BRADFORD WRITES!
University of Pittsburgh-Bradford
Spring 2021

“More Than a Spice: Ginger and other Natural Remedies”

By Wyatt Druckenmiller

Ever since I was young, I knew that I wanted to help people. There was an urge inside of me to help the people in need. Fast forward to me in high school I still had that urge and passion to go out there and help people in this world. I decided to go to pharmacy school to become a pharmacist. While I am still in undergraduate school it came across to me what else is out there than just regular medications that would be at a pharmacy. What I discovered was there are herbal remedies out there that can help people. I wanted to learn more of this interesting topic. I hope to demonstrate that herbal remedies can be as effective or more effective than just using modern medication.

Herbal remedies have been out there for centuries, and most human civilizations have used only herbal remedies as medicine. For example, Native Americans utilized herbal remedies, and this worked well enough to prevent being wiped out by disease over thousands of years. Herbal remedies are promising because they don’t have artificial chemicals in them that can be harmful to a human, they are all natural. This makes one wonder: What kind of herbal remedies are out there? How are these herbal remedies used to treat people? What is the chemistry behind these herbal remedies? Some pharmaceutical drugs can have negative feedback on a person because of the chemicals that are in it, and herbal remedies are a good alternative because they are natural and may not affect the person negatively.

There are a lot of herbal remedies out there, and some are very helpful toward fighting cancer, such as certain essential oils. For instance, researchers are starting to use ginger as a

natural preservative instead of the use of a synthetic preservative. They are also using the herb ginseng as a treatment to help with fatigue. But before we get into specific application, we first must define our terms. *Johns Hopkins Medicine* writes, “Products made from botanicals, or plants, that are used to treat diseases or to maintain health are called herbal products, botanical products, or phytomedicines” (*Herbal Medicine*). The plant’s product that is used for internal use only is an herbal supplement (*Herbal Medicine*). They come in all forms, including dried, chopped, powdered, in a capsule or as a liquid (*Herbal Medicine*). Herbal supplements can be used in different ways and they can be in pill form, brewed as a tea, applied to skin as gels, lotions, or creams, and they can also be added to bath water (*Herbal Medicine*). While supplements can provide health benefits, here we will primarily focus on herbal remedies and their effectiveness as a supplement to “modern” medicine.

A great example of how herbal remedies are being used in medicine is ginger because it has unique properties to help combat cancer. The herb ginger has been used worldwide as a food and medicinal plant (Sharifi-Rad et al., 2017). Ginger has many uses as an herbal remedy. Traditional cultures have used ginger as an herbal remedy by traditional healing, and in particular the rhizome of the ginger (Sharifi-Rad et al., 2017). Ginger has a history of ethnobotanical uses is because it has an abundance of curative properties (Sharifi-Rad et al., 2017). There is antimicrobial activity in the rhizome essential oil that have two chemical components, and they are monoterpene and sesquiterpene hydrocarbons (Sharifi-Rad et al., 2017). According to Gould (1997), the hydrocarbon monoterpenes are found in essential oils of plants, fruits, vegetables, and herbs. They help prevent the process of carcinogenesis at initiation and promotion/progression stages. They are potentially effective at treating cancers that are in early and advanced stages (Gould, 1997). Monoterpenes are very essential in herbal remedies.

Sesquiterpenes are known for its calming properties, and for giving support to the immune system (Sarah, 2017). They protect us from detrimental microbes because they act as antioxidants, and they also help in cellular repair (Sarah, 2017). The dried rhizome in ginger also shows as a promising source as a natural alternative compared to chemical food preservatives (Sharifi-Rad et al., 2017). The use of ginger as a natural preservative is going to make foods safer, and with less chemicals.

Ginger is known for its aromatic fragrance and penetrating taste. Mahomoodally et. al. (2021) explains that ginger as a natural product is composed of carbohydrates, water, protein, lipids, fibers and volatile essential oils There is a chemical breakdown in the ginger can be synthesized into a drug. A mechanism in the ginger that focuses on attacking cancer cells (Mahomoodally et al, 2021). Ginger has an active compound that could be used in cancer therapy, specifically Gingerol, Shogaol, Gingerdione, and Zingerol (Mahomoodally et al, 2021). Mahomoodally et al (2021) explains that "recently, pharmacological studies have probed into the validation of such claims, and now, ginger together with its associated bioactive compounds have been proven to have potential anticancer properties" (Mahomoodally et al, 2021). Some of the cancers that ginger can help treat are lung, liver, breast, cervical, and prostate (Mahomoodally et al, 2021). Some of the evidence that supports this is its cytotoxic effect against cancer cell lines, enzyme inhibitory action, combination of therapy with chemotherapeutic and phenolic compounds, as well as the use of nano-formulations of ginger bioactive compound as a cancer treatment (Mahomoodally et al, 2021). Ginger, as an herbal remedy that is turned into an essential oil, can help treat some cancers that are out there.

