

Article history :

Received : 20.08.2020

Accepted : 23.11.2020

Pharmacognosy and medicinal value of some exotic fruits and vegetables consumed in India

■ Harsh Pant, Vijaya Lobo¹, Anagha Santhosh¹ and Shashank Verma¹

Members of the Research Forum

¹Department of Botany, St. Xavier's College (Autonomous), Mumbai (M.S.) India

ABSTRACT : Plants have always been a vital source of medicines and other essential products that have been a part of human life ever since time immemorial. Pharmacognosy and its associated aspects have been going through constant evolution and investigation with every generation revealing different and new pharmaceutical properties of plants and their products. The horticulture sector of India has witnessed a great demand of exotic fruits and vegetables in the last decade. These are either imported or artificially introduced in an exotic and non-indigenous habitat. A large number of these exotic plants which are consumed as fruits and vegetables possess a variety of bioactive phytochemical compounds. These bioactive compounds impart them some really important medicinal and pharmacological properties such as anti-inflammatory, immunomodulatory, hepatoprotective, anticarcinogenic, antiulcerogenic, analgesics etc. This review article is an attempt to briefly address such exotic fruits and vegetables, the bioactive compounds associated with them and their medicinal properties useful to mankind.

KEY WORDS : Anti-inflammatory, Bioactive, Exotic, Phytochemical, Pharmacology

Author for correspondence :

Harsh Pant

Department of Botany, St. Xavier's College (Autonomous), Mumbai (M.S.) India
Email : harsh.pant@xaviers.edu.in

HOW TO CITE THIS ARTICLE : Pant, Harsh, Lobo, Vijaya, Santhosh, Anagha and Verma, Shashank (2020). Pharmacognosy and medicinal value of some exotic fruits and vegetables consumed in India. *Asian J. Hort.*, 15(2) : 39-52, DOI : 10.15740/HAS/TAJH/15.2/39-52. Copyright@2020 : Hind Agri - Horticultural Society

Plants have always been an integral part of pharmaceutical studies. Several plant based drugs and medicines are recommended for treatment of various diseases and disorders. According to an estimation by the World Health Organisation (WHO), 80 per cent of both rural and urban population across the globe makes huge health benefits from the usage of natural plant parts or plant based products (Chauhan and Singh, 2019). Natural plant products are usually reported to be safer than their synthetic counterparts. Even in the ancient times of Sushruta, plant based herbal remedies were practiced and it's the search of a better healthkind that humans over generations and through civilizations have tried to discover and use various plant products for their betterment (Ahmad and Ahamad, 2020). Plants are

excellent sources of crude drugs which are claimed to have pharmaceutical properties (Porwal *et al.*, 2020). Although the basis and roots of this field of ethnomedicine dates back to time immemorial, there is a considerable spurt in the research on herbal products and their potential applications in modern medicine (Leisegang, 2021). Not only plants famous for their medicinal properties are useful but there are several edible plant parts in our daily diet such as fruits and vegetables which carry a range of bioactive compounds that have medicinal properties.

The term exotic food products can be implied to those which are purchased or imported from other regions. The production area is usually not the same as that of the consumption region (Iyiade, 2013). In simple words, these are artificially introduced in a foreign habitat.

The last decade has witnessed a spurt in the demand of exotic food products ranging from non traditional oils and various types of gourmet cheese to a variety of fruits and vegetables (Vinayak, 2020). The market production and associated economics for the same has grown by a leap of 15-20 per cent per annum and is still growing (Rao and Mrunalini Sasanka, 2015). As compared to farming of traditional vegetables and fruits, cultivation of exotic counterparts is economically a better option from the business point of view (Rao and Mrunalini Sasanka, 2015). Most of these fruits and vegetables are especially used in the recipes of salads and continental cuisine along with other exotic products.

Some of the most commonly consumed exotic fruits in India are Pomelo (*Citrus maxima* (Burm.) Merr.), Passion fruit (*Passiflora edulis* Sims.), Fingered citron (*Citrus medica* var. *sarcodactylis* Swingle), Dragon fruit (*Hylocereus undatus* (Haw.) Britton and Rose), Wood apple (*Limonia acidissima* Groff). Among the vegetables are broccoli (*Brassica oleracea* var. *italica*), bell peppers (*Capsicum annum*), sweet basil (*Ocimum basilicum* L.), lemon grass [*Cymbopogon citratus* (DC.) Stapf], chinese cabbage [*Brassica rapa* var. *chinensis* (L.) Kitam], parsley (*Petroselinum crispum*), thyme (*Thymus vulgaris* L.), Oyster mushroom (*Pleurotus* spp.), red or purple cabbage (*Brassica oleracea* var. *Capitata* f. *rubra*) etc.

With recent developments in nutrition sciences, people across India have been switching to usage of these fruits and vegetables for medicinal purposes and health benefits. The consumption has risen in popularity as a result of the correlation between fruits and the treatment of some severe diseases (Garcia and Chane, 2017). Certain fruits like Avocado, Mangosteen and Acai are reported to have well established anti inflammatory and antioxidant properties (Joshi *et al.*, 2018).

Numerous exotic fruits are attracting a large population of India these days due to their high nutritious value and potential to treat a wide range of health issues (Madhuri, 2006). Like dragon fruit which is abundant in vitamin C, lycopene, calcium, iron, potassium and other nutrients, is associated with improvement of kidney function, lower cholesterol, regulate sugar levels and avoid colon cancer (Suryono, 2006). Pomelo peel extract significantly reduces blood glucose levels by 70.17 per cent. The extract increased HDL cholesterol by 4.43 per cent while reducing total cholesterol levels by 30.86 per cent (Ani and Ochu, 2020). As per a research

conducted by Xirui *et al.*, 2020, Cycloartane triterpenoids obtained from passion fruit could be used to treat Alzheimer's disease and Parkinson's disease.

Several exotic vegetables show the presence of bioactive compounds which have pharmacognosy potential. Alkaloids obtained from vegetables such as chinese cabbage and broccoli can impart health benefits such as chemoprotective properties (Delgado *et al.*, 2017). Extracts obtained from sweet basil are reported to contain hepatoprotective compounds, depressants of the central nervous system, immunity boosters and anticancer compounds (Ch *et al.*, 2015). According to a study done by Okan *et al.* (2020) oils obtained from seeds of Parsley have a strong antioxidant and antifungal activities. Oyster mushrooms yield a type of β -glucan called pleuran which has some antiviral properties and can also be used to treat prostate and breast cancer (Golak *et al.*, 2018). Decoction from lemon grass is reported to be antidiarrheal whereas its essential oils are effective in inhibiting the growth of *Plasmodium berghei* (Shah *et al.*, 2011). Similarly there are many other health benefits as well as pharmaceutical properties of several other exotic fruits and vegetables as well.

This review article is an attempt to briefly describe some of the most commonly sold and consumed exotic fruits and vegetables in India with respect to their short taxonomic description, bioactive compounds, pharmacognosy potential and medicinal values.

***Asparagus* spp.**

Botanical description :

Commonly referred to as sparrow grass, *Asparagus* is a perennial flowering plant which belongs to family Asparagaceae and was formerly a part of Liliaceae (Mfengwana and Mashele, 2021). The plant grows with a stout cylindrical stem possessing needle-like leaves and has bell shaped flowers (Gruben and Denton, 2004). The genus is reported to encompass around 300 species distributed primarily through Asian and European subcontinent (Joshi *et al.*, 2010).

There are several notable species under this genus such as *Asparagus officinalis* L., *Asparagus africanus* Lam., *Asparagus laricinus* Burch., *Asparagus racemosus* Willd., etc. which are reported to have some pharmaceutical properties (Mfengwana and Mashele, 2021).

Pharmacognosy and medicinal properties:

Pise *et al.* (2015) indicated that the most important

bioactive compounds reported in *Asparagus racemosus* Willd. are Shatavarins which are basically saponins with steroidal nature. They tried to assess the bioactivity of shatavarins using the lymphocytes from human blood and reported strong immunomodulatory effects which can be exploited for therapeutic purposes (Pise *et al.*, 2015). Racemosol and racemofuran extracted from roots of *Asparagus racemosus* Willd. were found to be anticarcinogenic in nature (Agarwal *et al.*, 2004). Extracts obtained from leaves and roots of *Asparagus laricinus* Burch. were shown to have anti-inflammatory effects owing to the presence of saponins (Just *et al.*, 1998). Linoleic acid is the most commonly found bioactive compound in *Asparagus officinalis* L. (Jang *et al.*, 2004). The effect of this compound present in the extracts of stems of *Asparagus* were reported to have inhibitory effects on cyclooxygenases and thus can impart anti-inflammatory properties.

The most important and commonly found bioactive compounds in the majority of the species of *Asparagus* are saponins which are indicated to be active in fighting against cancer. Saponins also have antimicrobial, anti-inflammatory and antidiarrheal properties as well (Joshi *et al.*, 2010). The Table 1. Given below summarises the various bioactive compounds and their pharmaceutical properties extracted from various parts of different species of *Asparagus*.

