UNIVERSITY OF BABYLON

COLLEGE OF PHARMACY

Graduation Project

Analytical study and medicinal uses of some medicinal plants from *Solanaceae Family*

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

﴿قُلْ هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ والَّذِينَ لا يَعْلَمُونَ
إِنَّما يَتَذَكَّرُ أُولُو الأَلْبابِ﴾

صدق الله العلي العظيم

إهداء

إلى من علّماني أبجدية الوجود...

أبي وأمي

إلى من علّموني أبجدية الحياة...

أساتذتي

إلى من علّموني أبجدية الحب والشجاعة...

إخوتي

وإلى أصدقائي...

من علموني أبجدية البحث عن الأمل

Introduction:-

Medicinal plants represent the most ancient form of medication, used for thousands of years in traditional medicine in many countries around the world. The empirical knowledge about their beneficial effects was transmitted over the centuries within human communities [khan, 2014].

Natural products play a pivotal role as a source of drug compounds and, currently, a number of modern drugs which are derived from traditional herbal medicine are used in modern pharmacotherapy [Patwardhan,2008].

Medicinal plants are the "backbone" of traditional medicine. Medicinal plants are view as a rich source of important ingredient that can be used in development and synthesis of different drugs. Besides that these plants plays a critical role in the development of human culture around the whole world (Singh, 2015).

The extraction procedure is a crucial step in the study of the bioactive molecules from plant sources. Currently, in addition to more traditional techniques, modern extraction methods are being utilized, such as ultrasound-assisted and supercritical fluid extraction methods [Azwanida,2015].

Moreover, the development of advanced tools for the qualitative and quantitative assessment of phytochemicals, such as high-performance liquid chromatography (HPLC) and liquid chromatography/mass spectrometry (LC/MS), significantly improved phytochemical investigation [Jamshidi-Kia,2018]. On the other hand, the biological properties of many plant species traditionally utilized together with their bioactive components have been elucidated until now. The more classical

bioassay-guided natural drug discovery process and the modern processes, including high-throughput screening[Jamshidi-Kia,2018.^Harvey; Cree,2010.], and even the new reverse pharmacognosy approach [Takenaka,2001.], allowed the identification of a great number of bioactive phytochemicals.

Nevertheless, medicinal plants still have a hopeful future, as the phytochemical composition and the potential health benefits of many species have not yet been studied or still need to be more deeply investigated [Jamshidi-Kia, F.2018.].

Human beings have depended on nature for their simple requirements for the sources for medicines, shelters, food stuffs, fragrances, clothing, flavors', fertilizers and means of transportation throughout the ages (Dar et al, 2017).

The existence of traditional cure in the disease treatment process is regarded as a fundamental part of modern pharmaceutical science. Various bio-ingredients of natural products plays a vital role in the discovery of synthetic medicines (Yuan et al., 2016).

In developing countries like India traditional medicines provides a cheap and alternative source for primary health care because of their believe in traditional medicines, choices, effectiveness, cultural priorities and most importantly due to lack of modern health facilities (Aziz et al., 2018).

Use of herbal medicines in developed countries has expanded sharply in the latter half of the twentieth century. Monographs on selected herbs are available from a number of sources, including the European Scientific Cooperative on Phytotherapy (ESCOP, 1999), German Commission E (Blumenthal et al., 1998) and the World Health Organi- zation (WHO,

1999). The WHO monographs, for example, describe the herb itself by a number of criteria (including synonyms and vernacular names) and the herb part commonly used, its geographical distribution, tests used to identify and characterize the herb (including macroscopic and microscopic examination and purity testing), the active principles (when known), dosage forms and dosing, medicinal uses, pharmacology, contra-indications and adverse reactions. Other resources that provide detailed information about herbal products in current use include the Natural Medicines Comprehensive Database (Jellin, 2002) and (Natural Products ALERT) (2001). Information about other available databases has been published by Bhat (1995).

The utilization of medicinal plants has increased worldwide so far in the context of the massive expansion of traditional medicine and increasing interest in herbal treatments (Akinyemi, and Ka, 2018). The pharmacological treatment of disease began long ago with the use of herbs (Schulz et al., 2001).

One problem is that ingredients once used for symptomatic management in traditional healing are now used in developed countries as part of health promotion or disease prevention strategies; thus, acute treatment has been replaced by chronic exposure (e.g., herbal products used for weight loss, Allison et al., 2001).

A second problem is that efficacy and effectiveness have rarely been demonstrated using modern scientific investigations. An evidence-based approach to this issue has only recently been implemented, and the results reveal that for most herbal products, considerable gaps in knowledge need to be remedied before one can be convinced about their efficacy.

One of the most difficult issues to contend with in translating traditional

herbal practices into conventional 'western' medicine is the individualization of prescriptions containing multiple herbal and other ingredients. There is little incentive for standar- dization of products for a mass market, when the intention has been to provide an indivi- dual prescription. To the small grower or the traditionally trained herbalist, standardization means understanding the growth conditions, the time of harvesting, the manner of extraction or other preparation of material so that a reliable (albeit small amount of) active ingredient can be offered to people. To the manufacturer or distributor of large quantities that will be sold in a supermarket or a health food store, standardization refers to industrial production under defined conditions, using so-called Good Manufacturing Practices (GMP) (Food & Drug Administration, 2002).

Herbal medicinal products (like other medicinal products) are made up and/or supplied to individual patients following a one-to-one consultation between patient and practitioner. Some herbal medicinal products are made according to accepted formulae and are prepared by pharmacists. According to Article 2.4 of Council Directive 65/65/EEC (European Commission, 1965).

There is a promising future of medicinal plants as there are about half million plants around the world, and most of them are not investigated yet for their medical activities and their hidden potential of medical activities could be decisive in the treatment of present and future studies [Singh 2015].