Based on these findings, researchers have continued to explore the use of herbal remedies to treat cancer. There was a recent ethnopharmacological survey of herbal remedies used to treat

numerous types of cancer, and they were considering traditional medicinial methods from the West Bank- Palestine (Jaradat et al, 2016). “Ethnopharmacology studies natural medicines from plants and other substances that have been traditionally used by groups to treat various human diseases.” This means that they are looking at herbal remedies that were being used by Palestinians that were never exposed to traditional medications or had the opportunity to use regular medicine. The reason Palestine is so unique is because its geological location is between Africa, Asia, and Europe (Jaradat et al, 2016). There are a lot of tribes especially in Africa and Asia that had limited contact with other people, and all they use is herbal remedies. Scientists want to go out there and find these tribes, and to see what they are using to fight off cancer and other diseases.

Essential oils are one of the ways they use herbal remedies to help people. A team of researchers did a comparative analysis of essential oils from eight herbal medicines that have a pungent flavor and are cool by nature with GC-MS and chemometric resolution methods (Zhao et al, 2009). These essential oils came from eight traditional Chinese medicines, and their pungent flavor is the main active ingredient of the herb (Zhao et al, 2009). In the analysis of essential oils Zhao et. al. (2009) says that “the use of essential oils is widespread in foods, drinks, cosmetics, and medicine, especially with aromatherapy becoming increasingly popular. The research investigation wanted to explore the relationship with the herbs from the view of chemistry, that way these herbs could be classified into categories, because of their pungent flavor and their cool nature from the TCM theory (Zhao et al, 2009). From this we can see that herbs can be used for therapy medication, and we can also learn more information about how these herbs can help people.

Another type of herbal remedy is ginseng. One treatment ginseng is used for is fatigue (Arring et al, 2018). There are over a million people that suffer from some sort of fatigue (Arring et at, 2018). Fatigue is poorly understood because there is a wide variation of severity between individuals (Arring et al, 2018). Ginseng is believed to improve energy, physical and emotional health, and well-being (Arring et at, 2018). There are two types of ginseng—American and Asian—used as treatment for fatigues, based on the studies that include fatigued participants with chronic illness (Arring et al, 2018).). Fatigue is something that most people experience, and ginseng is a natural herbal remedy that is out there that people can use with worrying about what kinds of artificial chemicals are in it.

Ginger, as mentioned above, is another herb that has been used used worldwide for its medicinal and biological properties (Sharifi-Rad et al., 2017). Researchers looked at the constituents in the ginger to see what medicinal properties they had: Constituents β-sesquiphellandrene (27.16%), caryophyllene (15.29%), α- zingiberene (13.97%), α-farnesene (10.52%), ar-curcumene (6.62%) (Sharifi-Rad et al., 2017). These constituents showed high activity in antimicrobials and antioxidants (Sharifi-Rad et al., 2017). Ginger that is rich in ar-curcumene (59%), β-myrcene (14%),1,8-cineol (8%), citral (7.5%) andα-zingiberene (7.5%) showed high effects as an anti-inflammatory remedy (Sharifi-Rad et al., 2017). Ginger also contains geranial (25.9%), α-zingiberene (9.5%), (E,E)-α-farnesene (7.6%), neral (7.4%)and ar-curcumene (6.6%), and these are major components that are an effective antibacterial and antifungal agent (Sharifi-Rad et al., 2017). These percentages, along with the long history of their use in medicine, suggest that the chemicals in ginger have healing properties