***Cymbopogon citratus* Staph.**

Botanical description:

Cymbopogon citratus Staph. is an aromatic grass belonging to the family poaceae. It is commonly referred to as lemon grass is a tall sedge which is perennial. The leaves are ligulate, linear and tapering towards the upper parts and is widely cultivated artificially in the Indian subcontinent (Srivastava *et al.*, 2013). The name Cymbogon is reflective of its flower spike arrangement which owes its roots to the Greek words kymbe and pogon which imply boat and beard. The plant is widely used in continental dishes for its sourness imparting flavour as well as aroma.

Pharmacognosy and medicinal properties:

Cymbopogon citratus is well documented for the aspects of pharmacognosy and is even traditionally used for its oils extracted from aerial parts which are used to treat indigestion and fever (Jeong *et al.*, 2009). *C. citratus* is ranked as the top species from the genus *Cymbopogon* for its ethnomedicinal uses more prevalently in the western Europe and parts of Eurasia.

Being an aromatic plant as well, *C. citratus* is mainly characterized for its essential oils. The most important phyto component in the essential oil obtained from lemongrass is Citral (Ming *et al.*, 1996). Citral is a racemic mixture of geranial and neral in the trans and cis isomeric forms, respectively (Sarer *et al.*, 1983). It has been reported that this component in the essential oil is really effective against amoebiasis as it inhibits the growth of *Entamoeba histolytica*. Citral, the essential oil, has also been shown to have antifungal properties and can inhibit certain human pathogenic fungi such as *Candida albicans* and *Aspergillus niger* and thereby can be used to treat fungal diseases such as candidiasis and aspergillosis (Boukhatem *et al.*, 2014). Citral has also been shown to possess some anti inflammatory properties as studied by Boukhatem *et al.*, 2014.

Extracts from stalks of *C. citratus* have been shown to cure diarrhea (Tangpu *et al.*, 2006) :

In a study on hepatocellular lesions induced by diethylnitrosamine (DEN) in rats it was found that the activity of DEN was inhibited by extracts from *C. citratus* thus citing its chemoprotective properties (Puatanachokchai *et al.*, 2002).

Extracts from the leaves of lemongrass are also helpful in a dose dependent manner to reduce the cholesterol levels (Agbafor and Akubugwo, 2007). Extracts obtained using ethanolic concentrations are also reported to have anti mutagenic properties which was able to reduce or inhibit metastasis in the lungs of a rat model system of study (Puatanachokchai, 1994).

Essential oil from lemongrass is also a sedative and capable of inducing as well as extending sleep time as

Table 1 : Summarized research on pharmacognosy potential of bioactive compounds found in various parts of different *Asparagus* species

Name of the plant	Plant part used	Bioactive phtochemical	Medicinal properties	References
<i>Asparagus racemosus</i> Willd.	Stem	Shatavarins	Immunomodulatory effects.	Pise <i>et al.</i> , 2015
<i>Asparagus racemosus</i> Willd.	Roots	Racemofuran and racemosol	Hepato protective properties	Agarwal <i>et al.</i> , 2004
<i>Asparagus laricinus</i> Burch.	Leaves and roots	Saponins	Anti-in flammatory	Just <i>et al.</i> , 1998
<i>Asparagus officinalis</i> L.	Stems	Linoleic acid	Anti-in flammatory	Jang <i>et al.</i> , 2004

reported by a study conducted on neural behaviour in mice using *Cymbopogon citratus* (Blanco *et al.*, 2007).

***Ocimum basilicum* L.**

Botanical description :

Ocimum basilicum L. is commonly referred to as sweet basil and belongs to the family Lamiaceae. It's a widely used exotic vegetable in preparation of continental dishes such as pesto sauce. Among the various other species under the genus *Ocimum*, sweet basil is one of the most widely cultivated condiments native to central and south african as well american regions (Barbalho *et al.*, 2012). In India *Ocimum sanctum* or holy basil is more common. *Ocimum basilicum* is a medicinal as well as an aromatic plant with herbaceous habitat and a height of approximately 0.9 meters. The leaves are simple and opposite with a glabrous texture and a small petiole (Jayaweera, 1981). The leaves have certain oil glands which give off volatile essential oils. Flowers are usually small, bracteate and hermaphrodite (Kirtikar and Basu, 2003).

Pharmacognosy and medicinal properties :

Sweet basil is prominently known for its essential oils which confer it both medicinal and aromatic properties. Phytocharacterization of the essential oils obtained from the leaves of sweet basil reported two major compounds namely, chavicol (approximately 68%) and linalool (approximately 26%) (Padalia and Verma, 2011). Certain other products such as tannins, saponins, cardiac glycosides and flavonoids were also reported in the extracts from *O. basilicum*.

Methanolic extracts of the essential oils from basil can inhibit certain human pathogenic bacteria such as *Vibrio cholerae*. The analgesic properties of this extract was another finding reported in Swiss Mice which was nearly the same as the potential of the medicine, aspirin

(Choudhary *et al.*, 2010). Further, this methanolic extract inhibits important proinflammatory cytokines and the associated receptors and therefore, possess anti-inflammatory properties as well (Chinnasamy *et al.*, 2006). Venâncio *et al.* (2011), suggested that the essential oil from sweet basil can potentially inhibit mediators such as prostaglandins which are associated with pain and hence, reflects certain antinociceptive effects. *Ocimum basilicum* L. is also shown to have inhibitory effects on α -amylase and α -glucosidase (El-Beshbishy and Bahashwan, 2012).

Certain other compounds isolated from *Ocimum basilicum* L. such as ursolic, 3-epi-maslinic, aliphatic, oleanolic, euscaphic and betulinic acids are beneficial to liver and are reported to be hepatoprotective in nature (Marzouk, 2009). Powders obtained from aerial parts of sweet basil were reported to show a decrease in the aspirin induced ulceration in mice and thus, is a reflection of its anti-ulcerogenic activity (Akhtar and Munir, 1989).

On the frog heart, an alcoholic extract of basil aerial parts had significant negative chronotropic and positive inotropic effects. The cardiotoxic effect is caused by a significant decrease in membrane Mg²⁺ATPase and an increase in Ca²⁺ and Na⁺/K⁺ ATPase. The aqueous extract had inotropic and chronotropic effects that were both positive. The aqueous and alcoholic extracts, respectively, developed cardiotoxic and β adrenergic symptoms (Murlidharan and Dhananjayan, 2004). Sweet basil is thus, potentially a huge pharmaceutical plant with a varied range of medicinal properties. The Table 2 given below summarizes some of these medicinal properties of various parts of *Ocimum basilicum* L.

***Petroselinum crispum*:**

Botanical description :

Petroselinum crispum (Mill.) Fuss, an Apiaceae member and known as Parsley, originated at Western

Table 2: Summarized pharmaceutical properties and bioactive compounds of *O. basilicum* L.

Type of extract and plant part used	Bioactive compounds identified	Medicinal properties	References
Methanolic extracts from leaves	Chavicol	Antimicrobial and antioxidant	Mohamad <i>et al.</i> , 2011
Ethanollic extracts from stem	Tannins	Anticarcinogenic and antiulcerogenic	Okwu and Emenike, 2006; Ruch <i>et al.</i> , 1989
Powder from aerial parts.	Saponins and Eugenol	Cardioprotective properties	Akhtar and Munir, 1989
Extracts from leaves	Ursolic acid 3-epi-maslinic acid, aliphatic acid, oleanolic acid.	Hepatoprotective properties	Marzouk, 2009
Methanolic extracts from leaves	Linalool	Antioxidant	Karimian <i>et al.</i> , 2011

Mediterranean region. *P. crispum* is an aromatic, erect annual herb with umbel inflorescence, pinnately compound leaves, bisexual flowers and bears shizocarp. Even though many cultivated varieties are reported for the plant, *P. crispum* var. neapolitanum, *P. crispum* var. crispum, *P. crispum* var. tuberosum are the three main varieties of *P. crispum* (Agyare *et al.*, 2017).

Pharmacognosy and medicinal properties:

Okan *et al.* (2020) studied the chemical composition of the essential oil obtained from parsley seeds. Essential oil was extracted from the leaves and roots as well (Bruneton, 1999). It was reported that the oil consisted of β -pinene, α -pinene, apiole, myrtenal, safrole, myristicin, 2,3,4,5-tetramethoxy-1-allylbenzene (Stankovi a *et al.*, 2005) and terpinolene (Orav *et al.*, 2003). Enhanced antioxidant and antifungal activity was shown by the oil of parsley seeds due to the presence of these compounds. Most importantly, nephrotoxic and hepatotoxic activity was reported in apiole (Okan *et al.*, 2020). Other major bio active compounds identified from *P. crispum* are the flavonoids (P apay *et al.*, 2012), which includes apigenin, luteolin, isorhamnetin, quercetin and chrysoeriol (Agyare *et al.*, 2017). Apigenin and kaempferol were also detected from the leaf extracts by Gadi *et al.* (2012). Hudson (1949) reported the presence of a sugar in the leaf, stem and seeds of *P. crispum*, known as Apiose.