The WHO endorses and promotes the addition of herbal drugs in national health care programs because they are easily accessible at a price within the reach of a common man and are time tested and thus considered to be much safer than the modern synthetic drugs [Singh and Singh, (1981)].

Even today, plants are not only indispensable in health care, but form the best hope of source for safe future medicines [Hamburger and Hostettmann, (1991)].

Solanaceae Family:-

The Solanaceae family represents around 85 genera of floweing plants consisting of over 2800 species globally (D'Arcy, 1986; Albuquerque et al., 2006). Its cosmopolitan distribution is best represented in tropical and temperate regions, with Australia and Latin America as major dispersal centers (Barroso et al., 1991). The greatest species diversity is reported in tropical South America and is considered to be the origin of Solanaceae (Hunziker, 1979).

Plant members are typically trees, shrubs and herbs, though there are some climbers, vines and epiphytes (Barroso et al. 1991).Leaves are usually simple; sometimes they are greatly lobed, petiolate/sub-sessile or phyllotaxy-alternate/alternate to opposed. Leaves are herbaceous, leathery or modified spines.

Importance of Family:-

The family is well-known for production of wide varieties of secondary metabolites for example, alkaloids, flavonoids and terpenes (Evans, 1986). Recently, the ecological importance of Solanum alkaloids in limiting frugivory (Cipollini and Levey, 1997; Albuquerque et al., 2006) and as antifungal agents (Cipollini and Levey, 1997) have been reported. While several members are pharmacologically important, like Atropa, Datura (Bohs and Olmstead, 1997), others serve as major food crops like peppers (Fig 1), eggplant (Fig 2) tomato (Fig 3) and tuberous potatoes (Fig 4) (Basu and De, 2003).

Figure 1: Several species of Capsicum (commonly known as pepper, chili, sweet pepper or bell pepper, hot chili pepper or chili pepper, jalapeno pepper etc) are known all over the globe, but two most commercially successful species that are cultivated across the planet are Capsicum annuum L. and Capsium frutescens L. 1-15. Different cultivars and/or germplasms /genotypes of different species of Capsicum showing the wide diversity of shapes, sizes, color, aroma, flavor and degree of hotness. 8. Flower of Capsium frutescens L. [Photo credits: 1-9: Ratnabali Sengupta; 10-15: Saikat Basu]

Figure 2: Eggplant (Solanum melongena L.) 1. Plant; 2. Flower; 3. Flower bud; 4-13. Different cultivars of eggplant grown across the gloabe for commercial production. [Photo credits: 1-3; 5-13: Ratnabali Sengupta; 4; Saikat Basu]

Figure 3. 1. Potato (Solanum tuberosum L.) plants growing under greenhouse conditions; 2. Potato root system showing growth of tubers; Tubers with 3. White-fleshed tuber; 4. Yellow-fleshed tuber; 5-6. Deep purple colored flesh; 7. Pink colored flesh; 8. Pale red colored flesh; 9. Deep purple colored flesh [Photo credits: 1: Saikat Basu; 2-3: Ratnabali Sengupta; 4-9: Xianping Li and Yanshan Li]

Figure 4. 1-6. Flowers and fruits of tomato (Solanum lycopersion L.); 7. Solanum nigrum L.; 8. Solanum sisymbriifolium Lam.; and 9. Solanum torvum Sw. [Photo credits: 1, 2, 4 & 6: Saikat Basu; 3, 5, 7-9: Ratnabali Sengupta]

Capsicum spp

Pepper (Capsicum spp.) is one of the oldest domesticated and utilized crops. Its use dates back to more than 7000 years in Mexico and is believed to have originated in tropical America .[(Andrews ,1999) ,(Bosland , 1996)]

Pepper belongs to the genus Capsicum which is a member of the Solanaceae family. The genus Capsicum consists of approximately 31 species of which the five domesticated species are C. annuum, C. baccatum, C. chinense, C. frutescens, and C. pubescen.(Moscone,2007)

Pepper is the most widely used spice and condiment in the world and is greatly priced for its pungency and adding special flavor to many cuisines throughout the world.(Andrews,1999)

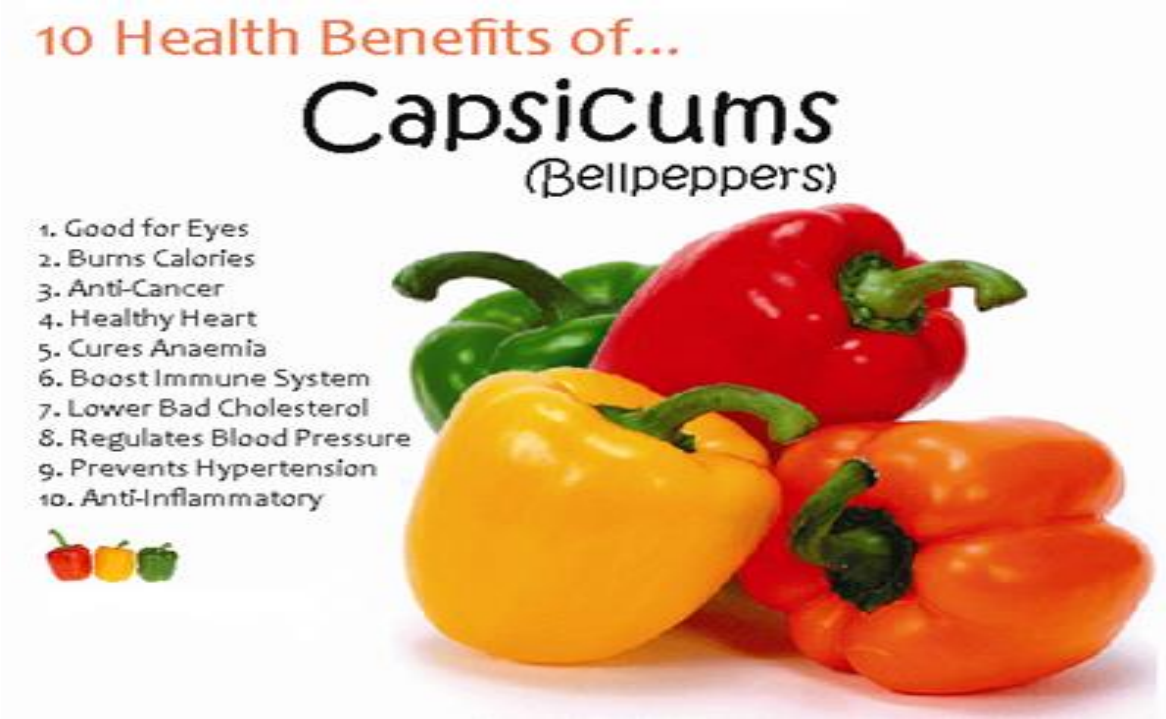
Historically it was used mainly for seasoning and as medicinal plant, but today its use extended to fresh and processed vegetable, spice, dried forms, used as food dye, bred as ornamental plant and production of extracts for various pharmaceutical and cosmetics industry.[(Paran,2007), (Djian-Caporalino,2009)]

