms232314710.
- [12] J. Gertsch, "How scientific is the science in ethnopharmacology? Historical perspectives and epistemological problems," *Journal of ethnopharmacology*, vol. 122, no. 2, pp. 177-183, 2009.
- [13] A. Arceusz, I. Radecka, and M. Wesolowski, "Identification of diversity in elements content in medicinal plants belonging to different plant families," *Food chemistry*, vol. 120, no. 1, pp. 52-58, 2010.



- [14] R. C. Molina-Quiroz *et al.*, "Exposure to sub-inhibitory concentrations of cefotaxime enhances the systemic colonization of *Salmonella Typhimurium* in BALB/c mice," *Open biology*, vol. 5, no. 10, p. 150070, 2015.
- [15] E. Bekoe, C. Agyare, J. Sarkodie, and D. Dadebo, "Herbal Medicines used in the treatment of Typhoid in the Ga East Municipality of Ghana," *International Journal of Tropical Disease & Health*, vol. 23, no. 4, pp. 1-13, 2017.
- [16] G. A. Koffuor, A. A. Abruquah, R. Audu, J. Amoah, and D. Agwah, "Patronage and perceived efficacy of herbal antityphoid preparations, and anti-*Salmonella* activity of a herbal preparation used in Ghana," *Journal of Applied Pharmaceutical Science*, vol. 6, no. 3, pp. 001-007, 2016.
- [17] F. Syamsuri *et al.*, "Expression of TLR-4 in *Salmonella typhi*-induced balb/c mice treated by miana leaves (*Coleus scutellaroides* (L) Benth)," *Indian J Public Heal Res Dev*, vol. 9, p. 1449, 2018.
- [18] B. Mathew, Y. Amos, O. Abimbola, I. Joshua, and A. Amos, "In Vitro Antimicrobial Activity of Stem Bark Extract of *Azadirachta indica* A. (JUSS) Against Antibiotic Resistant *Salmonella enterica* Serovar Typhi," *American Journal of Laboratory Medicine*, vol. 2, pp. 163-171, 11/28 2017, doi: 10.11648/j.ajlm.20170206.18.
- [19] P. Rani and N. Khullar, "Antimicrobial evaluation of some medicinal plants for their anti-enteric potential against multi-drug resistant *Salmonella typhi*," *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*, vol. 18, no. 8, pp. 670-673, 2004.
- [20] O. S. Mahdi, "Evaluation of inhibitory activity of extracts of *Apium graveolens*, *Coriandrum sativum* and *Cuminum cyminum* against number of pathogenic bacteria," *Kufa Journal For Veterinary Medical Sciences*, vol. 2, no. 2, pp. 37-50, 2011.
- [21] Z. Ud Din, A. A. Shad, J. Bakht, I. Ullah, and S. Jan, "In vitro antimicrobial, antioxidant activity and phytochemical screening of *Apium graveolens*," *Pakistan journal of pharmaceutical sciences*, vol. 28, no. 5, 2015.
- [22] S. Nandagopal and B. R. Kumari, "Phytochemical and antibacterial studies of Chicory (*Cichorium intybus* L.)- A multipurpose medicinal plant," *Advances in Biological Research*, vol. 1, no. 1-2, pp. 17-21, 2007.
- [23] A. Madani and S. Jain, "Anti-*Salmonella* activity of *Terminalia bellerica*: in vitro and in vivo studies," 2008.
- [24] A. Tesfaye, "Revealing the Therapeutic Uses of Garlic (*Allium sativum*) and Its Potential for Drug Discovery," (in eng), *ScientificWorldJournal*, vol. 2021, p. 8817288, 2021, doi: 10.1155/2021/8817288.
- [25] T. Adebolu and S. A. Oladimeji, "Antimicrobial activity of leaf extracts of *Ocimum gratissimum* on selected diarrhoea causing bacteria in southwem Nigeria," *African Journal of Biotechnology*, vol. 4, no. 7, pp. 682-684, 2005.
- [26] S. Adeola, O. Folonunso, O. Okedeyi, B. Ogungbe, O. Babatimehin, and O. Thanni, "Antioxidant and antimicrobial activities of the volatile oil of *Ocimum gratissimum* and its inhibition on partially purified and characterized extracellular protease of *Salmonella enteritidis*," *American journal of drug discovery and development*, vol. 4, no. 3, pp. 180-193, 2014.
- [27] S. Ghasemian *et al.*, "Molecular characterizations of antibiotic resistance, biofilm formation, and virulence determinants of *Pseudomonas aeruginosa* isolated from bum wound infection," (in eng), *J Clin Lab Anal*, vol. 37, no. 4, p. e24850, Apr 2023, doi: 10.1002/jcla.24850.
- [28] M. A. Osman, M. A. Aziz, M. R. Habib, and M. R. Karim, "Antimicrobial investigation on *Manilkara zapota* (L.) P. Royen," *Int J Drug Dev Res*, vol. 3, no. 1, pp. 185-190, 2011.
- [29] O. A. Olufunke, "Antibacterial activities of *Allium sativum*, *Momordica charantia* and *Zingiber officinale* on food-and water-borne pathogens," *African Journal of Plant Science and Biotechnology*, vol. 5, no. 1, pp. 15-19, 2011.
- [30] S. Balakrishnan, I. Sivaji, S. Kandasamy, S. Duraisamy, N. S. Kumar, and G. Gurusubramanian, "Biosynthesis of silver nanoparticles using *Myristica fragrans* seed (nutmeg) extract and its antibacterial activity against multidrug-resistant (MDR) *Salmonella enterica* serovar Typhi isolates," *Environmental Science and Pollution Research*, vol. 24, pp. 14758-14769, 2017.
- [31] R. I. Iyer, G. Jayaraman, and A. Ramesh, "In vitro responses and production of phytochemicals of potential medicinal value in nutmeg, *Myristica fragrans* Houtt," *Indian journal of science and technology*, vol. 2, no. 4, pp. 65-70, 2009.
- [32] E. Nkanwen, D. Gatsing, D. Ngamga, S. Fodouop, and P. Tane, "Antibacterial agents from the leaves of *Crinum purpurascens* herb (Amaryllidaceae)," *African health sciences*, vol. 9, no. 4, 2009.
- [33] J. J. Nair, J. van Staden, S. L. Bonnet, and A. Wilhelm, "Antibacterial properties of the family amaryllidaceae: Evaluation of plant extracts in vitro," *Natural Product Communications*, vol. 12, no. 7, p. 1934578X1701200735, 2017.
- [34] G. S. Kim *et al.*, "Biological and antibacterial activities of the natural herb *Houttuynia cordata* water extract against the intracellular bacterial pathogen salmonella within the RAW 264.7 macrophage," *Biological and Pharmaceutical Bulletin*, vol. 31, no. 11, pp. 2012-2017, 2008.

- [35] P. Kalia, N. R. Kumar, and K. Harjai, "Studies on the therapeutic effect of propolis along with standard antibacterial drug in serovar *Salmonella enterica* Typhimurium infected BALB/c mice," *BMC Complementary & Alternative Medicine*, vol. 16, 2016.