Several other pharmacological properties have been known to be exhibited by *P. crispum* like antiulcer, analgesic, anticoagulant, antidiabetic and spasmolytic (Agyare *et al.*, 2017). The *P. crispum* roots serve as an excellent diuretic (Pharmacopoeia jugoslavica, 1951), for treating several illnesses such as cystitis, myalgia, functional amenorrhoea, dyspepsia, menstrual disorders (Witchl and Bisset, 1994). The seeds of *P. crispum* are employed for treating kidney stones (Agyare *et al.*, 2017) and gastritis (rehecho *et al.*, 2011). It's also used as a carminative and diuretic as well (Rehecho *et al.*, 2011). The *P. crispum* leaves are known for healing a variety of health issues like Skin diseases (Aljanaby, 2013), prostatitis, hyperuricaemia, anaemia, amenorrhoea, dysmenorrhoea, induction of abortion (Ben itez *et al.*, 2010), and fluid retention management (Savikin *et al.*, 2013).

Pleurotus spp.

Botanical description :

The Oyster mushroom belongs to the genus *Pleurotus* and comes under Basidiomycetes. They

possess shell-like cap with lateral or eccentric stipe. They are observed growing on dead organic matter as they are capable of degrading lignocellulose (Mart nez-Carrera, 1998). Some of the major economically important *Pleurotus* species that is cultivated in India includes *P. florida*, *P. pulmonarius*, *P. citrinopileatus* (Khatun *et al.*, 2015), *P. ostreatus* (17) and *P. cystidiosus* (Khan *et al.*, 2008).

Pharmacognosy and medicinal properties:

The cell wall of the mushroom consists of the polysaccharides that exhibited high medicinal values, including α -glucans and β -glucans (17). The carboxymethylation of α -(1 \rightarrow 3)-glucans from *P. citrinopileatus* results in the formation of derivatives that possess high cytotoxic activity to cervical cancer cells, whereas it caused no harm to normal cells (Wiater *et al.*, 2015). The development of neoplastic cells of Ehrlich tumor and sarcoma 180 was suppressed by the polysaccharides obtained from *P. ostreatus* (Facchini *et al.*, 2014). Antinociceptive activity was shown by the β -glucans obtained from *P. pulmonaris* (Baggio *et al.*, 2012). The proteins obtained from *Pleurotus* spp. also showed important economic properties. The apoptosis of neoplastic cells L929 and HeLa was induced by a haemolytic protein called Nebrodeolysin obtained from *P. nebrodensis* (Lv *et al.*, 2009). The protein obtained from *P. ostreatus* possessed apoptotic activity towards monocytic leukaemia THP-1 and colorectal cancer cell line SW 480 (Wu *et al.*, 2011) and those from *P. cornucopiae* exhibit antihypertensive properties (Jang *et al.*, 2011).

The recent research on economic properties of *Pleurotus* spp. reveals the presence of several other bioactive compounds. An enzyme called Laccase was isolated from *P. ostreatus* that exhibited anti-viral effect towards hepatitis-C virus (El-Fakharana *et al.*, 2010). The lectins extracted from *P. citrinopileatus* possessed antiviral and antineoplastic properties (Li *et al.*, 2008). Wang *et al.* (2013) reported that the mycelium of *P. cornucopiae* contains terpenoids that are cytotoxic to HepG2 and HeLa cancer cells. Antihypercholesterolemic activity was exhibited by the lovastatin extracted from *P. florida* (Khan *et al.*, 2011). The ergosterols obtained from *p. cystidiosus* possess antifungal properties (Menikpurage *et al.*, 2009). The high composition of anti-atherosclerotic agents like lovastatin, chrysin and ergothioneine in *P. ostreatus* makes it more significant

in treating atherosclerosis (Abidin *et al.*, 2017).

***Hylocereus undatus*:**

Botanical description :

Hylocereus undatus (Haw.) Britton and rose which originated from Central and Northern South America and commonly known by different names like Dragon fruit, Night blooming Cereus, Strawberry Pear or Pithaya, belongs to the family Cactaceae (Kumar *et al.*, 2018 and Perween *et al.*, 2018). *H. undatus* is characterized by long, green stem, long flowers and the fruits that are usually rosy-red in colour, which is covered by long and large scales. The large white creamy flowers which bloom at night adds to their ornamental value. The growers from all around the globe are attracted to this fruit crop because of the delicious pulp of the fruit, its edible black seeds and appealing fruit colour (Perween *et al.*, 2018).

Pharmacognosy and medicinal properties:

According to the studies conducted by Cheok *et al.* (2020), one of the major bioactive compounds found in Dragon fruits are the betalains. Around 85 per cent of their total phenolics are composed of betalainic compounds (Esquivel *et al.*, 2007). High antioxidant activity is observed in these fruits due to the presence of natural antioxidants like betacyanin, phenolic acid, flavonoid, ascorbic acid, as well as fibres (Kumar *et al.*, 2018; Choo and Yong, 2011; Komindr, 2004 and Wu *et al.*, 2006).

Perween *et al.* (2018) studied the role of Dragon fruit in treating several health issues. High flavonoid content in these fruits is used to treat heart related diseases. It also acts against the bleeding issues associated with vaginal discharge. Experiments by

Poolsup and Suksomboon (2017) explained the role of Dragon fruit in treating prediabetes and type 2 diabetes. By regenerating β -cells of the pancreas and lowering the resistance of fibroblast growth factor-21 (FGF-21), Dragon fruit is reported to help in treating diabetes (Ismaviani, 2014 and Song *et al.*, 2016). The insulin resistance is improved through purified peel betacyanins and white dragon fruit juice (Song *et al.*, 2015 and 2016). Other health benefits include balancing of the production of blood by enhancing the levels of erythrocyte and haemoglobin, the formation of cardiac tissues, prevention of cancer in the colon and prostate and minimizing aortic stiffness (Kumar *et al.*, 2018). These betalain rich fruits are also reported to enhance the functions of the endothelium and vascular system (Cheok *et al.*, 2020).

***Citrus medica var. sarcodactylis swingle* :**

Botanical description :

The rutaceae member *Citrus medica* L. var. *sarcodactylis* (Noot.) Swingle cultivated widely in China, Japan and Taiwan, is called by different names such as Fingered Citron, Longevity Orange and Buddha-Hand Citron (Li *et al.*, 2019 and Peng *et al.*, 2009). This small erect tree consists of ovate-lanceolate leaves, axillary spines, large flower buds, axillary flowers and holds berry with an aromatic and fragrant peel. The fruit possess finger-like sections that can be seedy or without seeds (Lim, 2012).

Pharmacognosy and medicinal properties:

The fingered citron was reported to be a rich source of flavonoids and the major flavonoids observed includes hesperidin, diosmetin-6-8-di-C-glucoside, diosmetin-6-C-glucoside, scutellarein 42-methyl ether 7-glucoside, limocitrol 3-alpha-l-arabinopyranosyl-(1->3)-galactoside.

Sr. No.	Plant part used	Medicinal properties	Bioactive compounds	References
1.	Stem and root bark	Anti-inflammatory	Xanthyletin, nordenatin, atalantoflavon	(Chan <i>et al.</i> , 2010)
2.	Stem bark	Anti-inflammatory, anticancer	Lonchocarpol	(Chan <i>et al.</i> , 2009)
3.	Fruit	Hypoglycemic activity	Essential oils (d-limonene, γ -terpenene, β -pinene, α -pinene)	(Peng <i>et al.</i> , 2009)
4.	Fruit peel	influences the activities of autonomous nervous system and emotions	Essential oils	(Sayorwan and Rumruay, 2017)
5.	Fruit peel	Enhance the respiratory rate, blood pressure and decreased drowsiness	Essential oils	(Hongratanaworakit and Buchbauer, 2007)

These compounds are shown to improve anti-aging and antioxidant activity (Luo *et al.*, 2020). Researches indicate that the citron peel is composed of limonene, and also consists of several other compounds such as steroids, p-coumaric acids, nomilin, triterpenoids (Feng and Fengchang, 2004 and Yin *et al.*, 2004) and gamma terpinene (Shiota, 1990). In Table 2, the pharmaceutical properties of bioactive compounds associated with different parts of plants are summarised (Lim, 2012).

Studies done by Jiang *et al.* (2001) indicated that the xiayou decoction (made of 15 herbal components and one among them is fingered citron) was used to treat mental health problems like anxiety and depression in the functional dyspepsia (FD) patients. The fruit is also used to treat distension and pain in the chest (Lim, 2012).

Citrus maxima :

Botanical description:

Citrus maxima (Burm.) Merr., also called as Pomelo or Shaddock, is a citrus plant that belongs to the family Rutaceae and are grown in warm climates of Southeast Asia, including India, Indonesia, Taiwan, China and the Philippines (Thielen *et al.*, 2013). *C. maxima* is a perennial tree with an average length of 5-10 m and are hermaphrodite. Pink and white fleshed fruits are observed with a size of about 30 cm width, that is yellowish green in colour and looks like pear. The petiolate leaves possess a citrus odour and the flowers have a sweet fragrance (Abirami *et al.*, 2013).