An evidence based report by Arthritis Research UK showed that around four out of 10 people in the UK use complementary medicine (includes herbal medicine) at some point in their lives and suggested the report may help people to select useful treatment.(Macfarlane,2012).

Nutritional value:-

Chili peppers are rich in many minerals, vitamins and amino acids essential for human health and growth.(Pawar et al,2011) found chilies to hold all the best properties to be considered as a food. Peppers contain

wide array of phytochemicals such as vitamins, phenolics and flavonoids that are important anti-oxidants which may reduce degenerative diseases.[(Abdul Salam,2015),(Howard,2000)]Peppers are rich in vitamin C, vitamin A, vitamin E most B vitamins and in particular vitamin B5.[(Howard,2000),(Ganguly,2017)]They also are very high in potassium, magnesium, iron and rich in calcium and phosphorus.[(Pawar et al,2011),(Abdul Salam,2015)]Peppers include many species and hundreds of varieties and types. They are consumed as fresh unripe fruits, ripened red or other colors and dried forms. The different species, varieties and consumption forms vary in their nutritional and anti-oxidant contents.(Howard,2000).



Capsaicin the active Ingredient

Capsaicin an alkaloid in chili peppers that makes them hot, is used as an analgesic in topical ointments, nasal sprays, and dermal patches to relieve pain.(Fattori et al,2016).

Fruit pungency which is probably the most important flavor trait of peppers is characteristic of the genus Capsicum and it is due to an alkaloid compounds known as capsaicinoids that are unique to Capsicum.[(Moscone,2007)(Rodriguez-Burruezo et al,2010)].

Capsaicin and its related compounds are the active ingredients in pepper that are related to the anti-microbial and anti-carcinogenic and other medicinal properties in pepper. Scoville organoleptic method and High Performance Liquid Chromatography (HPLC) are used for measuring pungency.[(Rodriguez-Burruezo et al,2010)&(Bosland,2010)].

Pungency is dependent on the genetic makeup of the pepper plant and other environmental factors.(Bosland et al,2012).

Therapeutic properties

Chili pepper has preventive and therapeutic properties for many ailments such as different types of cancer, rheumatism, stiff joints, bronchitis and chest colds with cough and headache, arthritis, heart arrhythmias and used as stomachic(Pawar et al,2011).Chili preparations for treating ailments can be standard capsaicin, pharmaceutically prepared gels, creams and plasters, essential oils distilled from pods, powder prepared by crashing pods and extracts by soaking pods in water or ethanol.[(Macfarlane et al,2012)&(Abdul Salam,2015)].

Chili pepper act as antioxidants and has protective role against many diseases such as cancer, diabetics, cardiovascular and anemia. Vitamins E, C and β-carotene are important as protective antioxidant and peppers are rich in vitamins C and E as well as carotenoids and xanthophylls.[(Perucka, Materska,2007),Mateos et al,2013)].

Adverse effects and toxicity

Internally, it may cause gastrointestinal cramping, pain, and diarrhea. Topically, it may cause painful irritation of mucous membrane [Fleming،2000].

Acute myocardial infarction was recorded in 40 years old man admitted to emergency department with complains of chest pain and dyspnea after exposure the pepper gas that sprayed to environment during a social event [Skidmore-Roth,2001].

Capsicum annuum should not be used during pregnancy and lactation, in people with hypersensitivity and in children. The plant should not be used on open wounds or abrasions, or near the eyes [Lininger et al,1999]. Interactions were reported with concomitant administration of Capsicum annuum with aspirin and salicylic compounds. It also decreased the actions of α-adrenergic blockers, clonidine and methyldopa [(Ling et al,2009)&(Lininger et al,1999)&(Felter,1992)].