The two major compounds that are found in ginger that are used most frequently are 6-gingerol, and 6-shogaol (Sharifi-Rad et al., 2017). These two compounds have multiple healing

properties, and that is why these are the most often used in an herbal remedy. The way ginger works as an anti-inflammatory is that it inhibits 2 enzymes: 5-lipoxygenase and prostaglandin synthetase (Sharifi-Rad et al., 2017). These enzymes reduce the biosynthesis of pro-inflammatory cytokines and an example would be tumor necrosis factor (TNF) (Sharifi-Rad et al., 2017). TNF means that there is a protein in the body that gets messed up and starts over producing TNF, and this creates inflammation. Rheumatoid arthritis is one of these types of diseases (Rheumatoid arthritis). There was a clinical trial done that had promising effects in reducing the cytokines from the patients that were suffering from osteoarthritis (Sharifi-Rad et al., 2017). The common form of arthritis is Osteoarthritis (*Osteoarthritis,* 2020). This is caused by normal wear and tear; it is when the protective cartilage that cushions the ends of the bones starts wearing down (*Osteoarthritis,* 2020). The chemical compound 6-shogaol worked well against potent antioxidants and anti-inflammatory properties because of its unsaturated ketone moiety (Sharifi-Rad et al., 2017). 6-gingerol, and 6-shogaol are known to help slow down the progression of cancer (Sharifi-Rad et al., 2017). Ginger is a world-renowned herbal remedy that has been used to help people with arthritis and in the future, it might give more answers as a beneficial cure to fight against cancer.

Ginger has been proven to help people that are dealing with cancer, including breast cancer, cervical cancer, prostate cancer, lung cancer, and liver cancer. In breast cancer, there was a methanolic solution of ginger that showed a time-dependent cytotoxic effect on the cell line of the breast cancer (Mahomoodally et al, 2021). Methanolic means “containing methanol,” usually as a solvent. The 6- shogaol compound was found that it could hinder the growth of cancer cells by activating a peroxisomal proliferator receptor (Mahomoodally et al, 2021). In 10-gingerol causes an initiation of the caspase-3 and it inhibited orthotopic tumor growth of breast cancer

metastasis (Mahomoodally et al, 2021). 10-gingerol also inhibits the metastasis on the lung, bone, and brain (Mahomoodally et al, 2021). In cervical cancer there was a study that found 6-shogaol showed high inhibition against HeLa, and it was more effective than α-zingiberene (Mahomoodally et al, 2021). 6-gingerol also blocks the cell cycle from G0/G1 phase in the HeLa cell and it causes the death of that cell (Mahomoodally et al, 2021). Hela cells last longer than normal cells and gives more time to researchers (Anne Marie Helmenstine). In prostate cancer the ginger can reduce the cell viability of number of prostate cancer cells (Mahomoodally et al, 2021). In lung cancer 6-Shogaol is more effective than the 10-gingerol (Mahomoodally et al, 2021). The ginger was able to dimmish the TNF in rats that had liver cancer (Mahomoodally et al, 2021). Maybe in the future and with more testing ginger will be a better remedy for people to use.

It is important to remember that herbal remedies have been around throughout human history and continue to be used. The previously mentioned ethnopharmacological survey (Jaradet et. al., 2016) on herbal remedies that were used for various treatment of different types of cancers, couple with data from the World Health Organization, suggests that “80% of the population in developing countries have utilized ethnomedicines for health care requirements, and 60% of people use natural plants to help battle against cancer” (Jaradat et al, 2016). One of the interesting things is that 50% of modern pharmaceutical medications come from plants (Jaradat et al, 2016). And with the percentages of people getting cancer on the rise every year, these students suggest that herbal remedies can be used as an supplement or alternative to traditional medicine.

This ethnopharmacological survey was conducted from March 2015 to June 2015 and sought to explore how effective herbal remedies are used to treat different types of cancers

(Jaradat et al, 2016). The places that were surveyed included West Bank/Palestine, Nablus, Jenin, Tubas, Toulkarm, Salfeit, Qalqilya, Ramallah, Jericho, Jerusalem, Bethlehem, and Hebron (Jaradat et al, 2016). They carried out the study by interviews with one hundred and fifty herbalists, traditional healers and rural dwellers that used herbal remedies to treat different types of cancer. The information that the interviews collected was the names of plants, the parts used, the way these plants were used in treatment for cancer and their methods of preparation (Jaradat et al, 2016). The way to identify the species used that are most important are, Factor of informant's consensus (F_{ic}), Fidelity level (Fl), and Use-value (UV) that was calculated (Jaradat et al, 2016). The data collected showed that 72 plants, belonging to 44 families, can be utilized as a treatment for cancer; the two common plants that were used are Compositae and Lamiaceae. The most common part of the plants that are used is the leaves and the fruit that was produced. The most common cancer that was treated was lung cancer. The plant that was used is called Ephedra alata, and it was most used in Palestine. The (F_{ic}) showed high levels in all the plants. For most of the plants the (Fl) was at 100%, and the highest (UV) was at (0.72), and that was from the Ephedra alata (Jaradat et al, 2016). From this study we can see that the herbalist are still using herbal remedies in Palestine as a treatment for cancer (Jaradat et al, 2016). This survey was well thought through and it shows that in Palestine, where hospitals are not very common,they can use herbal remedies for a way as treatment for something as big as cancer.

