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Anti-inflammatory and antioxidant immunomodulatory effects of some natural common plants

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Abstract

Immunity is the body's defense system against infectious diseases. Many factors trigger an immune response including infections, immunization, and various external stimuli. In healthy organisms, the immune system maintains homeostasis within the body. The function and efficiency of the immune system are influenced by various exogenous and endogenous factors leading to either immunosuppression or immune stimulation; several agents that have activities to normalize or modulate the immune response are called immunomodulators. Due to the occurrence of chemical drug-related adverse effects such as drugs used as chemotherapy for treating different kinds of cancer, natural immunomodulators are the potential agents to replace them or even to reduce the severe side effects in the therapeutic regimens. The prevention and treatment of inflammatory diseases using natural bioactive compounds extracted from different natural sources have been reported in human history. The immunomodulatory characteristics of the natural bioactive compounds' therapeutics have gathered the attention of researchers. Innovative technologies and promising research on the immunomodulatory effects of the bioactive compounds' products extracted from different sources such as plants, fungi, or algae with immunomodulatory potential or/and anti-inflammatory, may enrich us with valuable entities to develop novel immunomodulatory agents to be involved in present chemotherapeutic strategies. Hence, in the current review, the immunomodulatory antioxidant and anti-inflammatory effects of some common plants have been shown.

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1- Introduction

Immunity is the natural defense mechanism by which the body can fight off or protect itself from infectious diseases. A vast number of reasonable factors affect the immune system stimulating it and causing the triggering of appropriate responses such as infections, immunization, and different external stimuli (Baxter, 2007). When a foreign antigen enters the body, specific cells of the immune system can recognize it and the immune response is strongly triggered (Jantan et al., 2015).

The immune system consists of many types of cells that can identify, recognize, and destroy foreign antigens, in addition to protein signaling cytokines and receptors, different pathway molecules as well as physical and microbial barriers that protect the body from infectious invaders such as fungi, viruses and bacteria (Gasmi et al., 2023; Parkin & Cohen, 2001). The immune system is divided into two categories, innate immunity which is memory-independent and can trigger non-specific immune responses, and acquired adaptive immunity which is mainly memory-dependent (Marshall et al., 2018; Parkin & Cohen, 2001).

The internal body homeostasis is maintained by the immune system in a healthy body. However, exogenous and endogenous factors can change the function and efficiency of the immune system, resulting in immunosuppression or immunological stimulation (Nimbalkar et al., 2018). Several agents that can normalize or modulate the immune response have been observed and known as immunomodulators (Tanishq & Sujata).

Bioactive compounds of natural sources are among the substances that have immunomodulating effects, they have different effects on the immune response either suppression or stimulation. In medical fields, immunomodulators are divided into three categories, immunoadjuvants, immunostimulants, and immunosuppressants.

Adjuvants are specific substances that are coupled with vaccines to add more stimulant and enhancing effects and to increase and durability of the immune response (Pulendran et al., 2021). While those substances that enhance or induce the immune response are known as immunostimulants, such substances are used in treating immunodeficient diseases as well as infectious diseases (Patil et al., 2012). Immunosuppressants are substances that can inhibit and downregulate the strength of the immune response, thus they could be used in the treatment of allergies, autoimmune diseases, and in the case of organ transplants (Lazar et al., 2018; Mellon et al., 2022).

Immunomodulators may include chemotherapeutic compounds and monoclonal antibodies. However, those of their general usage encounter major limitations for their risky side effects. Non-steroidal anti-inflammatory drugs (NSAIDs) are widely used to reduce inflammation (Sostres et al., 2013). However, prolonged use of NSAIDs is also associated with severe side effects such as gastrointestinal bleeding, also several COX-2 inhibitors are associated with cardiovascular problems (Harirforoosh et al., 2013). Thus, effective, safe immunomodulatory drugs from natural sources with fewer side effects are strongly needed and recommended to replace the chemotherapeutic drugs to overcome the expected side effects to achieve successful treatment of diseases and boosting, and maintaining the immune system (Alhaithloul, 2023; Das, 2022; Gasmi et al., 2023; Gurib-Fakim, 2006; Jantan et al., 2015).

It was found that treatments of various diseases using substances derived from medicinal plants and other natural resources have been used earlier in the human history and in local cultures and communities (Abdein, 2018; Alhaithloul, 2023; Street & Prinsloo, 2013; Venturella et al., 2021). Nowadays, more interest was directed by the modern international communities on using immunomodulating drugs derived from natural sources for treatment many diseases (Huang et al., 2010; Scalbert et al., 2005).

Truffle:

Truffle is a gastronome food used in the high standard food for its high content of aroma (Mustafa et al., 2020; Patel, 2012). It was well-known and used by Romans, Greeks, ancient Egyptians and Babylonians as food and in traditional medicine (Mustafa et al., 2020; Rosa-Gruszecka et al., 2017) (Abdel-Mageed et al., 2019; De Silva et al., 2012). Truffle is an ascomycetous fungus a member of Tuberaceae, generally, they

are growing under the soil surface (Abdel-Mageed et al., 2019; Sirag, 2009). Many truffle species belong to the genus *Tuber* which is considered as the true truffle (Zambonelli et al., 2015).
Truffle showed strong hypoglycemic, and hypocholestrolemic effects as well as its potent anti-inflammatory effects. Such effects were attributed to its richness with antioxidant factors such as vitamin C, B12, and D, acidic polysaccharides, folate, polyphenols, ergothioneine and fibers (De Silva et al., 2012). In a diabetic rat model, Truffle could significantly lower glucose levels and corresponding pancreatic inflammation represented by IL-1B and iNOS oxidative stress (Abdel-Mageed et al., 2019; Dawood et al., 2023). In LPS/IFN-γ-stimulated RAW 264.7 macrophages through modulation of the TLR4 activation, Truffle had a significant anti-inflammatory role through inhibiting the production of NO, iNOS, and COX-2 leading to downregulation of inflammatory cytokines TNF-α and IL-6 mRNA expression without affecting their protein levels (Dawood et al., 2023). Isolated polysaccharides of Truffle showed immunomodulatory activity It also showed immunomodulatory properties (Seema Patel, 2012; Tang et al., 2008). Due to its high content of antioxidants that act as scavengers for the peroxy radicals, it can reduce lipid peroxidation especially those species in the Asian area and Saudi Arabia and Gulf countries, and it plays a role as hepatoprotective bioactive material (Al-Laith, 2010; Mandeel & Al-Laith, 2007).