Pharmacognosy and medicinal properties:

Pomelo extract has been related to a range of health effects, including anti-toxic, heart stimulant, anti-diabetic, and also promotes hypercholesterolemia (Ani and Anigam, 2018). Some bioactive compounds, like flavonoids and saponins are present in *C. maxima* peel that decreases the chances of acquiring chronic diseases such as diabetes (Elekofehinti, 2015). In herbal medicine, *C. maxima* is being used to cure a number of health

problems like diabetes, heart diseases, etc (Ajeet and Navneet, 2017). Treatment of cough, fever, cancer and stomach conditions all involve the use of fruit (Kalidhar and Kaur, 2013).

EtOH is an alcoholic substance obtained from pericarp, mesocarp and leaves of *C. maxima*; serves as a growth inhibitor for various bacteria such as *E. coli.*, *Salmonella typhimurium* and *P. aeruginosa* (Borah *et al.*, 2012 and Das *et al.*, 2013). And EtOH isolated from leaf and bark has anti-neoplastic activity of upto 69.1 per cent and 15 per cent, respectively (Shivanand *et al.*, 2013). According to Shivanand *et al.* (2013) research, EtOH derived from stem bark functions as a hypoglycemic agent in diabetes (induced by streptozotocin).

The highest activity against *S. typhimurium* and *K. pneumoniae* is found in a MeOH extracted from pulp and leaves of *C. maxima*, So it is a quality curative agent for Typhoid and Pneumonia (Abirami *et al.*, 2013). A research done by Obah *et al.*, 2014 proves that juice extracted from *C. maxima* acts as an inhibitor against Angiotensin Converting Enzyme (ACE). DL-limonene (essential oil) obtained from *C. maxima*, prevents liver damage by blocking the formation of aflatoxin in the human body (Singh *et al.*, 2016).

Passiflora edulis:

Botanical description :

Passion fruit or *Passiflora edulis*, found in the tropics and subtropics mainly in South America, Caribbean, south Florida, South Africa and Asian countries (Xirui *et al.*, 2016). *Passiflora* genus belongs to the family Passifloraceae with approximately 500 sps. For commercial and medical purposes, *Passiflora edulis* is the most popular (Dhawan *et al.*, 2004). The plant list contains other varieties such as *P. edulis Sims*, *P. edulis f. edulis* and *P. edulis f. flavicarpa*. *P. edulis var. kerii* (Spreng.) etc. With purple fruits and black seeds, *P. edulis* is the most popular and widespread perennial climber. The peel is bright yellow, dense and hard. The

Table 4: Summarized medicinal properties and bioactive phytochemicals of different parts of Citrus maxima (Burm.) Merr.

Sr. No.	Plant part used	Medicinal properties	Bioactive compounds	References
1.	Pericarp and mesocarp	Treatment of typhoid, urinary tract infections	EtOH	(Borah <i>et al.</i> , 2012 and Das <i>et al.</i> , 2013)
2.	Leaf and stem bark	Anticancer and hypoglycemic activity	EtOH	(Shivanand <i>et al.</i> , 2013)
4.	Fruit pulp and leaves	curative agent for typhoid and pneumonia	MeOH	(Abirami <i>et al.</i> , 2013)
5.	Fruit peel	prevents liver damage	Essential oil (DL-Limonen)	(Singh <i>et al.</i> , 2016)

pulp has a pleasant aroma and a pH of 6 or lower (Narain *et al.*, 2010). Striate stem upto 16 cm long and more than 9 cm long tendrils are present at the axis. The leaves are 3 lobed at each node and borne along the stem alternately in an ascending spiral. 2.5 cm long filamentous corona, white petals and 2 glands at the petiole's apex are discerning features of the flower (Souza *et al.*, 2004).

Pharmacognosy and medicinal properties:

The majority of pharmacological studies on *P. edulis* have focused on its central nervous system (CNS) functions. *P. edulis* extracts have been shown to have possible therapeutic benefit. It is used as a tranquiliser and also very beneficial for the treatment of ADHD (attention-deficit hyperactivity disorder), anxiety, cancer, insomnia, etc. (Spencer and Seigler, 1983). Many phytochemicals such as flavonoids, alkaloids, phenols, cyanogenic compounds, terpenoids and others can be extracted from different parts of *P. edulis* (Taiwe and Kuete, 2017) *P. edulis* derivatives were shown to have hypoglycemic and antioxidant properties when used to treat streptozotocin-induced diabetes (Kandandapani *et al.*, 2015).

Enzyme gelatinase matrix metalloproteinases (MMP-2 and MMP-9) which causes metastatic tumor in humans can be inactivated by water extract of *P. edulis* (Puricelli *et al.*, 2003). 5,7-dihydroxyflavone acts as a great ligand for CNS as well as PBRs (peripheral benzodiazepine receptors) and in this way it acts as a great remedy for depression/anxiety (Medina *et al.*, 1990). *P. edulis* plant extract contains luteolin-6-C-glucoside. It also contains gamma amino butyric acid (GABA) that aids in the treatment of myocardial infarction (Ichimura *et al.*, 2006). Pe-AFP-1 (peptide) is isolated from the brown seed for *P. edulis* and acts as a potential compound for the treatment of Peritonitis, Endopathalmitis and Chronic Pulmonary Infection. because it inhibits the growth of *Trichoderma*

harzianum, *Fusarium oxysporum* and *Aspergillus fumigatus*, respectively (Pelegri *et al.*, 2006).

Limonia acidissima Groff :

Botanical description:

Limonia acidissima Groff is a tropical fruit that grows in Southern Asian countries like Sri Lanka, Bangladesh, India and it belongs to the family Rutaceae. For maximum fruit and inflorescence development, it prefers a semi-arid or dry environment. The plant's sustainable age is estimated to be between 12-70 years (Sharma *et al.*, 2014). Commonly called as a wood apple. If we're talking about India, this species can be found in Maharashtra, Chhattisgarh, Uttar Pradesh, Madhya Pradesh and the western portion of Himalyan Range (Kumar, 2017). It's a sluggish tree with some upward-growing branches that curve laterally and are partitioned into narrow branchlets that droop at the tops, it shed seasonally. The fruit's surface layer is extremely tough and brownish, while the flesh is bitter and has seeds trapped inside it. leaves are lumpy, alternative, greenish, and alternate. Flowers are tiny, abundant, reddish or green and are loosely trapped in panicles at the marginal ends of branches. The flesh is thick red, smelly, resinous, astringent, sour and sweet and contains white seeds (Vijayvargia and Vijayvergia, 2014).

Pharmacognosy and medicinal properties:

Flavonoids, saponins and tannins are found in *L. acidissima*. Few coumarins and tyramine products have also been reported in its fruit (Ilango and Chitra, 2009). Several organic chemicals present in this fruit, such as carotenoids, flavonoids, tyramines which are helpful in reducing the risk of many lethal disorders like cancer, Hypertension, etc (Abdollahi *et al.*, 2004). Coumarins have anticoagulant, COX-inhibitory and vasodilator properties. Dihydromyrcenol, a recent coumarin, is obtained from a methanol extract of *Limonia acidissima*'s root-bark (Ghosh *et al.*, 1982). Two

Table 5: Summarized pharmaceutical properties and bioactive phytochemicals of *Possiflora edulis*.

Sr. No.	Plant part used	Medicinal properties	Bioactive compounds	References
1.	Fruit (water extract)	Anti-depressant	Flavonoid (5,7dihydroxyflavone)	(Medina <i>et al.</i> , 1990)
2.	leaf	aids in the treatment of myocardial infarction	GABA (Gamma Amino Butyric Acid)	(Ichimura <i>et al.</i> , 2006)
3.	Seed	for the treatment of peritonitis, endopathalmitis	Peptide (Pe-AFP-1)	(Pelegri <i>et al.</i> , 2006).

limonoids, obacunone and acidissima were extracted from the stem bark and root bark of *Limonia acidissima* which aid in the treatment of cancers of colon, mouth, breast and lungs (John *et al.*, 2004).

Tyramine is an amino acid that aids in blood pressure regulation and recently two new tyramine derivatives, acidissiminol and acidissiminin epoxidized were isolated from the fruit of Wood Apple (Gosh *et al.*, 2004). leaf juice extract with honey or milk act as a potential remedy for intestinal problems Enterobiasis, Ascariasis, etc. The fruit of the *Limonia acidissima* has antineoplastic activity (Mishra *et al.*, 2009).

Conclusion:

Exotic fruits and vegetables have shown a tremendous and sudden increase in their appearance in the horticulture sector. These products have a much greater potential associated with pharmacognosy aspects than merely being high priced condiments. Vegetables like *Cymbopogon citratus* Staph., *Ocimum basilicum* L. are highly investigated medicinal and aromatic plants which have been known to the humankind as ethnomedicinal plants. With recent development in pharmacognosy, these plants have intrigued researchers for their essential oils which provide a range of medicinal properties such as anti-inflammatory, anticarcinogenic, sedative, analgesic etc. With a growing demand for mushrooms in the food sector, genera such as *Pleurotus*, *Agaricus* provide a sound basis for their medicinal aspects besides being a delicacy. Other fruits such as *Passiflora edulis* Sims, *Citrus maxima* (Burm) Merr., *Hylocereus undatus* (Haw.) Britton and Rose etc. are not just medically sound with potent antioxidant properties but also provide health benefits such as immunity which is a key factor to avoid various diseases. Thus, these exotic foods can be a promising asset to the field of health sciences in developing preventive medicines for various diseases. In depth investigation of these plants for their toxicology and biological activities with bioactives isolation and characterisation would bring some new insights. Also the metabolism of these bioactive compounds in target organisms needs to be studied as well. These exotic fruits and vegetables provide the local growers an access to commercial markets, as the customers are attracted by their nutraceutical importance and exotic properties, thereby increasing the revenue of the agricultural sector. With a great future prospective, these exotic food products show case a potent

pharmacognital value which need to be further investigated and valued in the Indian horticulture and study of medicinal properties of plants.