As noted above, Ginseng is another effective herbal remedy that can be used a supplement or alternative to modern medicine. Ginseng can be used as a treatment for fatigue (N. M. Arring et al, 2018). Over 32% of the population of the United States uses complementary and alternative medicine, and ginseng is on the top 10 list of most used natural products (N. M.

Arring et al, 2018). Both kinds of ginseng contain ginsenosides, which are active compounds that are believed to act on the central nervous system (N. M. Arring et al, 2018).

American Ginseng is native to the United States and Canada. There were four trials done on American ginseng for treatment for fatigue conducted by M Arring et. al. 92018). Each of these studies had a different measure in fatigue. The fatigue measures were Brief Fatigue Inventory, Multidimensional Fatigue Symptom Inventory Short Form, Fatigue Severity Scale, and Scores of Symptoms and Signs. The trials used a bias control; they had a double blinding and a placebo. Three of the trials were 8 weeks to 6 months, and the final study was a cross over study of 6 weeks followed by a 2-week washout, and then another 6-week crossover (N.M Arring et al, 2018). Two of these studies looked at the safety of the ginseng. Two of the studies had a high dose of 2000 mg per day of ginseng. Another trial had a high dose of 400 mg per day of ginseng. Three of the studies were in the United states, and the other one was in China (N.M Arring et al, 2018). Two of the studies used cancer survivors as a sample, while another study had patients with multiple sclerosis as a sample, and last study they had patients with HIV as a combination study. The reason these studies were strong is because they controlled multiple types of bias. Three of these studies showed improvement in fatigue with the intervention group compared to the control group. One study people was not found to be clinically meaningful, as it was difficult to assess because they only reported a combined baseline fatigue score (N.M Arring et al, 2018). These studies collectively suggest that American Ginseng provides promising results as a treatment for fatigue.

Asian ginseng is found in China, Korea, and Russia, and it is one of the most researched species of ginseng (N.M Arring et al, 2018). Researchers did six studies on Asian ginseng for fatigue (N.M Arring et al, 2018). Four of these studies just tested the ginseng itself. They also

did two studies as a combination of natural products (N.M Arring et al, 2018). The researchers utilized multiple fatigue assessments: Visual Analog Scale, Modified Fatigue Impact Scale, Numeric Self-Rating Scale, and Functional Assessment of Chronic Illness Therapy- Fatigue. Four of studies were double blind, placebo-controlled trials. The studies ranged from 4 weeks to 3 months. They administered an 80 to 2000 mg per day dose of ginseng, and the longest trial administered 250 mg dose twice a day. Five studies were done to evaluate the efficacy of fatigue using ginseng as a treatment (N.M Arring et al, 2018). The participants of these studies were people with cancer, fibromyalgia, chronic fatigue, multiple sclerosis, and functional fatigue. Four of the studies showed that there was a significant improvement in people with fatigue (N.M Arring et al, 2018), further suggesting that the use of Asian ginseng as an herbal remedy has effective properties in treating fatigue.

There was an analysis done with essential oils and eight herbal medicines that haze pungent flavor and cool by nature (C. Zhao et al. 2019). The essential oils from the herbal medicines are Flos Chrysanthemi (Baiju), Flos Chrysanthemi (Hangju), Herba Menthae (Bohe), Folirm Mori(Sangye), Fructus Arctii(Niubangzi), Herba Epuiseti Hiemalis(Muzei), Fructus Viticis(Man-jingzi), Radix Bupleuri(Chaihu) (C. Zhao et al. 2019). The Chinese materia medica (CMM) has a long history of practical use, and it has been used in extensive historical literature (C. Zhao et al. 2019). It can have five different flavors which are sour, sweet, bitter, and salty (C. Zhao et al. 2019). The herbs that are containing essential oils have a broad effectiveness as diaphoresis, regulating vital energy, alleviating pain, dispelling wind, invigorating the stomach, bacteriosis, dephlogistication, and modifying the taste (C. Zhao et al. 2019). The researchers are looking at these herbs with a point of view of chemistry, to obtain some knowledge of why the herbs are classified into a category of pungent and cool by nature, from the TCM theory (C.