Ficus carica

Fig *(Ficus carica)* originated in the Middle East areas such as Syria, Asia Minor, and Iran, then, it spread to the Mediterranean basin countries (Mars, 2001). It is one of the important edible fruits with a significant commercial value that belongs to the Moraceae family (Patil & Patil, 2011). The compounds found in *Ficus* plants include triterpenoids, oleanolic, ursolic, protocatechuic, hydroxy ursolic, and maslinic acids, as well as alkaloids, flavonoids, tannins, phenolic acids, glycosides, steroids, and saponins. These plants are also claimed to include enzymatic components such as ascorbate peroxidase, catalase, peroxidase, and phenolic compounds, flavonoids, and vitamin C, as well as non-enzymatic elements such phenolic constituents, vitamin C, and flavonoids (Chandra et al., 2023).
As a medicinal plant, *Ficus carica* has notable anti-hyperglycemic, anti-arthritic, anti-depressant, and antibacterial properties that assist in controlling blood glucose and lower the risk of arthritis. Additionally, it has a strong anthelmintic action that aids in lowering childhood parasite issues (Arun et al., 2023). Prenylated isoflavone derivatives were identified and shown to have strong anti-inflammatory properties because they inhibited NO generation in a recent phytochemical study on fig fruit (Liu et al., 2019).
It has been demonstrated that the flavonoids rutin, hesperetin, and morin can effectively lower the levels of inflammatory cytokines TNF-α, IL-1β, and IL-6 in diabetic mice (Ginwala et al., 2019).
It was shown that the flavonoid quercetin inhibited the release of iNOS and TNF-α by macrophages and the secretion of IL-1β and TNF-α in RAW 2647, when exposed to bacterial LPS. Additionally, in the mouse model, quercetin decreased IL-6 and TNF-α (Ginwala et al., 2019). In research conducted on human triple-negative cells, the flavone apigenin present in fig fruit suppressed immune cell activation and down-regulated TNF-α, which in turn promoted the up-regulation of IL-1α and IL-6. Apigenin is a reasonably tiny molecule that can be used to treat CNS inflammation because it has been demonstrated to pass the blood-brain barrier and reach the cerebrospinal fluid compartment (Ginwala et al., 2019).

Silymarin (*Silybum marianum*)

Silybum marianum is originally from the mountains of the Mediterranean, Asia, and North African regions, but is grown today in several parts of the world (Saleh, 2016). Silymarin is usually found as a standardized extract obtained from the seeds of the Milk Thistle plant *Silybum marianum* (MacDonald-Ramos et al., 2021). Chemically, silymarin is a polyphenolic flavonoid extract consisting of about 70–80% silymarin flavonolignans (silybin A, silybin B, isosilybin A, isosilybin B, silychristin, isosilychristin, silydianin, and the flavonoids taxifolin, quercetin and kaempferol) along with 20–35% fatty acids and several other polyphenolic components (Neha et al., 2016).
Preclinical and clinical research has demonstrated that silymarin and its flavonolignans significantly impart pro-apoptotic, antioxidant, and anti-inflammatory properties, inducing a wide range of biological and

pharmacological activities, such as immunomodulation, hepatoprotection, neuroprotection, anti-diabetic, and anti-cancer properties (Wadhwa et al., 2022).

Based on grown cells, including immune cells and other types of cells, the anti-inflammatory capabilities of silymarin, or its primary ingredient, silibinin/silybin, have been demonstrated in various in vitro systems. It is thought that macrophages and monocytes are crucial regulators of inflammation and significant participants in the innate immune response. They are efficient innate immunity drivers that carry out phagocytosis, cause inflammation, and trigger the adaptive immune response, which resolves the inflammation and establishes hemostasis (Austermann et al., 2022).

On one hand, numerous studies conducted over the past two decades have shown that the protective benefits of silymarin are primarily associated with the NF-κB pathway inhibition and the downregulation of pro-inflammatory cytokines, such as TNF-α and IL-1β (Kim et al., 2013). On the other hand, SM/SB can induce transcriptional factors (e.g., Nrf2), which control the body's defense against oxidative and inflammatory stressors (Zhao et al., 2021).

It has been determined that interleukin 8 (IL-8) is a protumoral cytokine, and there is evidence that inhibiting IL-8 lowers the risk of tumor development. In general, flavonoids lower IL-8 levels. Koltai and Larry, 2022 demonstrated that curcumin, apigenin, and silybin might lower IL-8 levels (Koltai & Fliegel, 2022).

Hibiscus sabdariffa

Hibiscus sabdariffa (HS) is a shrub from the Malvaceae family (Ali et al., 2018). It is grown in numerous places of the world, including West Africa, South Asia (Sindi et al., 2014), the West Indies, Jamaica, China, and the United States (Gerald et al., 2019). It is also grown in Egypt, Saudi Arabia, Sudan, In Australia, India, Thailand, Nigeria, and Latin America, it is commonly known as Rosella, Mesta, Krajeab, Zobo, and Sorrel (Ali et al., 2018).

The dried HS calyx's water decoction is frequently drunk as a beverage (Müller & Franz, 1992) and utilized in traditional medicine to treat pyrexia (Ali et al., 2018; Frank et al., 2005), dyslipidemia, diabetes (Jiménez-Ferrer et al., 2012), high blood pressure, liver diseases, ulcers, abscesses, and anemia (Ali et al., 2018). The fleshy HS calyces are eaten as vegetables (Jabeur et al., 2019) and are also used to make wine, cakes, syrup, and colorants (Christian et al., 2006).