REFERENCES

- Abdollahi, M., Ranjbar, A., Shadnia, S., Nikfar, S. and Rezaiee, A. (2004).** Pesticides and oxidative stress: A Review. *Med. Science Monit.*, **10** : 141-147.
- Abidin, M.H.Z., Abdullah, N. and Abidin, N. Z. (2017).** Therapeutic properties of *Pleurotus* species (*Oyster mushrooms*) for atherosclerosis: A review. *Internat. J. Food Propert.*, **20** (6) : 1251-1261.
- Abirami, A., Nagarani, G. and Siddhuraju, P. (2013).** Antibacterial activity of crude extract of *Citrushystrix* and *Citrus maxima*. *Int. J. Pharma.Sci. Res.*, **4** (1) : 296-300.
- Agbafor, K.N. and Akubugwo, E.I. (2007).** Hypocholesterolaemic effect of ethanolic extract of fresh leaves of *Cymbopogon citratus* (lemon grass) *African J. Biotechnol.*, **6** : 596-598.
- Agrawal, A., Sharma, M., Rai, S.K., Singh, B., Tiwari, M. and Chandra, R. (2008).** The effect of the aqueous extract of the roots of *Asparagus racemosus* on hepatocarcinogenesis initiated by diethylnitrosamine. *Phytotherapy Research.*, **22** (22) : 1175-1182
- Agyare, C., Appiah, T., Boakye, Y.D. and Apenteng, J.A. (2017).** *Petroselinum crispum*: a review. *Medicinal Spices and Vegetables from Africa*, Academic Press, 527-547pp.
- Ahmad, J. and Ahamad, J. (2020).** Drug discovery from plant sources: Scope, approach and challenges. *Bioactive Phytochemicals: Drug discovery to product development*, 1-13. doi: 10.2174/9789811464485120010004
- Akhtar, M.S. and Munir, M. (1989).** Evaluation of the gastric antiulcerogenic effects of *Solanumnigrum*, *Brassica oleracea* and *Ocimumbasilicum* in rats. *J. Ethnopharmacology*, **27**(1-2): 163-76.
- Ali, A.H. and Kitabul, Mukhtar (2007).** *Fit tib* (Urdu Translation). Vol II. New Delhi: CCRUM, 75-76 pp.
- Aljanaby, A.A.J.J. (2013).** Antibacterial activity of an aqueous extract of *Petroselinum crispum* leaves against pathogenic bacteria isolated from patients with burns infections in Al-najaf Governorate, Iraq. *Res. Chem. Intermed.*, **39** (8) : 3709-3714.
- Ani, P. N. and Aginam, P. C. (2018).** Effect of *Citrus maxima* juice on fasting blood glucose, lipid profile, liver enzyme and body weight. *Nutr. Food Sci.*, **48** : 755-763.
- Ani, P. and Ochu, K. (2020).** Anti-diabetic, anti-hyperlipidemic and hepatoprotective potential of shaddock (*Citrus maxima*) peel extract. *Acta Sci. Pol. Technol. Aliment.*, **19** (3) : 271-278.

- Baggio, C.H., Freitas, C.S., Marcon, R., Werner, M.F.P., Rae, G.A., Smiderle F.R., Sasaki, G. L., Iacomini, M., Marques, M.C.A. and Santos, A.R.S. (2012).** Antinociception of β -D-glucan from *Pleurotus pulmonarius* is possibly related to protein kinase C inhibition. *Int. J. Biol. Macromol.*, **50** : 872-877.
- Bandaranayake, W.M. (2006).** Quality control, screening, toxicity and regulation of herbal drugs, In: *Modern phytomedicine. Turning Medicinal Plants into Drugs* eds Ahmad I., Aqil F., Owais M. (Weinheim:Wiley-VCH GmbH and Co. KGaA;) 25–57 10.1002/9783527609987.ch2.
- Barbalho, S., Machado, F., Rodrigues, J., Silva, T. and Goulart, R. (2012).** Sweet basil (*Ocimum basilicum*): much more than a condiment. *Tang. Humanitas Medicine*, **2**(1) : 3.1-3.5. doi: 10.5667/tang.2011.0023.
- Baroh, M., Ahmed, S. and Das, S. (2012).** A comparative study of the antibacterial activity of the ethanolic extracts of *Vitexnegunda* L., *Fragaria vesca* L., *Terminalia arjuna* and *Citrus maxima*. *Asi. J. Pharma. Biol. Res.*, **2**(3): 183-187.
- Benítez, G., González-Tejero, M.R. and Molero-Mesa, J. (2010).** Pharmaceutical ethnobotany in the western part of *Granada province* (southern Spain): ethnopharmacological synthesis. *J. Ethnopharmacol.*, **129** (1) : 87–105.
- Blanco, M.M., Costa, C.A., Freire, A.O., Santos, J.G and Costa, I.M. (2007).** Neurobehavioral effect of essential oil of *Cymbopogon citratus* in mice. *Phytomedicine*, **16** : 265–270.
- Bruneton, J. (1999).** Pharmacognosy, phytochemistry medicinal plants, 2nd Ed., Intercept Ltd, London, pp. 519–520.
- Chandrasekhara Rao, C.C. and Mrunalini, Sasanka V. (2015).** Exotic veggies: A practical utility of innovation lured by the easy returns. *Internat. J. Appl. Res.*, **1**(12): 1038-1041.
- Chan, Y.Y., Li, C.H., Shen, Y.C. and Wu, T.S. (2010).** Antiinflammatory principles from the stem and root barks of *Citrus medica*. *Chem Pharm Bull.* (Tokyo) **58** (1) : 61–65.
- Chan, Y.Y., Wu, T.S. and Kuo, Y.H. (2009).** Chemical constituents and cytotoxicity from the stem bark of *Citrus medica*. *Heterocycles*, **78** (5) : 1309–1316.
- Cheok, A., George, T. W., Rodriguez-Mateos, A. and Caton, P. W. (2020).** The effects of betalain-rich cacti (dragon fruit and cactus pear) on endothelial and vascular function: a systematic review of animal and human studies. *Food & Function*, **11**(8): 6807–6817.
- Chinnasamy, S., Balakrishnan, G., Kontham, S.V., Baddireddi, S.L. and Balakrishnan, A. (2007).** Potential anti-inflammatory properties of crude alcoholic extract of *Ocimum basilicum* L. in human peripheral blood mononuclear cells. *J. Health Science*, **53** (4) : 500-505.
- Ch, M., Naz, S., Sharif, A., Akram, M. and Saeed, M. (2015).** Biological and pharmacological properties of the sweet basil (*Ocimum basilicum*). *British J. Pharmaceutical Research*, **7**(5): 330-339. doi: 10.9734/bjpr/2015/16505.
- Choo, W. S. and Yong, W. K. (2011).** Antioxidant properties of two species of *Hylocereus* fruits. *Advances in Applied Science Research*, **2** (3) : 418-425.
- Choudhury, G.B., Prabhat, K.J., Nayak, B.S., Panda, S.K. and Tripathy, S.K. (2010).** Phytochemical investigation and evaluation of analgesic activity of leafy extracts of various *Ocimum (Tulsi)* species. *The Indian Pharmacist*, **8** (12): 67-70.
- Das, S., Baroh, M. and Ahmed, S. (2013).** Antibacterial activity of the ethanolic extract of leaves of *citrus maxima* (Burm.) Merr. On *Escherichiacoli* and *Pseudomonas aeruginosa*. *Asi. J. Pharma. Clin. Res.*, **6** (4) : 136-139.
- De, Blasi V., Debrot, S., Menoud, P.A., Gendre, L. and Schowing, J.J.(1990).** Amoebicidal effect of essential oils *in vitro* *Toxicol. Clin. Exp.*, **10** (6) : 361-373.
- Delgado, Martins A, Parisi, S, Daniel, M. and Vaz, Almeida (2017).** *Greens and other vegetable foods chemistry of the mediterranean diet*. Springer Int Publishing, pp. 59-137.
- Dhawan, K., Dhawan, S. and Sharma, A. (2004).** Passiflora: a review update. *J.Ethnopharmacol.*, **94** : 1–23. doi: 10.1016/j.jep.2004.02.023.
- El-Beshbishy, H.A. and Bahashwan, S.A. (2012).** Hypoglycemic effect of basil (*Ocimum basilicum*) aqueous extract is mediated through inhibition of $\{\alpha\}$ -glucosidase and $\{\alpha\}$ -amylase activities: An *in vitro* study. *Toxicol. Ind. Health*, **28** : 42-50.
- Elekofehinti, O.O. (2015).** Saponins: Anti-diabetic principles from medicinal plants – A review. *Pathophysiol.*, **22** : 95–103.
- El-Fakharany, E.M., Haroun, B.M., Ng, T.B. and Redwan E.R., (2010).** *Oyster mushroom* laccase inhibits hepatitis C virus entry into peripheral blood cells and hepatoma cells. *Protein Pept. Lett.*, **17** : 1031-1039.
- Esquivel, P., Stintzing, F. C. and Carle, R. (2007).** Phenolic compound profiles and their corresponding antioxidant capacity of purple pitaya (*Hylocereus* sp.) genotypes. *Zeitschrift für Naturforschung C*, **62** (9-10) : 636-644.
- Facchini, J.M., Alves, E.P., Aguilera, C., Gern, R.M.M., Silveira, M.L.L., Wisbeck, E. and Furlan, S.A. (2014).** Antitumor activity of *Pleurostostreatus* polysaccharide fractions on *Ehrlich tumor* and *Sarcoma 180*. *Int. J. Biol. Macromol.*, **68** : 72-77.
- Feng, Y. and Fengchang, L. (2004).** Studies on the constituents of *Citrus medica* L. var. *Sarcodactylis*. *Zhongguoyaoxuezhazhi (Zhongguoyaoxuehui: 1989)*, **39** (1) : 20-21.
- Gadi, D., Bnouham, M., Aziz, M., Ziyat, A., Legssyer, A., Bruel,**