Solanum melongena

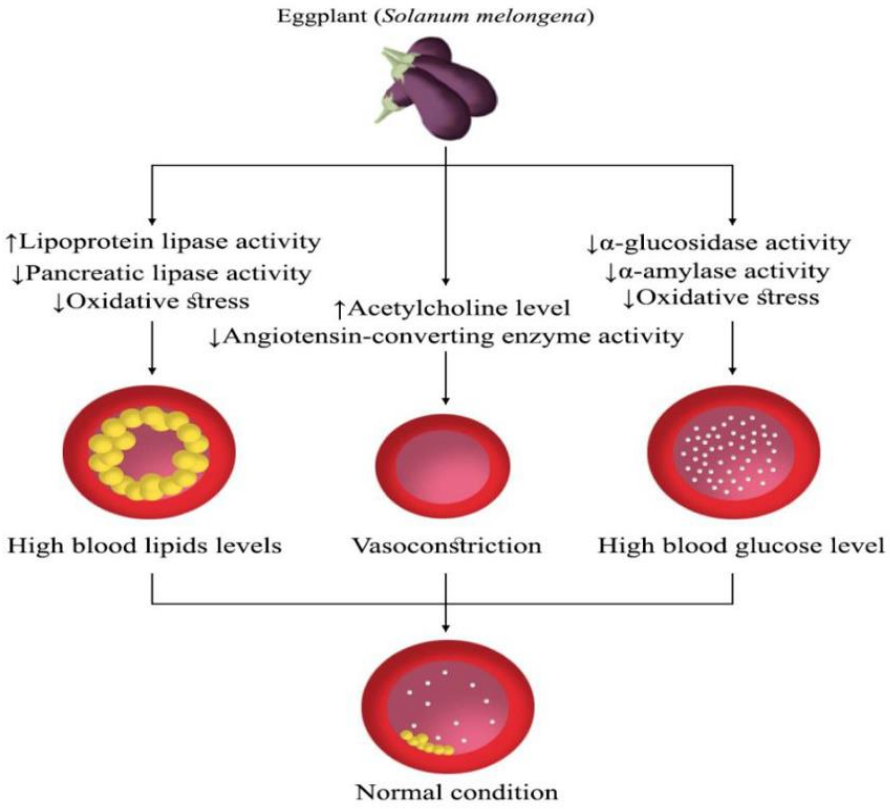
Eggplant (Solanum melongena) is one of the common plants grow all around the world, especially in Asian countries, the Middle East, and around the Mediterranean basin [(cericola et al,2013)&(Daunay,2008)]. Eggplant belongs totheSolanaceae family and the genus Solanum (Sukprasansap,2019). Based on the fruit shape, eggplant has been classified into three types including, egg-shaped, long slender shape, and dwarf types (Niño-Medina et al,2017).

Dietary supplement

It also has known as aubergine and it is an important source of fiber, minerals (iron, calcium, potassium, magnesium, sodium, zinc, and phosphorus), vitamins C, thiamin, niacin, B6, B12, A, E, D, and K (Gürbüz et al,2018).

Therapeutic properties

Eggplant has been used in the treatment of several diseases, including asthma, bronchitis, diabetes, arthritis, and hypercholesterolemia (Magioli,2005)&(Guimarães et al,2000). The clinical use of eggplant is due to its phenolic and alkaloid contents (Daunay,2008).



Active ingredient of eggplant

The delphinidin (an anthocyanin) and chlorogenic acid (a phenolic acid) are the main phenolic compounds in the skin and pulp of eggplant (Niño-Medina et al,2017) (Figure1). It has been reported that delphinidin can induce endothelial vasodilation by the activation of the nitric oxide (NO) pathway (Patel et al,2013). Delphinidin also has shown antihypertensive effects via interrupting the renin (an aspartyl protease)-angiotensin system (RAS) signaling pathway (Parichatikanond et al,2012). The overactivation of this system is one of the most important risk factors for the development of hypertension (Gonzalez,2020). Delphinidin reduces the expression and activation of the angiotensin-converting enzyme (ACE) (Parichatikanond et al,2012)delphinidin has exhibited inhibitory properties against the

α-amylase enzyme, and thereby it may be useful in the treatment of diabetes and its complications such as overweight and obesity, and cardiovascular disease (Demir et al,2019)Chlorogenic acid has been found to enhance NO status, improve endothelial function, and lower blood pressure (Mubarak et al,2012). Also, chlorogenic acid has shown beneficial effects on type 2 diabetes mellitus by increasing the translocation of glucose transporter 4 (GLUT4) to the plasma membrane, enhancing glucose transport to skeletal muscle, and inhibiting gluconeogenesis, besides delaying intestinal glucose absorption (Ong,2012). It has been suggested that chlorogenic acids exhibit anti-obesity and antihyperlipidemic activities by alleviating the levels of free fatty acids and triglycerides (TG) (Sudeep et al,2016). Additionally, several studies have reported the pharmacologic aspects of eggplant, such as anti-oxidant (Kaur,2002), anti-inflammatory (Im et al,2013), antibacterial (Gubarev et al,1998), antifungal (Das,2010).

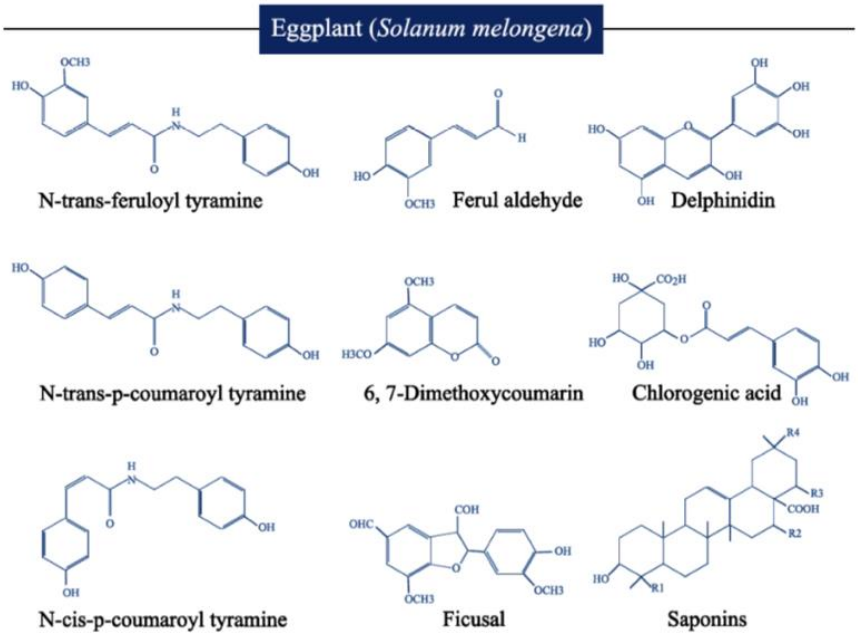


Figure 1. The structure of the main compounds in the skin, pulp, and root of eggplant

Side effects

Inspite of all the health benefits that eggplant provides, consumption of this vegetable in large quantities can have some harmful effects on your body. Nasunin, present in eggplant, is a phytochemical which can bind with iron and remove it from the cells. The oxalates in this vegetable can cause stones in the kidney. Finally, eggplant belongs to the nightshade family of vegetables and may cause allergic reactions in some people if taken in large quantities (Sharma,2008).