ACE1 catalytically converts angiotensin I (Ang I) to angiotensin II (Ang II), which leads to the accumulation of Ang II. Different hypertension models have shown elevated levels of inflammatory mediators as well as cellular antioxidant capacity depletion (Abdel-Rahman et al., 2017; Abdel-Zaher et al., 2018; Dange et al., 2014). Ang II-induced activation of the angiotensin II receptor type 1 (AT1 receptor) can activate NF-κB, resulting in the production of pro-inflammatory genes (Dange et al., 2014; Mezzano et al., 2004). ACE1 inhibitors can reduce Ang II levels, inhibiting Ang II-induced activation of AT1 receptors. The antioxidant (Alegbe et al., 2019; Sindi et al., 2014) and ACE1 inhibitory (Herrera-Arellano et al., 2007; Ojeda et al., 2010) properties of HS extract constituents suggest that it can decrease inflammatory reactions. HS has been shown to reduce NF-κB levels in LPS-stimulated recombinant Human hepatoma cell line (HepG2) cells (Chou et al., 2016), metabolic syndrome, and TAA-intoxicated rats (Ezzat et al., 2016).

Acacia spp

Acacia nilotica is a tannin-rich medicinal plant, that belongs to the genus Acacia with about 900 species and has great anti-viral and cytotoxic effects (Raheel et al., 2014). The plant contains a significant quantity of terpenoids, alkaloids, polyphenols, saponins, proteins, and polypeptides (Ali et al., 2012; Kaur et al., 2005).

Acacia catechu heartwood aqueous extracts are a rich source of catechin and epicatechin, and potent antioxidant activity is detected and suggested to be responsible for the anti-inflammatory, tissue protectant, analgesic, and antineoplastic activities (Stohs & Bagchi, 2015). *Acacia nilotica*, is nominated as a medicinal tree, and belongs to the family Mimosaceae, it is abundant in phenolic substances involving gallic acid, condensed tannin, and other substances (Alka Bhargava et al., 1998). *Acacia nilotica* was used to treat

amoeboid dysentery, viral-caused colds, bronchitis, bacterial-caused diarrhea, bleeding piles leukoderma, and fungal diseases (Alka Bhargava et al., 1998).
Anti-inflammatory effect of *Acacia nilotica* subsp. Kraussiana was documented (Eldeen et al., 2010). Potent anti-inflammatory, antipyretic, analgesic, antidepressant, and anticoagulant activities were found in the extracts of *Acacia modesta* (Latif et al., 2020). An Algerian Sahara plant, *Acacia tortilis* extract, and the phenolic compounds discovered were suggested to be useful as cytotoxic and anti-inflammatory medicines (Ziani et al., 2020). Studies showed that *Acacia confusa* heartwood extracts or derived phytocompounds are of high potential for preventing inflammatory diseases caused by increased production of reactive oxygen species (Wu et al., 2008). The pharmaceutical properties of *Acacia hydaspica* could be due to its indigenous value against inflammatory diseases (Afsar et al., 2015). *Acacia catechu* extract showed significant anti-inflammatory activity in subjects with knee osteoarthritis, it was traditionally used as an antimicrobial, anti-inflammatory, and antifungal component (Stohs & Bagchi, 2015). Overproduction of nitric oxide leads to inflammatory diseases, although it is useful for several physiological functions (Guzik et al., 2003; Sharma et al., 2007). *Acacia catechu* was found to control the production of nitric oxide (Sunil et al., 2019).

Chili pepper (*Capsicum species*)

Antioxidant and anti-inflammatory components of plants and their role in potential health function through their effect against various pathological processes have been extensively studied in recent years (Menichini et al., 2009; Mueller et al., 2010). Bioactive compounds of peppers were found to have antioxidant, anti-inflammatory, and antimicrobial activities (Alvarez-Parrilla et al., 2011; Careaga et al., 2003; Spiller et al., 2008). Chilis is classified in the genus *Capsicum*, in the family Solanaceae, and its fruits are known as berries (Azlan et al., 2022). The beneficial functions of chili peppers as anti-tumor, anti-cancer, and antioxidant were studied (Hsu & Yen, 2007; Leung, 2008; Malagarie-Cazenave et al., 2009).
Raw and roasted peppers were found to have strong antioxidant activity (Hamed et al., 2019). The significant role of chili pepper as an anti-inflammatory agent was reviewed (Villa-Rivera & Ochoa-Alejo, 2020). Bioactive compounds and vitamin C found in chili peppers are of great therapeutic importance due to their anti-inflammatory activities (Azlan et al., 2022). Bioactive compounds, like flavonoids, phenolic acids, carotenoids, and ascorbic acid were found in *Capsicum* (Deepa et al., 2007), and antioxidant and anti-inflammatory activities were reported in these compounds (Janssens et al., 2014), which are essential components for the human immune system building up and maintaining (Howard et al., 1994). Pepper mixed with maize flour was used to cure a common cold, chili peppers for treating infected wounds, on the feet to cure athlete's foot fungus (Bosland et al., 2012), capsaicin is used as a medication for arthritis, and as a cream to reduce post-operative pain (Seraglio et al., 2019). *Capsicum* was used to treat parasitic infections, wound healing, rheumatism, coughs, and sore throat, chili peppers were found to have antifungal, antiviral, anti-inflammatory, and immunomodulatory actions (Badia et al., 2017; Batiha et al., 2020). Phenols, capsaicinoids and ascorbic acid components which have anti-inflammatory or antioxidant properties were found to be significantly greater in *C. baccatum* fruit compared to other species of peppers (Antonious et al., 2006; Carr & Frei, 1999; Chen et al., 2006; Kim et al., 2003).

Licorice (*Glycyrrhiza glabra*)

Licorice is scientifically known as Glycyrrhiza glabra and belongs to the Leguminosae family. Licorice is one of the most commercially valuable plants globally, having a wide range of uses in the pharmaceuticals, cosmetics, and food industries (Fenwick et al., 1990).
various secondary metabolites found in licorice such as flavanones, coumarins, chalcones, isoflavones, and many more are contained by triterpenoid saponins and phenolic compounds(Bao et al., 2021).
Glycyrrhizin, glycyrrhizinic acid, isoliquiritin, and glycyrrhizic acid are other main chemicals in this plant with antiatherogenic, anti-cancer, anti-diabetic, anti-microbial, antispasmodic, anti-inflammatory, and anti-asthmatic properties (Gaur et al., 2014).
Licorice has shown anti-inflammatory activities due to decreasing PGE2, MMPs, TNF, and free radicals