- A., Berrabah, M., Legrand, C., Fauvel Lafeve, F. and Mekhfi, H., (2012).** Flavonoids purified from parsley inhibit human blood platelet aggregation and adhesion to collagen under flow. *J. Complement. Integr. Med.*, **9** : 19.
- Golak-Siwulska, I., Kaluzewicz, A., Spizewski, T., Siwulski, M., and Sobieralski, K. (2018).** Bioactive compounds and medicinal properties of *Oyster mushrooms (Pleurotus sp.)*. *Folia Horticulturae*, **30** (2) : 191-201. doi: 10.2478/fhort-2018-0012.
- Gosh, P., Sil, P. and Das, S. (2004).** Tyramine derivatives from the fruit of *Limonia acidissima*. *J. Natural Products*, **54** (5): DOI: 10.1021/np50077a24.
- Gracia, R. and Chanes, J. (2017).** Exotic fruit juices. *Innovation Tech. in Beverage Processing*, **5** (10) : 1102.
- Grubben, G.J.H. and Denton, O.A. (2004).** *Plant resources of tropical Africa*, **2** : Vegetables. PROTA Foundation, Wageningen; Backhuys, Leiden; CTA, Wageningen.
- He, X., Luan, F., Yang, Y., Wang, Z., Zhao, Z., Fang, J., Wang, M., Zuo, M. and Li, Y. (2020).** Passifloraedulis: An insight into current researches on phytochemistry and pharmacology. *Front. Pharmacol.*, doi: 10.3389/fphar.2020.00617.
- Hildah, Mfengwana, P. and Sitheni Mashele, S. (2021).** Medicinal properties of selected *Asparagus* species: A Review. *Matrix Sci. Pharma.*, **4** : 18-21.
- Hongratanaworakit, T. and Buchbauer, G. (2007).** Autonomic and emotional responses after transdermal absorption of sweet orange oil in humans: placebo controlled trial. *Internat. J. Essential Oil Therapeutics*, **1** : 29-34.
- https://www.indiaperspectives.gov.in/en_US/indias-exotic-food-basket. 27 February, 2021.
- Hudson, C.S. (1949).** Apiose and the glycosides of the parsley plant. *Adv. Carbohydr. Chem.*, **4** : 57-74.
- Ichimura, T., Yamanaka, A., Ichiba, T., Toyokawa, T., Kamada, Y., Tamamura, T. and Maruyama, S. (2006).** Antihypertensive effect of an extract of *Passifloraedulis* rind in spontaneously hypertensive rats. *Biosci. Biotechnol. Biochem.*, **70** (3): 718-721.
- Ismaviani, N.D. (2014).** Effect of red dragon (*Hylocereus polyrhizus*) fruit pulp juice on blood glucose and regeneration of beta-pancreatic cells in alloxan-induced diabetic rats [abstract of BSc thesis]. Faculty of Pharmacy. Widya Mandala Catholic University Surabaya.
- Iyiade, A.F. (2013).** Comparative economic analysis of indigenous and exotic vegetables in Ibadan metropolis, *Oyo State, Nigeria. Pacific J. Sci. Technol.*, **14** : 246-250.
- Jang, D.S., Cuendet, M., Fong, H.H.S., Pezzuto, J.M. and Kinghorn, A.D. (2004).** Constituents of *Asparagus officinalis* evaluated for inhibitory activity against cyclooxygenase-2. *J. Agric. & Food Chem.*, **52** (8) : 2218-2222.
- Jang, J.H., Jeong, S.C., Kim, J.H., Lee, Y.H., Ju, Y. C. and Lee, J.S. (2011).** Characterization of a new antihypertensive angiotensin I-converting enzyme inhibitory peptide from *Pleurotus cornucopiae*. *Food Chem.*, **127** : 412-418.
- Jayaweera, D.M.A. (1981).** Medicinal plants, (Indigenous and Exotic) used in ceylon. Part III. Colombo: The National Science Foundation of Sri Lanka pp.101-3.
- Jeong, M.R., Park, P.B., Kim, D.H., Jang, Y.S., Jeong, H.S. and Choi, S.H. (2009).** Essential oil prepared from *Cymbopogon citrates* exerted an antimicrobial activity against plant pathogenic and medical micro-organisms. *Mycobiology*, **37** : 48-52.
- Jiang, B., Lin, J. and Zhang, Y. (2001).** Clinical observation on Xiaoyu decoction plus psychotherapy in treating functional dyspepsia. *Chin. J. Integr. Med.*, **7** (1) : 19-21.
- Joshi, G., Rawat, M., Bisht, V., Negi, J. and Singh, P. (2010).** Chemical constituents of *Asparagus*. *Pharmacognosy Reviews*, **4** (8) : 215. doi: 10.4103/0973-7847.70921.
- Joshi, S., Jadhav, V. and Kadam, V. (2018).** Exotic fruits and vegetable food as nutritional supplement for diabetics, obesity and metabolic diseases. *Internat. J. Curr. Pharmaceut. Res.*, **10** (2) : 51. doi: 10.22159/ijcpr.2018v10i2.25843.
- Just, M.J., Recio, M.C., Giner, R.M., Cullar, M.J., Manez, S. and Bilia, A.R. (1998).** Antiinflammatory activity of unusual *Lupanesaponins* from *Bupleurum fruticosum*. *Planta Medica.*, **64** : 404-407.
- Kandandapani, S., Balaraman, A.K. and Ahamed, H.N. (2015).** Extracts of passion fruit peel and seed of *Passifloraedulis* (Passifloraceae) attenuate oxidative stress in diabetic rats. *Chin. J. Nat. Med.*, **13** (9) : 680-686.
- Karimian, P., Kavooosi, G. and Saharkhiz, M.J. (2011).** Antioxidant, nitric oxide scavenging and malondialdehyde scavenging activities of essential oils from different chemotypes of *Zataria multiflora*. *Nat. Prod. Res.*, **26**(22) : 2144-2147. doi: 10.1080/14786419.2011.631136.
- Khan, M. A., Amin, S. R., Uddin, M. N., Tania, M. and Alam, N. (2008).** Comparative study of the nutritional composition of oyster mushrooms cultivated in Bangladesh. *Bangladesh J. Mushroom*, **2** (1) : 9-14.
- Khan, M.A., Rahman, M.M., Tania, M., Uddin, M.N. and Ahmed, S. (2011).** *Pleurotussajor-caju* and *Pleurotus florida* mushrooms improve some extent of the antioxidant systems in the liver of hypercholesterolemic rats. *Open Nutraceuticals J.*, **4** : 20-24.
- Khatun, S., Islam, A., Cakilcioglu, U., Guler, P. and Chatterjee, N.C. (2015).** Nutritional qualities and antioxidant activity of