Zhao et al. 2019). In the experiment the essential oils were analyzed by using gas chromatography and mass spectroscopy (C. Zhao et al. 2019). They found 144 compounds in the eight traditional Chinese medicines by using gas chromatography- mass spectroscopy with help from using chemometric resolution methods (C. Zhao et al. 2019). Many of the compounds were terpenes, which are 14 monoterpenes and 19 sesquiterpenes, but there were also ketones, aldehydes, and phenols (Zhao et al. 2019). The compounds in these essential oils and herbal medicines help make up their healing abilities.

Some people argue that herbal remedies are not as effective as pharmaceutical drugs. One example of pharmaceutical drugs perhaps not being as effective for example is the influenza virus. According to Mousa (2017), the influenza vaccine is only effective when the vaccine strains match the epidemic strains antigenically and it doesn't protect against antigenically distinct pandemic influenza virus. The frequent alteration of the viral antigenic structure shows difficulties in the development of vaccine especially for RNA viruses (Mousa, 2017). Another thing is that making a new specific vaccine takes a lot of time, and the vaccine might turn out to be unsuccessful (Mousa, 2017). There is no fully effective vaccine or medication for the respatory viral infection, and when people start looking at other ways of treat the influenza virus, they turn to herbal remedies (Mousa, 2007).

Ancient nations used traditional herbal medications to treat colds and the flu. Many herbs have been used as a medication treating viral respiratory infections, as there are chemical and biochemical agents that are isolated from the plants to be used as treatment (Mousa 2007). There is an herbal medicine called Maoto which has been used to treat patients with influenza in Japan. Maoto has four medicinal herbs: Ephedrae Herba, Cinnamomi Cortex, Armeniacae Semen, and Glycyrrhizae Radix (Mousa, 2007). The maoto granules, when given to adults with the seasonal

influenza, was associated with equivalent clinical and virological efficacy to neuraminidase inhibitors. The maoto showed antipyretic activity in mice that were infected with influenza virus, and it reduced the virus by augmentation of the virus-bound natural antibodies (Mousa 2007). Similarly effective, an herb called licorice root has an active compound called Glycyrrhizin (Mousa 2007). Scientist infected mice with influenza A2 so that they could investigate the active compound Glycyrrhizin. The study showed that Glycyrrhizin might protect the mice that were exposed to a deadly dose of influenza. Researcher investigated the mechanism for glycyrrhizin for protection against infection from influenza A virus. What they found was that the glycyrrhizin showed clear reduction in number of influenza A virus infected human lung cells (Mousa 2007).

There are many other herbs that can help treat the common cold and the influenza virus. For instance, there is an herbal product called COLD-fX (CVT-E002) and it is a proprietary extract from the North American ginseng root (Mousa 2007). Elderly patients that were immunocompetent and took COLD-fX during the early cold and flu season reduced the risk and duration of the respiratory symptoms by 48% and 55% (Mousa 2007). Elderberries were also found to help reduce the virus; the berries' extract inhibits the virus infection in vitro, and one key factor in the antiviral effects is polyphenol (H. A.-L. Mousa). Another remedy is cranberries, and they can modify the immunity of the participant that drinks cranberry juice (Mousa 2007). The juice can help modify the ex vivo of proliferation of $\gamma\delta$-T cells, and they are in the epithelium and serve as a first line of defense and improving this can help reduce the symptoms with the cold and flu virus (Mousa 2007). These herbal remedies show that they can be an effective alternative when the influenza vaccine is ineffective due to changes to the viruses strained that was targeted.

The significance of this research is to show that there are other possibilities for medication that are out there. For example, if someone has cancer and does not want to use an invasive drug treatment like chemo, they can use an herbal remedy that is less invasive. Some of the times the chemo makes the person sicker than the cancer. A good way to compensate for that is the person can use an herbal remedy that can help cure the cancer or prolong a ther life. That is why this research is important and must be supported, as it can help people with cancer and other illnesses supplement their other treatments. Al of us, not just doctors, should care about this research, because there are ways these herbal remedies are proving they have effective healing components to them. If there is a person that doesn't want to use a traditional medicine, they can use an herbal remedy as an alternative. Ginger as an herbal remedy in particular needs further research because there are many chemicals with great potential to help people.