validated by its traditional uses such as relieving coughing, eliminating phlegm, stimulating digestive functions, alleviating pain, and many others more(Yang et al., 2017).
In Collagen-Induced Arthritis (CIA) rats, licorice processed DGN products dramatically reduced Rheumatoid arthritis (RA) symptoms. Where licorice has shown anti-inflammatory effects through TLR4/NF-α /NLRP3 signaling pathway on CIA rats and LPS-induced RAW264.7 cells and regulated the metabolic profile in managing RA(Yang et al., 2017).
In vivo anti-inflammatory, activities have been shown by total flavonoids isolated from licorice extracts and licorice via suppressing cyclooxygenase 9COX-2) gene, inducible nitric oxide synthase (iNOS), and signals of mitogen-activated protein kinases (MAPKs)(Shin et al., 2008; Vasanth et al., 2020).
Flavonoids are keeping multiple pathway integrated mechanism of action, therefore, showing anti-inflammatory properties. As a result, flavonoids of licorice are the potential medication for inflammation with minor adverse effects (Yu et al., 2019).
It significantly attenuated the expression of iNOS and IL-1b and decreased the levels of Malondialdehyde (MDA) and Nitric Oxide (NO) at the site of inflammation(Yin et al., 2018). A study was conducted to examine the protective effect of isoliquiritigenin, a flavonoid monomer. Isoliquiritigenin lessens oxidative stress by modulating the Nrf2/HO-1, reducing acute pancreatitis in a pancreatitis mode(Liu et al., 2018; Zhang et al., 2018). Secondary metabolites and licorice extracts have shown anti-inflammatory activities to treat various diseases in addition to acute kidney disease. Isoliquiritigenin reduces LPS-stimulated acute kidney damage by the suppression of NF-α stimulated formation HMGB (Tang et al., 2018).

Conclusion

The occurrence of chemical drug-related adverse effects such as drugs used as chemotherapy for treating different kinds of inflammatory diseases, natural immunomodulators are the best safer choice as potent agents to replace them or even to reduce the severe side effects in the therapeutic regimens.

COMPETING INTERESTS

The authors have no compting interest to declare.

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REFERENCES

Abdein, M. A. E.-H. (2018). Genetic diversity between pumpkin accessions growing in the northern border region in Saudi Arabia based on biochemical and molecular parameters. *Egyptian Journal of Botany*, *58*(3), 463-476 .

Abdel-Mageed, A. M., Osman, A. K. E ,.Awad, N. S., & Abdein, M. A. (2019). Evaluation of Antidiabetic Potentiality of Truffles and Balanites Aegyptiaca among Streptozotocin Induced Diabetic Rats. *International Journal of Pharmaceutical Research & Allied Sciences*, *8* .(1)

Abdel-Rahman, R. F ,.Hessin, A. F., Abdelbaset, M., Ogaly, H. A., Abd-Elsalam, R. M., & Hassan, S. M. (2017). Antihypertensive effects of roselle-olive combination in L-NAME-induced hypertensive rats. *Oxidative medicine and cellular longevity*, *2017* .

Abdel-Zaher, A. O., Farghaly, H. S., El-Refaiy, A. E., & Abd-Eldayem, A. M. (2018). Protective effect of the standardized leaf extract of G inkgo biloba (EGb761) against hypertension-induced renal injury in rats. *Clinical and Experimental Hypertension*, *40*(8), 703-714 .

Afsar, T ,.Khan, M. R., Razak, S., Ullah, S., & Mirza, B. (2015). Antipyretic, anti-inflammatory and analgesic activity of Acacia hydaspica R. Parker and its phytochemical analysis. *BMC complementary and alternative medicine*, *15*, 1-12 .

Al-Laith, A. A. A .(2010) .Antioxidant components and antioxidant/antiradical activities of desert truffle (Tirmania nivea) from various Middle Eastern origins. *Journal of Food Composition and Analysis*, *23*(1), 15-22 .

Alegbe, E. O., Teralı, K., Olofinsan, K. A., Surgun, S., Ogbaga ,C. C., & Ajiboye, T. O. (2019). Antidiabetic activity-guided isolation of gallic and protocatechuic acids from Hibiscus sabdariffa calyxes. *Journal of food biochemistry*, *43*(7), e12927 .

Alhaithloul, H. A. (2023). Phytochemical Screening of Some Medicinal Plants in Al Jouf, KSA. *Open Journal of Ecology*, *13*(2), 61-79 .

Ali, A., Akhtar, N., Khan, B. A., Khan, M. S., Rasul, A., Zaman, S., Khalid, N., Waseem, K., Mahmood, T., & Ali, L. (2012). Acacia nilotica: a plant of multipurpose medicinal uses. *Journal of medicinal plants research*, *6*(9), 1492-1496 .

Ali, M. K., Ashraf, A., Biswas, N. N., Karmakar, U. K., Afroz, S., Md, K. A., Ayesha, A., Nripendra, N. B., Utpal, K. K., & Shamima, A. (2018). **玫瑰茄花萼乙醇提取物的抗痛**觉敏感, **抗炎及止泻作用的**实验研究. *Journal of Integrative Medicine* .631-626 ,(6)9 ,

Alka Bhargava, A. B., Anubha Srivastava, A. S., & Kumbhare, V. (1998). Antifungal activity of polyphenolic complex of Acacia nilotica bark .

Alvarez-Parrilla, E., de la Rosa, L. A., Amarowicz, R., & Shahidi, F. (2011). Antioxidant activity of fresh and processed Jalapeno and Serrano peppers. *Journal of agricultural and food chemistry*, *59*(1), 163-173 .

Antonious, G. F., Kochhar, T. S., Jarret, R. L., & Snyder, J. C. (2006). Antioxidants in hot pepper: variation among accessions. *Journal of Environmental Science and Health, Part B*, *41*(7), 1237-1243 .

Arun, A., Pavithra, R., & Kanimozhi, S. (2023). An in vitro analysis of Ficus carica's antioxidant potential. *Research Journal of Pharmacy and Technology*, *16*(2), 676-680 .

Austermann, J., Roth ,J., & Barczyk-Kahlert, K. (2022). The good and the bad: Monocytes' and macrophages' diverse functions in inflammation. *Cells*, *11*(12), 1979 .

Azlan, A., Sultana, S., Huei, C. S., & Razman, M. R. (2022). Antioxidant, anti-obesity, nutritional and other beneficial effects of different chili pepper: A review. *Molecules*, *27*(3), 898 .