Nicotiana tabacum

Nicotiana spp. is one of the most important nonfood crops that are widely cultivated worldwide (MOON et al., 2009). It belongs to family Solanaceae which has more than 64 species, being Nicotiana tabaccum one of the most cultivated species among them (REN; TIMKO, 2001). It was proven that N. tabaccum is natural amphidiploid

(2n = 4x = 48) arisen by hybridization of wild progenitor species.Numerous types of tobacco are defined by different criteria such as region of production, intended use in cigar (i.e., filler, binder and wrapper) and cigarette manufacturing, method of curing (flue-, air-, sun- and fire-cured tobacco) as well as morphological and biochemical characteristics (i.e., aromatic fire-cured, bright leaf tobacco, Burley tobacco, Turkish or oriental tobacco) (REN; TIMKO, 2001). Turkish or oriental tobacco has a much milder flavor and contains less nicotine and fewer carcinogens than other varieties (DAVIS; NIELSEN, 1999). In order to get an American Blend type of cigarette, it is mixed with more robust tobacco such as Virginia and Burley tobacco.

Types of Tobacco

The kind of tobacco and its associated products used worldwide vary considerably from place to place and also depend upon the choice of the individual consumers. The choice of tobacco used often reflects the socio-economic status of the users. Certain tobacco products are rather expensive and their consumptions, in a way, reflect the users' luxurious way of life. The availability of such tobacco products is also an important factor in the users' selection for consumption. Generally, tobacco can be divided into two types, smoking (combustible) and smokeless (non-combustible) tobacco. Smoking is the most common practice of tobacco consumption all over the world and consists of great number of varieties. Every cultures and communities have different specific names or brands for the smoked tobacco products. Some of the most popular varieties include cigarette, cigar, pipe, hookah, bidi, cheroot, cigarillos, little cigar, kreteks, etc. Smoked tobacco products are initially hand rolled, but after the industrial revolution, factories and industries took over its production and is currently one of the biggest industries.[(World Health Organization,2006)&(Eriksen et al,2012)]

Chemical Composition of Tobacco

Tobacco is known to contain more than 8000 chemicals, out of which more than 80 have probable carcinogenic properties.[(International Agency for Research on Cancer,2004)&(Arimilli et al,2012)].

Many of these chemicals exhibit toxic, cytotoxic, genotoxic, mutagenic, teratogenic and carcinogenic properties and some of them are classified under class I carcinogens. The types of chemicals present in smoked and smokeless tobaccos also differ. Many chemicals are synthesized during the burning/ pyrolysis of the tobacco in the process of

smoking.[(Chiba & Masironi.1992)&(Husgavfel-Pursiainen,2004)].

Adverse effects

Besides cancer, it has also been known to cause several diseases mostly involving the pulmonary system like bronchitis, asthma, tuberculosis, laryngitis, pharyngitis, etc. and autoimmune rheumatic diseases.[Rose et al,2016]. Tobacco not only causes cancer deaths but is also responsible for great number of deaths from cardiovascular, chronic obstructive pulmonary and degenerative diseases[Warren et al,2000].The use of tobacco has also been known to cause adversities in pregnancy outcomes, possibly leading to abortion[Kallen,1999].

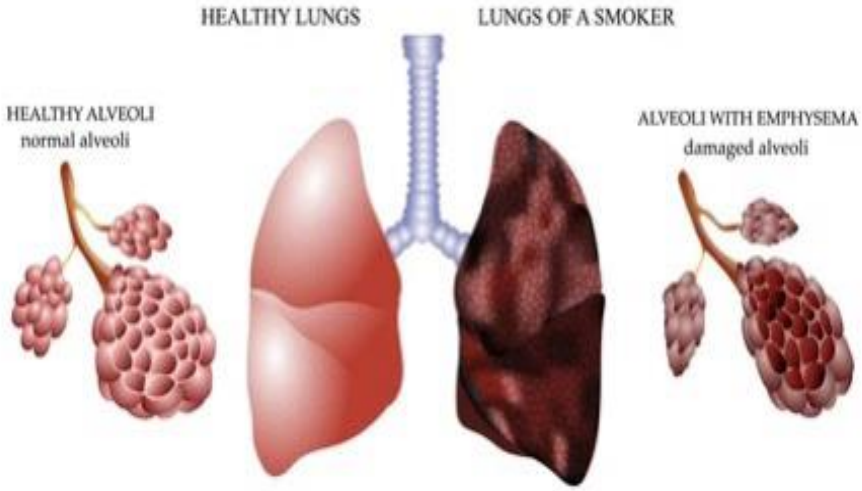
Theraputic properties

leaves and flowers revealed biological and pharmacological activities, such as antimi- crobial, anti-proteolytic, antioxidant and insect- icidal (Bakht et al, 2013; Digrak et al, 2001; Ibrahim et al, 2011; Jassbi et al., 2017).