- three edible oyster mushrooms (*Pleurotus* spp.). *NJAS-Wageningen J. Life Sci.*, **72** : 1-5.
- Kirtikar, K.R. and Basu, B.D. (2003).** *Indian medicinal plants with illustrations*. 2nd Ed. VIII. Uttaranchal: Oriental Enterprises, 2701-2705 pp.
- Kirtikar, R.R. and Basu, B.D. (2008).** *Indian medicinal plants*, 1. International Book Distributors, 495-496pp.
- Komindr, S. (2004).** Phytate and fibre content in Thai fruits commonly consumed by diabetic patients. *J. Med. Assoc. Thai.*, **87** (12) : 1444-1446.
- Kumar, A. and Deen, B. (2017).** Studies on preparation and storage of jelly from wood apple (*Limoniaacidissima*) fruits. *J. Pharmacognosy & Phytochemistry*, **6** (6) : 224-229.
- Kumar, S.B., Issac, R. and Prabha, M. L. (2018).** Functional and health-promoting bioactivities of dragon fruit. *Drug Invention Today*, **10** (3) : 3307-3310.
- Leisegang, K. (2021).** Herbal pharmacognosy: An introduction. *Herbal Medicine In Andrology*, 17-26. doi: 10.1016/b978-0-12-815565-3.00003-5.
- Li, Y.R., Liu, Q.H., Wang, H.X. and Ng, T.B. (2008).** A novel lectin with potent antitumor, mitogenic and HIV1 reverse transcriptase inhibitor activities from the edible mushroom *Pleurotuscitrinopileatus*. *Biochim.Biophys.Acta Gen. Sub.*, **1780** : 51-57.
- Li, Z.H., Cai, M., Yang, K. and Sun, P.L. (2019).** Kinetic study of d-limonene release from finger citron essential oil loaded nanoemulsions during simulated digestion *in vitro*. *J. Functional Foods*, **58** : 67-73.
- Lim, T. K. (2012).** *Citrus medica* var. *sarcodactylis*. In : *Edible medicinal and non-medicinal plants*, Springer, Dordrecht, pp. 690 - 694.
- Llango, K. and Chitra, V. (2010).** Wound healing and antioxidant activities of the fruit pulp of *Limoniaacidissima* Linn. (Rutaceae) in Rats. *Trop. J. Pharm. Res.*, **37**: 120-125.
- Luo, X., Wang, J., Chen, H., Zhou, A., Song, M., Zhong, Q. and Cao, Y. (2020).** Identification of flavonoids from finger citron and evaluation on their antioxidative and antiaging activities. *Frontiers in Nutrition*, **7**: 584900. PMID 33195374 DOI: 10.3389/fnut.2020.584900.
- Lv, H., Kong, Y., Yao, Q., Zhang, B., Leng, F.W., Bian, H.J., Balzarini, J., Damme, E.V. and Bao, J. K. (2009).** Nebrodeolysin, a novel hemolytic protein from mushroom *Pleurotus nebrodensis* with apoptosis-inducing and anti-HIV-1 effects. *Phytomed.*, **16** : 198-205.
- MacLeod, J., Moeller, P. and Bandara, R. (2004).** Acidissimin, a new limonoid from *Limoniaacidissima*. *J. Nat. Prod.*, **52** (4): DOI: 10.1021/np50064a040.
- Madhuri, S. (2017).** Nutritive and medicinal value of dragon fruit, *Asian J. Hort.*, **12** : 267-271.
- Martínez-Carrera, D. (1998).** Cultivation of oyster mushrooms. *USDA database*, 242-245pp.
- Marzouk, A.M. (2009).** *Hepatoprotective triterpenes* from hairy root cultures of *Ocimum basilicum* L. *Z Naturforsch C.*, **64** : 201-209.
- Medina, J.H., Paladini, A.C., Wolfman, C., de Stein, M.L., Calvo, D., Diaz, L.E. and Peña, C. (1990).** Chrysin (5,7-di-OH-flavone), a naturally-occurring ligand for benzodiazepine receptors, with anticonvulsant properties. *Biochem.Pharmacol.*, **40** (10) : 2227–2231.
- Menikpurage, I.P., Abeyunga, D.T.U., Jacobsen, N.E. and Wijesundara, R.L.C. (2009).** An oxidize ergosterol from *Pleurotus cystidiosus* active against anthracnose causing *Colletotrichum gloeosporioides*. *Mycopathologia*, **167** : 155-162.
- Ming, L., Figueiredo, R., Machado, S. and Andrade, R. (1996).** In: *Proceedings of the International Symposium on Medicinal and Aromatic Plants*. Mexico: Acta Horticulturae Leiden; 1996. Yield of essential oil of and citral content in different parts of lemongrass leaves (*Cymbopogon citratus* (DC.) Stapf.) *Poaceae*; pp. 555–559.
- Mishra, A., Arora, S., Gupta, R., Manvi-Punia, R.K. and Sharma, A.K. (2009).** Effect of *Feroniaelephantum* (Correa) fruit pulp extract on indomethacin-induced gastric ulcer in albino rats. *Tropical J. Pharmaceutical Research*, **8** : 509–514.
- Mohamad, R.H., El-Bastawesy, A.M., Abdel-Monem, M.G., Noor, A.M., Al-Mehdar, H.A., Sharawy, S.M. and El-Merzabani, M.M. (2011).** Antioxidant and anticarcinogenic effects of methanolic extract and volatile oil of fennel seeds (*Foeniculum vulgare*). *J. Med. Food*, **14** : 986-1001.
- Mohamed, Nadjib, Boukhatem, Mohamed, Amine, Ferhat, Abdelkrim, Kameli, Fairouz, Saidi and Hadjer, Tchoketch Kebir (2014).** Lemon grass (*Cymbopogon citratus*) essential oil as a potent anti-inflammatory and antifungal drugs, *Libyan J. Medicine*, **9** : 1, DOI: 10.3402/ljm.v9.25431.
- Morton, J.F. (1987).** Mexican lime. In: *Fruits of warm climates*, 1sted; Creative Resource System: Winterville, 1987, NC, USA, 168-172.
- Muralidharan, A. and Dhananjayan, R. (2004).** Cardiac stimulant activity of *Ocimum basilicum* Linn extracts. *Indian J. Pharmacol.*, **36** : 163-166.
- Narain, N., Nigam, N. and de, Sousa Galvão, M. (2010).** Passion fruit, In : *Handbook of fruit and vegetable flavours*, Wiley Online Library. Chapter 20, 345–389. doi: 10.1002/9780470622834.ch20.
- Oboh, G., Fatai, O. Bello and Ayokunle, O. (2014).** Ademosun,

Hypocholesterolemic properties of grapefruit (*Citrus paradisi*) and Shaddock (*Citrus maxima*) juices and inhibition of angiotensin-1-converting enzyme activity. *J. Food & Drug Analysis*, **22** : 477-484.

Okan, O., Kilic, A., Onaran, A., Oz, M. and Denyz, Y. (2020). Endüstriyel ölçekte üretilen Nar (*Punica granatum* L.) ve Maydanoz (*Petroselinum crispum*) to humuya dönüştürülmesinin kimyasal bileşimi, antioksidan ve antifungal özelliklerinin belirlenmesi. *Artvin Çoruh Üniversitesi Orman Fakültesi Dergisi*. doi: 10.17474/artvinofd.683260.

Okan, O. T., Pekozlu, A. K., Onaran, A., Mehmet, O. Z. and Deniz, Y. (2020). Determination of chemical composition, antioxidant and antifungal properties of pomegranate (*Punica granatum* L.) and parsley (*Petroselinum crispum*) seed oil produced in industrial scale. *Artvin Çoruh Üniversitesi Orman Fakültesi Dergisi*, **21**(2) : 1-11.

Okwu, D.E. and Emenike, I.N. (2006). Evaluation of the phytonutrients and vitamin contents of citrus fruits. *Int. J. Mol. Med. Adv. Sci.*, **2** : 1-6.

Orav, A., Kailas, T. and Jegorova, A. (2003). Composition of the essential oil of dill, celery and parsley from Estonia. In: *Proceedings-estonian Acad. Sci. Chem.*, **52** (4) : 147-154.

Padalia, R.C. and Verma, R.S. (2011). Comparative volatile oil composition of four *Ocimum* species from northern India. *Nat. Prod. Res.*, **25** : 569-575.

Pápay, Z.E., Kósa, A., Boldizsár, I., Ruskai, A., Balogh, E. and Klebóvich, I. (2012). Pharmaceutical and formulation aspects of *P. crispum* extract. *Acta Pharm. Hung.*, **82** (1) : 3-14.

Pelegrini, P.B., Noronha, E.F., Muniz, M.A.R., Vasconcelos, I.M., Chiarello, M.D., Oliveira, J.T.A. and Franco, O.L. (2006). An antifungal peptide from passion fruit (*Passiflora edulis*) seeds with similarities to 2S albumin proteins. *Biochim. Biophys. Acta*, **1764** (6) : 1141-1146.

Peng, C. H., Ker, Y. B., Weng, C. F., Peng, C. C., Huang, C. N., Lin, L. Y. and Peng, R. Y. (2009). Insulin secretagogue bioactivity of finger citron fruit [*Citrus medica* (L.) var. *Sarcodactylis* Hort, Rutaceae]. *J. Agric. & Food Chemistry*, **57** (19) : 8812-8819.

Perween, T., Mandal, K. K. and Hasan, M. A. (2018). Dragon fruit: An exotic super future fruit of India. *J. Pharmacognosy & Phytochemistry*, **7**(2) : 1022-1026.

Pharmacopoeia Jugoslavica, I.I. (1951). Farmakopeja FNRJ, Pharmacopoeia jugoslavica, editio secunda, Medicinskaknjiga, Beograd.

Pise, M.V., Rudra, J.A. and Upadhyay, A. (2015). Immunomodulatory potential of shatavarins produced from *Asparagus racemosus* tissue cultures. *J. Nat. Sci. Biol. Med.*, **6** : 415-420.