Badia, A. D., Spina, A. A., & Vassalotti, G. (2017). Capsicum annuum L.: An overview of biological activities and potential nutraceutical properties in humans and animals. *Journal of Nutritional Ecology and Food Research*, *4*(2), 167-177 .

Bao, F., Bai, H.-Y., Wu, Z.-R., & Yang, Z.-G. (2021). Phenolic compounds from cultivated Glycyrrhiza uralensis and their PD-1/PD-L1 inhibitory activities. *Natural Product Research*, *35*(4), 562-569 .

Batiha, G. E.-S., Alqahtani, A., Ojo, O. A., Shaheen, H. M., Wasef, L., Elzeiny, M., Ismail, M., Shalaby, M., Murata, T., & Zaragoza-Bastida, A. (2020). Biological properties, bioactive constituents, and pharmacokinetics of some Capsicum spp. and capsaicinoids. *International journal of molecular sciences*, *21*(15), 5179 .

Baxter, D. (2007). Active and passive immunity, vaccine types, excipients and licensing. *Occupational medicine*, *57*(8), 552-556 .

Bosland, P. W., Votava, E. J., & Votava, E. M. (2012). *Peppers: vegetable and spice capsicums* (Vol. 22). Cabi .

Careaga, M., Fernández, E., Dorantes, L., Mota, L., Jaramillo, M. E., & Hernandez-Sanchez, H. (2003). Antibacterial activity of Capsicum extract against Salmonella typhimurium and Pseudomonas aeruginosa inoculated in raw beef meat. *International Journal of Food Microbiology*, *83*(3), 331-335 .

Carr, A. C., & Frei, B. (1999). Toward a new recommended dietary allowance for vitamin C based on antioxidant and health effects in humans. *The American journal of clinical nutrition*, *69*(6), 1086-1107 .

Chandra, S., Kala, K., Negi, M. S., & Nautiyal, A. (2023). Current Medical and Drug Research .

Chen, Y.-H., Lin, S.-J., Chen, Y.-L., Liu, P.-L., & Chen, J.-W. (2006). Anti-inflammatory effects of different drugs/agents with antioxidant property on endothelial expression of adhesion molecules. *Cardiovascular & Haematological Disorders-Drug Targets (Formerly Current Drug Targets-Cardiovascular & Hematological Disorders)*, *6*(4), 279-304 .

Chou, S.-T., Lo, H.-Y., Li, C-.C., Cheng, L.-C., Chou, P.-C., Lee, Y.-C., Ho, T.-Y., & Hsiang, C.-Y. (2016). Exploring the effect and mechanism of Hibiscus sabdariffa on urinary tract infection and experimental renal inflammation. *Journal of ethnopharmacology*, *194*, 617-625 .

Christian, K., Nair, M., & Jackson, J. (2006). Antioxidant and cyclooxygenase inhibitory activity of sorrel (Hibiscus sabdariffa). *Journal of food composition and analysis*, *19*(8), 778-783 .

Dange, R. B., Agarwal, D., Masson, G. S., Vila, J., Wilson, B., Nair, A & ,.Francis, J. (2014). Central blockade of TLR4 improves cardiac function and attenuates myocardial inflammation in angiotensin II-induced hypertension. *Cardiovascular research*, *103*(1), 17-27 .

Das, K. (2022). Herbal plants as immunity modulators against COVID-19: A primary preventive measure during home quarantine. *Journal of Herbal Medicine*, *32*, 100501 .

Dawood, A. S., Sedeek, M. S., Farag, M. A., & Abdelnaser, A. (2023). Terfezia boudieri and Terfezia claveryi inhibit the LPS/IFN-γ-mediated inflammation in RAW 264.7 macrophages through an Nrf2-independent mechanism. *Scientific Reports*, *13*(1), 10106 .

De Silva, D. D., Rapior, S., Hyde, K. D., & Bahkali, A. H. (2012). Medicinal mushrooms in prevention and control of diabetes mellitus. *Fungal diversity*, *5* .29-1 ,6

Deepa, N., Kaur, C., George, B., Singh, B., & Kapoor, H. (2007). Antioxidant constituents in some sweet pepper (Capsicum annuum L.) genotypes during maturity. *LWT-Food Science and Technology*, *40*(1), 121-129 .

Eldeen, I., Van Heerden, F., & Van Staden, J. (2010). In vitro biological activities of niloticane, a new bioactive cassane diterpene from the bark of Acacia nilotica subsp. kraussiana. *Journal of ethnopharmacology*, *128*(3), 555-560 .

Ezzat, S. M., Salama, M. M., Seif el-Din, S. H., Saleh, S ,.El-Lakkany, N. M., Hammam, O. A., Salem, M. B., & Botros, S. S. (2016). Metabolic profile and hepatoprotective activity of the anthocyanin-rich extract of Hibiscus sabdariffa calyces. *Pharmaceutical biology*, *54*(12), 3172-3181 .

Fenwick, G., Lutomski, J & ,.Nieman, C. (1990). Liquorice, Glycyrrhiza glabra L.—Composition, uses and analysis. *Food chemistry*, *38*(2), 119-143 .

Frank, T., Janßen, M., Netzel, M., Straß, G., Kler, A., Kriesl, E., & Bitsch, I. (2005). Pharmacokinetics of anthocyanidin-3-glycosides following consumption of Hibiscus sabdariffa L. extract. *The Journal of Clinical Pharmacology*, *45*(2), 203-210 .

Gasmi, A., Shanaida, M., Oleshchuk, O., Semenova, Y., Mujawdiya, P. K., Ivankiv, Y., Pokryshko, O., Noor, S., Piscopo, S., & Adamiv, S. (202 .(3Natural Ingredients to Improve Immunity. *Pharmaceuticals*, *16*(4), 528 .

Gaur, R., Yadav, K. S., Verma, R. K., Yadav, N. P., & Bhakuni, R. S. (2014). In vivo anti-diabetic activity of derivatives of isoliquiritigenin and liquiritigenin. *Phytomedicine*, *2* .422-415 ,(4)1

Gerald, C. L., McClendon, C. J., Ranabhat, R. S., Waterman, J. T., Kloc, L. L., Conklin, D. R., Barton, K. Y. T., Khatiwada, J. R., & Williams, L. L. (2019). Sorrel extract reduces oxidant production in airway epithelial cells exposed to swine barn dust extract in vitro. *Mediators of inflammation*, *2019* .