Pharmacology of nicotine

Nicotine is a sympathomimetic drug that releases catecholamines, increases heart rate and cardiac contractility, constricts cutaneous and coronary blood vessels, and transiently increases blood pressure [Benowitz,2003]. Nicotine also reduces sensitivity to insulin and may aggravate or precipitate diabetes, and nicotine may contribute to endothelial dysfunction [(Eliasson,2003)& (Puranik,2003)].Nicotine is a tertiary amine composed of a pyridine and a pyrrolidine ring. Nicotine binds to acetylcholine receptors at

ganglia and neuromuscular junctions and in the brain (Benowitz, 1988).



Atropa belladonna

The plant Atropa belladonna is a perennial herb belonging to the family Solanaceae [Berdai et al,2012]. It is known to be extremely toxic and the name Atropa is derived from "Atropos" in Greek mythology that refers to one of the three fates which cut the fate of life; and Belladonna meaning "beautiful women" in Italian [Joshi,2003]. In ancient Roman times, the extract of this plant was used by women to dilate pupils to make them look attractive and also applied to the cheeks to give a pinkish–red glow to the skin [Cikla et al,2011]. Traditionally in Europe, during the middle ages, the plant was used as an herb to treat various illnesses, and also used as poison due to its toxicity [Moulton,2011]. The plant grows in the wild and is native to Europe, Africa, and Asia. It grows about 4 to 5 feet tall and has thick oval dark green foliage with black cherry-like berries making it look identical to blueberries and attractive to eat. This also happens to be a common reason for intoxication after ingestion of these berries in adults and children's [Berdai et al,2012]. The intoxication is caused by the alkaloids atropine, scopolamine and hyoscyamine, which are

present in the berries, leaves and roots. The intoxication causes anti-cholinergic effects on the body causing anti-cholinergic toxidrome [Berdai et al,2012]. The anti- cholinergic effects produced by the Atropa belladonna alkaloids cause delirium, hallucination, tachycardia, mydriasis (dilated pupils), dry mouth, flushed skin, blurred vision, urinary retention, vomiting and anhidrosis [(Caksen et al,2003)&(Laffargue et al,2011)].

Pharmacology effect

-Effect of Atropa belladonna on the central nervous system

The Atropa belladonna alkaloids atropine and scopolamine are known to be antagonist for muscarinic receptors. They block the muscarinic receptor acetylcholine, which plays an important role in the functioning of the brain for learning, memory and orientation. In the event of the muscarinic blockade, the absence of acetylcholine causes dysfunctional memory, disorientation and hallucination [Joshi,2003]. The respiratory rate increases and in some cases of overdose, leads to respiratory and cardiovascular failure [(Mirakhur,1980)&(Bouziri et

al,2011)].

-Effect of Atropa belladonna on peripheral nervous system

The alkaloid atropine acts as muscarinic antagonist and blocks the parasympathetic postganglionic muscarinic receptors [(Berdai et al,2012)&(Joshi,2003)&(Laffargue et al,2011)]. Atropine has a stronger effect than scopolamine in producing tachycardia and cardiovascular changes, although the peripheral effects of both atropine and scopolamine are the same [(Mirakhur,1979)&(Diaz,1980)]. The signs of peripheral effects manifested by the parasympathetic block include decreased secretions causing dryness of mouth, flushed skin, mydriasis, vomiting, constipation, urinary retention, fever, tachycardia and hypertension [(Berdai et al,2012)&(Joshi,2003)].

Medicinal use of Atropa belladonna

In Europe, through ancient times, plants from deadly nightshades were used to treat various airway diseases e.g. the fumes from the burnt plants were inhaled for relief from bronchoconstriction [Moulton,2011]. Muscarinic antagonists are known to be used as bronchodilators in asthma treatments. Due to their side effects, the anti-cholinergic drugs are not the first line of treatment; instead β-adrenergic receptor agonists and anti-inflammatory corticosteroids are routinely administered in patients with asthma and chronic obstructive pulmonary diseases [(Moulton,2011)&(National,2007)]. In the late 1800s, Atropa belladonna was therapeutically used to treat Parkinson's diseases because of its naturally occurring alkaloids, atropine and scopolamine [Adler,2008]. Atropine is also effective in treating certain cardiovascular conditions like bradycardia, though low doses of atropine have shown to cause bradycardia [Mirakhur,1980]. Atropine is also used as a premedication in

anesthesia, along-with other anticholinergics, since it decreases secretions [Mirakhur,1979]. Atropa belladonna alkaloids act as anti-emetics, anti-spasmodic and are also effective in the treatment of gastro-intestinal ulcers [Mintzer,2000].