Poolsup, N., Suksomboon, N. and Paw, N. J. (2017). Effect of dragon fruit on glycemic control in prediabetes and type 2 diabetes: A systematic review and meta-analysis. *Plos. One*, **12** (9) : e0184577.

Porwal, O., Singh, S.K., Patel, D.K., Gupta S, Tripathi, R. and Katekhaye, S. (2020). Cultivation, Collection and Processing of Medicinal Plants. *Bioactive Phytochemicals: Drug Discovery To Product Development*, 14-30. doi: 10.2174/9789811464485120010004.

Puatanachokchai, R. (1994). Antimutagenicity, cytotoxicity and antitumor activity from lemon grass (*Cymbopogon citratus*, Stapf) extract, Master's thesis, Faculty of Medicine. Thailand: Chiang Mai University; 1994.

Puricelli, L., Dell'Aica, I., Sartor, L., Garbisa, S., and Caniato, R. (2003). Preliminary evaluation of inhibition of matrix-metalloprotease MMP-2 and MMP-9 by *Passiflora edulis* and *P. foetida* aqueous extracts. *Fitoterapia*, **74** : 302-304. doi: 10.1016/S0367-326X(03)00023-6

Rehecho, S., Uriate-Pueyo, I., Calvo, J. and Calvo, M.I. (2011). Ethnopharmacological survey of medicinal plants in Nor-Yauyos, a part of the Landscape Reserve Nor-Yauyos-Cochas. *Peru. J. Ethnopharmacol.*, **133** (1) : 75-85.

Ruch, R.J., Cheng, S.J. and Klaunig, J.E. (1989). Prevention of cytotoxicity and inhibition of intercellular communication by antioxidant catechins isolated from Chinese green tea. *Carcinogenesis*, **10** : 1003-1008.

Sarer, E., Scheffer, J.J. and Baerheim, S.A. (1983). Composition of the essential oil of *Cymbopogon citratus* (DC.) Stapf cultivated in Turkey. *Scientia Pharmaceutica*, **51** : 58-63.

Savikin, K., Zdunic, G., Menkovic, N., Zivkovic, J., Cujic, N., Terescenko, M. and Bigovic, D. (2013). Ethnobotanical study on traditional use of medicinal plants in South-Western Serbia, Zlatibor district. *J. Ethnopharmacol.*, **146** (3) : 803-810.

Sayorwan, W. and Rumruay, V. (2017). Chemical compositions of fingered citron peel [*Citrus medica* (L.) var. *Sarcodactylis*] and its effect on the autonomic nervous system. *J. Health Research*, **31** (4) : 307-313.

Sharma, H. P., Patel, H., Sharma, S. and Vaishali (2014). Study of physico-chemical changes during wood apple, *Feronialimonia* maturation. *J. Food Res. & Technol.*, **2** (4) : 148-152.

Shiota, H. (1990). Volatile components in the peel oil from fingered citron [*Citrus medica* (L.) var. *sarcodactylis* Swingle]. *Flavour & Fragrance J.*, **5** (1) : 33-37.

Shivananda, A., Muralidhara, R.D. and Jayaveera, K.N. (2013). Analgesic and anti-inflammatory activities of *Citrus maxima* (*J. Burm*) Merr. in animal models. *Res. J. Pharma, Biol. Chem.*

Sci., 4 (2): 1800.

Singh, A., Pathak, V.M. and Navneet (2016). Screening of Antimicrobial potential of *Barleriaprionitis* Linn aerial parts against common respiratory tract pathogens. *Int. J. Curr. Microbio. Appl. Sci.*, 5 (7) : 542-549.

Singh, A. and Navneet (2017). *Citrus maxima* (Burm.) Merr. A traditional medicine: Its antimicrobial potential and pharmacological update for commercial exploitation in herbal drugs – A Review, *Internat. J. Chem. Tech. Res.*, 10 (5):642-651.

Song, H., Chu, Q., Xu, D., Xu, Y. and Zheng, X. (2016). Purified betacyanins from *Hylocereusundatus* peel ameliorate obesity and insulin resistance in high-fat-diet-fed mice. *J. Agric. & Food Chemistry*, 64 (1) : 236-244.

Song, H., Zheng, Z., Wu, J., Lai, J., Chu, Q. and Zheng, X. (2016). White pitaya (*Hylocereusundatus*) juice attenuates insulin resistance and hepatic steatosis in diet-induced obese mice. *PLoS One*, 11(2) : e0149670.

Souza, M.M., Pereira, T.N.S., Viana, A.P., Pereira, M.G. do, Amaral Júnior, A.T. and Madureira, H.C. (2004). Flower receptivity and fruit characteristics associated to time of pollination in the yellow passion fruit *Passifloraedulis* Sims f. *flavicarpa* Degener (Passifloraceae). *Sci. Hortic.*, 101 (4) : 373–385.

Spencer, K.C. and Seigler, D.S. (1983). Cyanogenesis of *Passifloraedulis*. *J. Agric. Food Chem.*, 31 (4) : 794–796.

Srivastava, V., Dubey, S. and Mishra, A. (2013). A review on lemon grass: Agricultural and Medicinal aspect. *Internat. Res. J. Pharm.*, 4 (8) : 42-44. doi: 10.7897/2230-8407.04807.

Stankoviæ, M. Z., Stanojeviæ, L. P., Nikolïæ, N. È. and Cakiæ, M.D. (2005). The effect of parsley [*Petroselinumcrispum* (Mill.) Nym.ex. AW Hill] seeds milling and fermentation conditions on essential oil yield and composition. *Chemical Industry & Chemical Engineering Quarterly/CICEQ*, 11(4) : 177-182.

Suryono, J. (2006). Consuming dragon fruit to treat various diseases. *Sinar. Tani.*, 15-21 pp.

Tangpu, V. and Yadav, T.A. (2006). *Some important folklore medicinal plants used by Tangkhul Nagas of Ukhrul District, Manipur.* TX, USA: Recent Progress in Medicinal Plants.

Tchoumboungang, F., Zollo, P.H., Dagne, E. and Mekonnen, Y. (2005). *In vivo* antimalarial activity of essential oils from *Cymbopogoncitratrus* and *Ocimumgratissimum* on mice

infected with *Plasmodium berghei*. *Planta Medica*, 71: 20–23.

Venâncio, A.M., Onofre, A.S., Lira, A.F., Alves, P.B., Blank, A.F., Antonioli, A.R., Marchioro, M., Estevam, C.S. and de, Araujo B.S. (2011). Chemical composition, acute toxicity and antinociceptive activity of the essential oil of a plant breeding cultivar of basil (*Ocimum basilicum* L.). *Planta Med.*, 77: 825-829.

Vijayvargia, P. and Rekha, V. (2014). A review on *Limoniaacidissima* L.: Multipotential medicinal plant. *Int. J. Pharm. Sci. Rev. Res.*, 28 (36) : 191-195.

Wang, S., Bao, L., Zhao, F., Wang, Q., Li, S., Ren, J., Li, L., Wen, H., Guo, L. and Liu, H. (2013). Isolation, identification and bioactivity of monoterpenoids and sesquiterpenoids from the mycelia of edible mushroom *Pleurotuscornucopiae*. *J. Agric. Food Chem.*, 61 : 5122-5129.

Wiater, A., Paduch, R., Pleszczyńska, M., Próchniak, K., Choma, A., Kandfer-Szerszen, M. and Szczodrak, J. (2011). α -(1→3)-D-Glucans from fruiting bodies of selected macromycetes fungi and the biological activity of their carboxymethylated products. *Biotechnol. Lett.*, 33 : 787-795.

Wichtl, M. and Bisset, N.G. (1994). *Herbal drugs and phytopharmaceuticals*, Medpharm Scientific Publishers, Stuttgart.

Wu, J.Y., Chen, C.H., Chang, W.H., Chung, K.T., Liu, Y.W., Lu, F.J. and Chen, Ching-Hsein (2011). Anti-cancer effects of protein extracts from *Calvatialilacina*, *Pleurotusostreatus* and *Volvariellavolvacea*. *Evid.-Based Complement. Alternat. Med.*, doi:10.1093/ecam/ neq057.

Wu, L. C., Hsu, H. W., Chen, Y. C., Chiu, C. C., Lin, Y. I. and Ho, J.A.A. (2006). Antioxidant and antiproliferative activities of red pitaya. *Food Chemistry*, 95(2) : 319-327.

Xu, F.Q., Wang, C., Yang, L., Luo, H., Fan, W., Zi, C., Dong, F., Hu, J. and Zhou, J. (2013). C-dideoxyhexosyl flavones from the stems and leaves of *Passifloraedulis* Sims. *Food Chem.*, 136 : 94–99. doi: 10.1016/j.foodchem.2012.07.101.

Yin, F., Cheng, L. and Lou, F.C. (2004). Studies on the constituents of *Citrus medica* L. var. *sarcodactylis* (Noot.) Swingle. *Zhongguo. Tianran. Yaowu.*, 2 (3) : 149-151.

Zhang, Y. H. (2018). A kind of *Passifloraedulis* drink rich in organic chromium [Machine Translation]. *Faming Zhuanli. Shenqing.*, CN 107821886 A 20180323.

15th
Year
★★★★★ of Excellence ★★★★★