Ginwala, R., Bhavsar, R., Chigbu, D. G. I., Jain, P., & Khan, Z. K. (2019). Potential role of flavonoids in treating chronic inflammatory diseases with a special focus on the anti-inflammatory activity of apigenin. *Antioxidants*, *8*(2), 35 .

Gurib-Fakim, A. (2006). Medicinal plants: traditions of yesterday and drugs of tomorrow. *Molecular aspects of Medicine*, *27*(1), 1-93 .

Guzik, T., Korbut, R., & Adamek-Guzik, T. (2003). Nitric oxide and superoxide in inflammation. *J physiol pharmacol*, *54*(4), 469-487 .

Hamed, M., Kalita, D., Bartolo, M. E., & Jayanty, S. S. (2019). Capsaicinoids, polyphenols and antioxidant activities of Capsicum annuum: Comparative study of the effect of ripening stage and cooking methods. *Antioxidants*, *8*(9), 364 .

Harirforoosh, S., Asghar, W., & Jamali, F. (2013). Adverse effects of nonsteroidal antiinflammatory drugs: an update of gastrointestinal, cardiovascular and renal complications. *Journal of Pharmacy & Pharmaceutical Sciences*, *16*(5), 821-847 .

Herrera-Arellano, A., Miranda-Sánchez, J., Ávila-Castro, P., Herrera-Álvarez, S., Jiménez-Ferrer, J. E., Zamilpa, A., Roman-Ramos, R., Ponce-Monter, H., & Tortoriello, J. (2007). Clinical effects produced by a standardized herbal medicinal product of Hibiscus sabdariffa on patients with hypertension. A randomized, double-blind, lisinopril-controlled clinical trial. *Planta medica*, *73*(01), 6-12 .

Howard, L. R., Smith, R., Wagner, A., Villalon, B., & Burns, E. (1994). Provitamin A and ascorbic acid content of fresh pepper cultivars (Capsicum annuum) and processed jalapenos. *Journal of Food Science*, *59*(2), 362-365 .

Hsu, C.-L., & Yen, G.-C. (2007). Effects of capsaicin on induction of apoptosis and inhibition of adipogenesis in3 T3-L1 cells. *Journal of agricultural and food chemistry*, *55*(5), 1730-1736 .

Huang, R.-Y., Yu, Y.-L., Cheng, W.-C., OuYang, C.-N., Fu, E., & Chu, C.-L. (2010). Immunosuppressive effect of quercetin on dendritic cell activation and function. *The Journal of Immunology*, *184*(12), 6815-6821 .

Jabeur, I., Pereira, E., Caleja, C., Calhelha, R. C., Soković, M., Catarino, L., Barros, L., & Ferreira, I. C. (2019). Exploring the chemical and bioactive properties of Hibiscus sabdariffa L. calyces from Guinea-Bissau) West Africa). *Food & function*, *10*(4), 2234-2243 .

Janssens, P. L., Hursel, R., & Westerterp-Plantenga, M. S. (2014). Capsaicin increases sensation of fullness in energy balance, and decreases desire to eat after dinner in negative energy balance. *Appetite* ,77 , .51-46

Jantan, I., Ahmad, W., & Bukhari, S. N. A. (2015). Plant-derived immunomodulators: an insight on their preclinical evaluation and clinical trials. *Frontiers in plant science*, *6*, 655 .

Jiménez-Ferrer, E., Alarcón-Alonso, J., Aguilar-Rojas, A ,.Zamilpa, A., Tortoriello, J., & Herrera-Ruiz, M. (2012). Diuretic effect of compounds from Hibiscus sabdariffa by modulation of the aldosterone activity. *Planta medica*, 1893-1898 .

Kaur, K., Michael, H., Arora, S., Härkönen, P., & Kumar, S. (2005). In vitro bioactivity-guided fractionation and characterization of polyphenolic inhibitory fractions from Acacia nilotica (L.) Willd. ex Del. *Journal of ethnopharmacology*, *99*(3), 353-360 .

Kim, B.-R., Seo, H.-S., Ku, J.-M., Kim, G.-J., Jeon, C. Y., Park, J. H ,.Jang, B.-H., Park, S.-J., Shin, Y.-C., & Ko, S.-G. (2013). Silibinin inhibits the production of pro-inflammatory cytokines through inhibition of NF-κB signaling pathway in HMC-1 human mast cells. *Inflammation Research*, *62*, 941-950 .

Kim, C.-S., Kawada ,T., Kim, B.-S., Han, I.-S., Choe, S.-Y., Kurata, T., & Yu, R. (2003). Capsaicin exhibits anti-inflammatory property by inhibiting IkB-a degradation in LPS-stimulated peritoneal macrophages. *Cellular signalling*, *15*(3), 299-306 .

Koltai, T., & Fliegel, L .(2022) .Role of silymarin in cancer treatment: facts, hypotheses, and questions. *Journal of Evidence-Based Integrative Medicine*, *27*, 2515690X211068826 .

Latif, S., Ismail, H., Khan, M. R., Rahim, A. A., Mehboob, R., Dilshad, E., Sajid, M., Haider, S. I., Anwaar, S., & Majeed, M. N. (2020). Pharmacological evaluation of Acacia modesta bark for antipyretic, anti-inflammatory, analgesic, antidepressant and anticoagulant activities in Sprague Dawley rats. *Pakistan Journal of Pharmaceutical Sciences*, *33*(3), 101 .1024-5

Lazar, V., Ditu, L.-M., Pircalabioru, G. G., Gheorghe, I., Curutiu, C., Holban, A. M., Picu, A., Petcu, L., & Chifiriuc, M. C. (2018). Aspects of gut microbiota and immune system interactions in infectious diseases, immunopathology, and cancer. *Frontiers in Immunology*, *9*, 1830 .

Leung, F. W. (2008). Capsaicin-sensitive intestinal mucosal afferent mechanism and body fat distribution. *Life sciences*, *83*(1-2), 1-5 .