Atropa belladonna intoxication

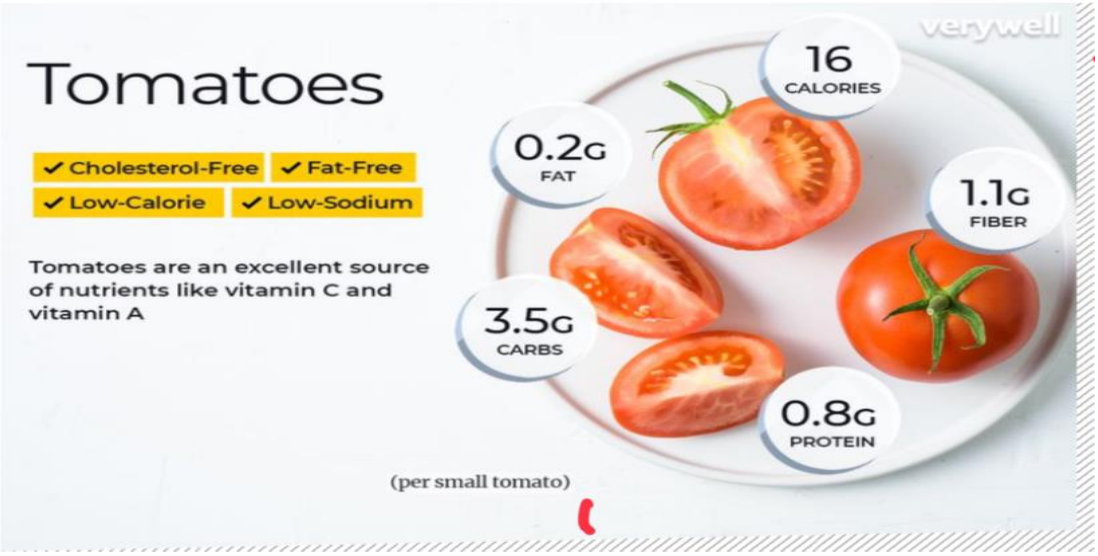
The severity of the symptoms caused by Atropa belladonna poisoning may vary from mild to moderate to severe, depending on the dose and source. The concentration of the alkaloids present in the berries and leaves may also differ depending on the species. Some species of Atropa belladonna are hybrid and may not produce all the symptoms of toxic anti-cholinergic syndrome [Berdai et al,2012].Atropine crosses the blood brain barrier and patients with central anti- cholinergic syndrome show loss of memory, confusion, disorientation, hallucination, in-coordinated movements and agitated delirium with acute psychosis [(Berdai et al,2012)&(Joshi,2003)]. Severe cases of central anti-cholinergic toxidrome may present with coma, seizures, respiratory and cardiovascular failure [Joshi,2003]. The peripheral toxicity produced by the alkaloids of Atropa belladonna causes inhibition of secretions and relaxation of smooth muscles in the gastro-intestinal and urinary tract, leading to dryness of

mouth, constipation, diminished bowel sounds or ileus and urinary retention [Fidan,2011]. The heart rate increases (tachycardia) with hypertension as a result of parasympathetic block caused by anti-cholinergic agents. Ocular changes include pupillary dilation with paralysis of the ciliary muscle which results in loss of accommodation [(Caksen et al,2003)&(Fidan,2011)].

Solanum lycopersicum

Tomatoes (Solanum lycopersicum), which are frequently included in the Mediterranean diet and are widely consumed as vegetables, play an important role in nutrition because of their well-established health benefits [Salehi et al,2019]. Tomatoes are used in many processed food products such as sauces, salads, soups, and pastes [Lenucci et al,2006]. Common nutrients reported to be present in tomatoes are vitamins, minerals, fiber, protein, essential amino acids, monounsaturated fatty acids, carotenoids and phytosterols [Abdullahi et al,2016]. These nutrients perform various body functions including constipation prevention, reduction in high blood pressure, stimulation of blood circulation, maintenance of lipid profile and body fluids, detoxification of body toxins and maintaining bone structure as well as strength [Vats et al,2020].Tomatoes are also an excellent source of nutrients and bioactive compounds, commonly known as secondary metabolites, the concentrations of which are correlated with the prevention of human chronic degenerative diseases, such as cardiovascular disease (CVD), cancer, and neurodegenerative diseases [Cheng et al,2019]. Due to the high concentrations of different natural antioxidant chemicals, such as carotenoids (β-carotenoids and lycopene), ascorbic acid (vitamin C), tocopherol (vitamin E) and bioactive phenolic compounds (quercetin, kaempferol, naringenin and lutein, as well as caffeic, ferulic and chlorogenic acids), tomatoes can help ameliorate many diseases, especially

chronic diseases [Navarro-González,2018].



Antioxidant Properties and Bioactive Compounds in Tomato

Antioxidants are biomolecules that (1) prevent the oxidation of other molecules by inhibiting the initiation and elongation of the oxidizing chain reaction of ROS and (2) by inhibiting the proliferation of cells, free radical scavenging, the modulation of enzymatic activity via chelation of metallic ions and signal transduction pathways [Sies et al,2020].Antioxidants, which are bioactive reducing agents, prevent cellular damage caused by ROS, including superoxide anion radicals, hydroxyl radicals and hydrogen peroxide [García-Sánchez et al,2020].Generally, antioxidant compounds play important roles in the prevention of several human degenerative diseases, including CVDs, diabetes, cancer, neurological diseases, and aging, by minimizing oxidative stress caused by ROS [Abdel-Daim et al,2019].

Phenolic compounds present in tomato are considered as the primary antioxidant based on their ability to donate hydrogen atoms to reactive free

radicals [Martínez-Valverde et al,2002].

Health Benefits

Tomatoes offer several health benefits related to their phytonutrient content:

-May Reduce Risk of Prostate Cancer

Lycopene is an antioxidant in tomatoes that has been associated with a reduced risk of prostate cancer. [Chen et al,2015] Lycopene acts on various biochemical pathways that help prevent cancer cells from developing and spreading. Lycopene is higher in processed tomato foods (such as ketchup or canned tomatoes) because the processing involves removing water and leaving a more concentrated tomato product.[Story et al,2010]

-Supports Heart Health

The lycopene in tomatoes works synergistically with other antioxidant vitamins (like vitamins A, E, and C) to provide compounding beneKts for heart health. Some studies demonstrate a relationship between the lycopene in tomatoes and an oxidized LDL and arterial plaque reduction. [Mozos et al,2018] Tomatoes also contain potassium, which is well-known to reduce blood pressure. [National Institutes of Health Office of Dietary Supplements]

-Aids Eyesight

Tomatoes are an excellent source of vitamin A, and more speciKcally, tutein and zeaxanthin. These two forms of vitamin A accumulate in the retina and prevent age-related macular degeneration. [National Institutes of Health Office of Dietary Supplements] Consuming tomatoes as a part of

dishes that include some fat (such as in a salad with olive oil) improves absorption of the fat-soluble vitamins, which are crucial for good eyesight.