Natural herbal remedies are part of the future of medicine. There are things that we know herbal remedies can help with, but there is so much that we do not know. That is why we need to explore the advancement of herbal remedies in medicine. Researchers need to get this information out there because many people have never heard of herbal remedies, or disregard them as "quack science." But these remedies are working, and more people should consider then as an alternative or supplement for pharmaceutical drugs.

References

Anne Marie Helmenstine, P. D. (n.d.). *What HeLa Cells Are and Why They Are Important*. ThoughtCo. https://www.thoughtco.com/hela-cells-4160415#:~:text=HeLa%20cells%20have%20been%20used%20to%20test%20the,in%20the%20development%20of%20the%20first%20polio%20vaccine

Arring, N. M.; Millstine, D.; Marks, L. A.; Nail, L. M.. Ginseng as a Treatment for Fatigue: A Systematic Review. *The Journal of Alternative and Complementary Medicine* **2018**, *24* (7), 624–633.

Gould, M. N. Cancer chemoprevention and therapy by monoterpenes. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1470060/ (accessed Mar 24, 2021).

Herbal Medicine. https://www.hopkinsmedicine.org/health/wellness-and-prevention/herbal-medicine (accessed Mar 18, 2021).

Jaradat, N. A.; Al-Ramahi, R.; Zaid, A. N.; Ayesh, O. I.; Eid, A. M.. Ethnopharmacological Survey of Herbal Remedies Used for Treatment of Various Types of Cancer and Their Methods of Preparations in the West Bank-palestine. *BMC Complementary and Alternative Medicine* **2016**, *16* (1).

Mahomoodally, M. F.; Aumeeruddy, M. Z.; Rengasamy, K. R. R.; Roshan, S.; Hammad, S.; Pandohee, J.; Hu, X.; Zengin, G.. Ginger and Its Active Compounds in Cancer Therapy: From Folk Uses to Nano-therapeutic Applications. *Seminars in Cancer Biology* **2021**, *69*, 140–149.

Methanolic medical definition. (n.d.). Retrieved April 19, 2021, from https://www.merriam-webster.com/medical/methanolic

Mousa, H. A.-L. (2016). Prevention and Treatment of Influenza, Influenza-Like Illness, and Common Cold by Herbal, Complementary, and Natural Therapies. *Journal of Evidence-Based Complementary & Alternative Medicine*, *22*(1), 166–174. https://doi.org/10.1177/2156587216641831

Osteoarthritis. (2020, February 22). Retrieved April 14, 2021, from https://www.mayoclinic.org/diseases-conditions/osteoarthritis/symptoms-causes/syc-20351925#:~:text=Osteoarthritis%20is%20the%20most%20common,%2C%20knees%2C%20hips%20and%20spine.

Rheumatoid arthritis - ra - center: Symptoms, pain relief, causes, tests, and medications. (n.d.). Retrieved April 14, 2021, from https://www.webmd.com/rheumatoid-arthritus/how-does-tnf-cause-inflamation

Sarah, D. Sesquiterpenes- a Long Word, a Cool Constituent in Essential Oils. https://www.saratoga.com/living-well/2015/12/sesquiterpenes-a-long-word-a-cool-constituent-in-essential-oils/ (accessed Mar 24, 2021).

Sharifi-Rad, M., Varoni, E., Salehi, B., Sharifi-Rad, J., Matthews, K., Ayatollahi, S., Kobarfard, F., Ibrahim, S., Mnayer, D., Zakaria, Z., Sharifi-Rad, M., Yousaf, Z., Iriti, M., Basile, A., & Rigano, D. (2017). Plants of the Genus Zingiber as a Source of Bioactive Phytochemicals: From Tradition to Pharmacy. *Molecules (Basel, Switzerland)*, *22*(12), 2145–. https://doi.org/10.3390/molecules22122145

Study.com. Ethnopharmacology: Definition and examples. https://study.com/academy/lesson/ethnopharmacology-definition-examples.html (accessed Mar 28, 2021).

Zhao, C.; Zeng, Y.; Wan, M.; Li, R.; Liang, Y.; Li, C.; Zeng, Z.; Chau, F.-T.. Comparative Analysis of Essential Oils from Eight Herbal Medicines with Pungent Flavor and Cool Nature by GC-MS and Chemometric Resolution Methods. *Journal of Separation Science* **2009**, *32* (4), 660–670.