Liu, X., Zhu, Q., Zhang, M., Yin, T., Xu, R., Xiao, W., Wu, J., Deng, B., Gao, X & ,.Gong, W. (2018). Isoliquiritigenin ameliorates acute pancreatitis in mice via inhibition of oxidative stress and modulation of the Nrf2/HO-1 pathway. *Oxidative medicine and cellular longevity*, *2018* .

Liu, Y.-P., Guo, J.-M., Yan, G., Zhang, M.-M., Zhang, W-.H., Qiang, L., & Fu, Y.-H. (2019). Anti-inflammatory and antiproliferative prenylated isoflavone derivatives from the fruits of Ficus carica. *Journal of agricultural and food chemistry*, *67*(17), 4817-4823 .

MacDonald-Ramos, K., Michán, L., Martínez-Ibarra, A., & Cerbón, M. (2021). Silymarin is an ally against insulin resistance: A review. *Annals of hepatology*, *23*, 100255 .

Malagarie-Cazenave, S., Olea-Herrero, N., Vara, D., & Díaz-Laviada, I. (2009). Capsaicin, a component of red peppers, induces expression of androgen receptor via PI3K and MAPK pathways in prostate LNCaP cells. *FEBS letters*, *583*(1), 141-147 .

Mandeel, Q. A., & Al-Laith, A. A. A. (2007). Ethnomycological aspects of the desert truffle among native Bahraini and non-Bahraini peoples of the Kingdom of Bahrain. *Journal of ethnopharmacology*, *110*(1), 118-129 .

Mars, M. (2001). Fig (Ficus carica L.) genetic resources and breeding. II International Symposium on Fig 605 ,

Marshall, J. S., Warrington, R., Watson, W., & Kim, H. L. (2018). An introduction to immunology and immunopathology. *Allergy, Asthma & Clinical Immunology*, *14*(2), 1-10 .

Mellon, L., Doyle, F., Hickey, A., Ward, K. D., de Freitas, D. G., McCormick, P. A., O'Connell, O., & Conlon, P. (2022). Interventions for increasing immunosuppressant medication adherence in solid organ transplant recipients. *Cochrane Database of Systematic Reviews* .(9)

Menichini, F., Tundis, R., Bonesi, M., Loizzo, M. R., Conforti, F., Statti, G., De Cindio, B., Houghton, P. J., & Menichini, F. (2009). The influence of fruit ripening on the phytochemical content and biological activity of Capsicum chinense Jacq. cv Habanero. *Food Chemistry*, *114*(2), 553-560 .

Mezzano, S., Aros, C., Droguett, A., Burgos, M. E., Ardiles, L., Flores, C., Schneider, H., Ruiz-Ortega ,M., & Egido, J. (2004). NF-κB activation and overexpression of regulated genes in human diabetic nephropathy. *Nephrology Dialysis Transplantation*, *19*(10), 2505-2512 .

Mueller, M., Hobiger, S., & Jungbauer, A. (2010). Anti-inflammatory activity of extracts from fruits, herbs and spices. *Food Chemistry*, *122*(4), 987-996 .

Müller, B. M., & Franz, G. (1992). Chemical structure and biological activity of polysaccharides from Hibiscus sabdariffa. *Planta medica*, *58*(01), 60-67 .

Mustafa, A. M., Angeloni, S., Nzekoue, F. K., Abouelenein, D., Sagratini, G., Caprioli, G., & Torregiani, E. (2020). An overview on truffle aroma and main volatile compounds. *Molecules*, *25*(24), 5948 .

Neha, Jaggi, A. S., & Singh, N. (2016). Silymarin and its role in chronic diseases. *Drug discovery from mother nature*, 25-44 .

Ojeda, D., Jiménez-Ferrer, E., Zamilpa, A., Herrera-Arellano, A., Tortoriello, J., & Alvarez, L. (2010). Inhibition of angiotensin convertin enzyme (ACE) activity by the anthocyanins delphinidin-and cyanidin-3-O-sambubiosides from Hibiscus sabdariffa. *Journal of ethnopharmacology*, *127*(1), 7-10 .

Parkin, J., & Cohen, B. (2001). An overview of the immune system. *The Lancet*, *357*(9270), 1777-1789 .

Patel, S. (2012). Food, health and agricultural importance of truffles .

Patil, U., Jaydeokar, A., & Bandawane, D. (2012). Immunomodulators: A pharmacological review. *Int J Pharm Pharm Sci*, *4*(1), 30-36 .

Patil, V. V., & Patil, V. R. (2011). Ficus carica Linn.-an overview. *Research Journal of Medicinal Plant*, *5*(3), 246-253 .

Pulendran, B., S. Arunachalam, P., & O'Hagan, D. T. (2021). Emerging concepts in the science of vaccine adjuvants. *Nature Reviews Drug Discovery*, *20*(6), 454-475 .

Raheel, R., Aslam, M. S., Asghar, S., & Ashraf, M. (2014). Phytochemical, ethnopharmacological review of Acacia nilotica (Desi Kikar) and taxo-pharmacology of genus Acacia. *Indian Res J Pharm Sci*, *1*, 65-72 .

Rosa-Gruszecka, A., Hilszczańska, D., Gil, W., & Kosel, B. (2017). Truffle renaissance in Poland–history, present and prospects. *Journal of ethnobiology and ethnomedicine*, *13*, 1-11 .

Saleh, M. (2016). Distribution of Silymarin in the Fruit of Silybum marianum L. *Pharm Anal Acta*, *7*(511), 2 .

Scalbert, A., Manach, C., Morand, C., Rémésy, C., & Jiménez, L. (2005). Dietary polyphenols and the prevention of diseases. *Critical reviews in food science and nutrition*, *45*(4), 287-306 .

Seema Patel, S. P. (2012). Food, health and agricultural importance of truffles: a review of current scientific literature .

Seraglio, S. K. T., Silva, B., Bergamo, G., Brugnerotto, P., Gonzaga, L. V., Fett, R., & Costa, A. C. O. (2019). An overview of physicochemical characteristics and health-promoting properties of honeydew honey. *Food Research International*, *119*, 44-66 .

Sharma, J., Al-Omran, A., & Parvathy, S .(2007) .Role of nitric oxide in inflammatory diseases. *Inflammopharmacology*, *15*, 252-259 .