-Protects Against Sun Damage

The phytonutrients in tomatoes are protective against some of the eLects of UVB damage. [Groten et al,2019] Although tomatoes alone aren't enough to prevent skin cancer, including tomatoes in your meal plan may improve your body's resilience to the dangers of certain types of sun rays.

-May Reduce Risk of Diabetes Complications

Tomatoes have been associated with antihyperglycemic eLects in rodents but not in humans. Nonetheless, tomatoes are still beneKcial for people with diabetes. Tomatoes have been shown to reduce the oxidative stress that's caused by diabetes. They also reduce in:ammation, accelerated atherosclerosis, and tissue damage, all common complications of the disease. [Saleem,2018]

Allergies

If you have seasonal allergies to grass pollen, you may experience an oral allergy after eating tomatoes. [Oral allergy syndrome. American College of Allergy, Asthma, and Immunology.] Symptoms may include itchy mouth, ears, or throat or swelling of the lips, mouth, tongue, and throat. Talk to your doctor if you suspect you may be allergic to tomatoes.

Adverse Effects

Tomatoes are naturally acidic. If you suffer from acid reflux or heartburn, you may want to limit your intake of tomatoes and tomato products. [Diet and gastroesophageal reflux disease. American Society For Gastrointestinal Endoscopy.].It is also associated with some health risks

includingirritable bowel syndrome (IBS), migration, allergy, body aches, arthritis, and urinary problems[Salehi et al,2019].

Solanum tuberosum

Potatoes are tubers first cultivated in the Andes region of South America.The English word ‘potato’ comes from Spanish patata [Madison,2015].Potato is the best source of carbohydrate (approximately 26 g in a medium potato). The predominant form of this carbohydrate isstarch[Cummings et al,1996]. The storage and cooking method used can significantly affect the nutrient availability of potato [Madiwale et al,2012]. Cooking and then cooling potatoes significantly(cooked potato)resistant starch, which increases to about 13% upon cooling) [Englyst et al,1992]. A medium-sized, 150 g enhances resistant starch contains about 7% 27mg (45% of the daily value [DV]),starch potato with the peel provides vitamin C-potassium-620 mg(18% of DV), vitamin B6- (10% of DV) and trace amounts of thiamin, riboflavin, niacin, iron, folatemagnesium,phosphorus,, and zinc[Ferretti,2011].

Dose

There is no clinical declaration to support a specific potato dosage but the toxic glycoalkaloids present in sprouting potatoes. A suggested acceptable level of total glycoalkaloid in commercial potato cultivars is not greater than 200 mg/kg fresh potato [Friedman et al,2009]

TRADITIONAL USES

Tubers and leaves extracts have antimicrobial activity against Gram positive and Gram-negative bacteria [Council of Scientific and Industrial Research.1976].Iron, calcium, phosphorous, magnesium and zinc in potatoes are helpful in maintaining and building bone structure and strength [Bone Health,2014].In addition, potassium, calcium and magnesium have been found in potatoes naturally to decrease blood pressure because of its vasodilation effects [Antinoro,2014].

Choline is helpful in muscle movement, sleep, learning and memory. Choline also helps to maintain the structure of cellular membrane, helps in the transmission of nerve impulses, aids in the absorption of fat and suppresses chronic inflammation[Choline et al,2014].Potatoes lower the risk of colorectal cancer due to folate, which plays a role in DNA synthesis and repair, thereby preventing the formation of from mutations in the DNA [Machowsky et al,214]. Potatoes help to prevent constipation improve health of digestive tract [Megan Ware RDN,2016]. A reduced glycemic response is evaluated when potatoes are precooked and eaten cold or reheated [Fernandes et al,2005].Potato juice is traditionally used in the management of dyspepsia and gastritis[Chrubasik et al,2006].

Pharmacological properties

anti-oxidant activities

Phytochemicals such as flavonoids and related phenolic compounds

which are generally present in sweet potatoes have been reported to have multiple biological effects, such as antioxidant activity. Purple-fleshed variety has been reported to contain anthocyanins, which possess antioxidant activity [Teow et al,2007].

Anti-diabetic effect

The blood glucose lowering effect of white skinned sweet potato in type 2 diabetic patients has been linked to an increase in blood levels of adiponectin; an adipocyte hormone that serves as an important modifier of insulin metabolism [Ludvik et al,2008].

Anti-cancer potential

Extracts from different parts of sweet potato have also been reported to exhibit anticancer and antitumor properties. Sweet potato extract inhibits proliferation and induces apoptosis in prostate cancer cells in vivo and in vitro [Karna et al,2011].

Anti-ulcer potential

Ulcer is characterized by the shedding of inflamed tissue from the skin or mucous membrane [Hermes et al,2013]. Methanol extract of sweet potato roots showed gastroprotective activity against aspirin-induced ulcer in Wistar rats in a dose dependent manner [Panda et al,2012].

Effective on cardiovascular system

The oxidation of low-density lipoprotein can cause complications which can result into atherosclerosis leading to cardiovascular disease [Mazza et al,2007].

Effect on immune system

Sweet potato extracts have also been reported to have modulatory effects on the immune system and health. Ethyl acetate fractions of bioactives extracted from two different cultivars of sweet potato exhibited immunomodulatory activities in a cultivar dependent manner in mice splenocytes [Chen et al,2013].

Haematological effects

Sweet potato leaf is used in traditional medicine as a remedy for anaemia due to it haematinic effects [Osime et al,2008]. In a recent study by Montejo et al, sweet potato leaves powder diet increased the packed cell volume, haemoglobin levels and red blood cells in mice [Montejo et al,2015].

ADVERSE REACTIONS

Allergic reactions (AD, contact dermatitis, rhinitis, and wheezing), abdominal pain, diarrhea, nausea, vomiting have been reported and are generally affiliated with the consumption of blighted, sprouted or greening potatoes [(Friedman et al,2006)&(Korpan et al,2004)].

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