Shin, E. M., Zhou, H. Y., Guo, L. Y., Kim, J. A., Lee, S. H., Merfort, I., Kang, S. S., Kim, H. S., Kim, S., & Kim, Y. S. (2008). Anti-inflammatory effects of glycyrol isolated from Glycyrrhiza uralensis in LPS-stimulated RAW264. 7 macrophages. *International immunopharmacology*, *8*(11), 1524-1532 .

Sindi, H. A., Marshall, L. J., & Morgan, M. R. (2014). Comparative chemical and biochemical analysis of extracts of Hibiscus sabdariffa. *Food Chemistry*, *164*, 23-29 .

Sirag, H. (2009). Biochemical and hematological studies for the protective effect of oyster mushroom (Pleurotus ostreatus) against glycerol-induced Acute Renal Failure in rats. *Journal of Biological sciences*, *9*(7), 7 .752-46

Sostres, C., Gargallo, C. J., & Lanas, A. (2013). Nonsteroidal anti-inflammatory drugs and upper and lower gastrointestinal mucosal damage. *Arthritis research & therapy*, *15*, 1-8 .

Spiller, F., Alves, M. K., Vieira, S. M., Carvalho, T. A., Leite ,C. E., Lunardelli, A., Poloni, J. A., Cunha, F. Q., & de Oliveira, J. R. (2008). Anti-inflammatory effects of red pepper (Capsicum baccatum) on carrageenan-and antigen-induced inflammation. *Journal of Pharmacy and Pharmacology*, *60*(4), 473-478 .

Stohs, S .J., & Bagchi, D. (2015). Antioxidant, anti-inflammatory, and chemoprotective properties of Acacia catechu heartwood extracts. *Phytotherapy research*, *29*(6), 818-824 .

Street, R., & Prinsloo, G. (2013). Commercially important medicinal plants of South Africa: a review. *Journal of chemistry*, *2013* .

Sunil, M., Sunitha, V., Radhakrishnan, E., & Jyothis, M. (2019). Immunomodulatory activities of Acacia catechu, a traditional thirst quencher of South India. *Journal of Ayurveda and Integrative Medicine*, *10*(3), 18 .191-5

Tang, Y.-J., Zhu, L.-L., Liu, R.-S., Li, H.-M., Li, D.-S., & Mi, Z.-Y. (2008). Quantitative response of cell growth and Tuber polysaccharides biosynthesis by medicinal mushroom Chinese truffle Tuber sinense to metal ion in culture medium. *Bioresource technology*, *99*(16), 7606-7615 .

Tang, Y., Wang, C., Wang, Y., Zhang, J., Wang, F., Li, L., Meng, X., Li, G., Li, Y., & Wang, L. (2018). Isoliquiritigenin attenuates LPS-induced AKI by suppression of inflammation involving NF-κB pathway. *American journal of translational research*, *10*(12), 4141 .

Tanishq, C., & Sujata, D. Journal of Natural Products and Resources .

Vasanth, M., Purushotham, K., Sathish, M., Vimal Raj, D., & Venkatesh, M. (2020). In-vitro anti-inflammatory activity of liquorice (Glycyrrhiza glabra) using aqueous extract. *Int. J. Res. Pharm. Sci*, *11*, 657-662 .

Venturella, G., Ferraro, V., Cirlincione, F., & Gargano, M. L. (2021). Medicinal mushrooms: bioactive compounds, use, and clinical trials. *International journal of molecular sciences*, *22*(2), 634 .

Villa-Rivera, M. G., & Ochoa-Alejo, N. (2020). Chili pepper carotenoids: Nutraceutical properties and mechanisms of action. *Molecules*, *25*(23), 5573 .

Wadhwa, K., Pahwa, R., Kumar, M., Kumar, S., Sharma, P. C., Singh, G., Verma, R., Mittal ,V., Singh, I., & Kaushik, D. (2022). Mechanistic insights into the pharmacological significance of silymarin. *Molecules*, *27*(16), 5327 .

Wu, J.-H., Tung, Y.-T., Chien, S.-C., Wang, S.-Y., Kuo, Y.-H., Shyur, L.-F., & Chang, S.-T. (2008). Effect of phytocompounds from the heartwood of Acacia confusa on inflammatory mediator production. *Journal of agricultural and food chemistry*, *56*(5), 1567-1573 .

Yang, R., Yuan, B.-C., Ma, Y.-S., Zhou, S., & Liu, Y. (2017). The anti-inflammatory activity of licorice, a widely used Chinese herb. *Pharmaceutical biology*, *55*(1), 5-18 .

Yin, L., Guan, E., Zhang, Y., Shu, Z., Wang, B., Wu, X., Chen, J., Liu, J., Fu, X., & Sun, W. (2018). Chemical profile and anti-inflammatory activity of total flavonoids from glycyrrhiza uralensis fisch. *Iranian journal of pharmaceutical research: IJPR*, *17*(2), 726 .

Yu, X., Bao, Y., Meng, X., Wang, S., Li, T., Chang, X., Xu, W., Yang, G., & Bo, T. (2019). Multi-pathway integrated adjustment mechanism of licorice flavonoids presenting anti-inflammatory activity. *Oncology Letters*, *18*(5), 4956-4963 .

Zambonelli, A., Iotti, M., & Hall, I. (2015). Current status of truffle cultivation: recent results and future perspectives. *Italian Journal of Mycology*, *44*, 31-40 .

Zhang, M., Wu, Y.-Q., Xie, L., & Xiao, J. (2018). Isoliquiritigenin protects against pancreatic injury and intestinal dysfunction after severe acute pancreatitis via Nrf2 signaling. *Frontiers in pharmacology*, *9*, 401474 .

Zhao, X., Wang, H., Yang, Y., Gou, Y., Wang, Z., Yang, D., & Li, C .(2021) .Protective effects of silymarin against D-Gal/LPS-induced organ damage and inflammation in mice. *Drug design, development and therapy*, 1903-1914 .

Ziani, B. E., Carocho, M., Abreu, R. M., Bachari, K., Alves, M. J., Calhelha, R. C., Talhi, O., Barros, L., & Ferreira, I. C. (2020). Phenolic profiling, biological activities and in silico studies of Acacia tortilis (Forssk.) Hayne ssp. raddiana extracts. *Food bioscience*, *36*, 100616 .