Phytochemical and Therapeutic Efficiency Review of Malus Domestica

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ABSTRACT

Apples are the edible fruit produced by the apple tree Malus domestica. The apple tree is cultivated worldwide and is the most widely grown species in the genus Malus. The apple tree originates from Central Asia. Apple has been developed for thousands of years in Asia and Europe and brought to North America by European colonizers. Apple has a high nutritional value so that it can be a good food source. Humans widely consume an apple. Different cultivars are bred for a variety of flavors and uses, including cooking, eating raw, and juice production. Phytochemically, apples are reported to contain triterpenoids, flavonoids, organic acids, and sterols. Pharmacologically, this fruit is reported to have Antioxidants, Antiobesity, Anticholesterol, Anticancer, Enzyme Inhibitor and Antimicrobial.Malus domestica has an incredible viewpoint for the treatment of infections like acid neutralizer, hostile to diarrheal, delicate purgative, diuretic and depurative, hearing misfortune etc. Further studies and examinations can be performed on the plant for its different pharmacological potential. This present review gives a detail information regarding describe active constituents, therapeutic uses and pharmacological activities of both species of Malus domestica.

KEYWORDS: Malus domesticus, Herbal Medicines, Anti-oxidant, Apple, Pharmacological activity

INTRODUCTION

About 80% of the world population relies on the use of traditional medicine, which is predominantly based on plant material. Scientific studies available on medicinal plants indicate that promising phytochemicals can be developed for many health problems. More over some of the pathological condition where the scientific drugs become crippled but traditional herbal therapy can be a satisfying option which demands an ample amount of research[1]. The attempt is made to present an overview of Malus domestica for its phytochemical and pharmacological activities. The diverse flora and fauna of the planet earth have offered the treatment of various diseases in human beings since ancient history. Among these herbs are the prominent sources of medicines across the globe. Traditionally they have

been used to cure, prevent or treat diseases. Traditional systems of medicine continue to be widely practiced in both rural and urban areas[2]. Population rise, inadequate supply of drugs, prohibitive cost of treatments, side effects of several allopathic drugs and development of resistance to currently used drugs for infectious diseases have led to increased emphasis on the use of plant materials as a source of medicines for a wide variety of human ailments[3].

Apples are produced commercially in 91 countries on about 13 million acres. World apple production has increased about 17% in the last decade[4]. Average yields are 10,000 lbs/acre worldwide. Apples (Malus sp., Rosaceae) are a rich source of nutrient as well as non-nutrient components and contain high levels of polyphenols and other phytochemicals. Main structural classes of apple constituents include hydroxycinnamic acids, dihydrochalcones, flavonols (quercetin glycosides), catechins and oligomericprocyanidins, as well as triterpenoids in apple peel and anthocyanins in red apples[5].

Figure 1. Plant of Malus domestica

Scientific classification

Kingdom	: Plantae
Clade	: Tracheophytes
Clade	: Angiosperms
Clade	: Eudicots
Clade	: Rosids
Order	: Rosales
Family	: Rosaceae
Genus	: Malus
Species	: M. domestica

Vernacular Name:

English	: Apple
Gujarati	: Safarjan
Hindi, Oriya	: Sev

Kannada : Sebu
Kashmiri : Tsoonth
Marathi : Safar Chad
Malayalam : Epal

Phytochemistry

The variety of phytochemicals, and the concentration of these phytochemicals may depend on many factors, such as cultivar of the apple, harvest and storage of the apples, and processing of the apples. Concentration of phytochemicals also varies greatly between the apple peels and the apple flesh. Apples are freshly fruit with high water content about (85%) and a low sugar content (on average, about 10-12% weight)[6-8]. The main carbohydrates are fructose (6%), glucose (2.2%). The most well studied antioxidant compounds in the apples are quercetin-3 galactoside, quercetin-3-glucoside, quercetin-3-rhamnoside, catechin, epicatechin, procyanidin, cyanidin-3-galactoside, coumaric acid, chlorogenic acid, gallic acid, and phloridzin.

Recently researchers have examined the average concentrations of the major phenolic compounds in six cultivars of apples. They found that the average phenolic concentrations among the six cultivars were: quercetin glycosides, 13.2 mg/100 g fruit; vitamin C, 12.8 mg/100 g fruit; procyanidin B, 9.35 mg/100 g fruit; chlorogenic acid, 9.02 mg/100 g fruit; epicatechin, 8.65 mg/100 g fruit; and phloretin glycosides, 5.59 mg/100 g fruit. The compounds most commonly found in apple peels consist of the procyanidins, catechin, epicatechin, chlorogenic acid, phloridzin, and the quercetin conjugates. In the apple flesh, there is some catechin, procyanidin, epicatechin, and phloridzin, but these compounds are found in much lower concentrations than in the peels. More recent work has shown that apple peels contain two to six times (depending on the variety) more phenolic compounds than in the flesh, and two to three times more flavonoids in the peels when compared to the flesh[9,10].

Chemical Oxidation of Apple

The reaction taking place in the first stage of browning is an enzyme-catalysed oxidation of benzene-1,2-diol to a quinone. In the second stage, the quinone reacts with water to form benzene-1,2,4-triol. Benzene-1,2,4-triol then reacts with any unchanged quinone, followed by a rearrangement to form a dicyclic compound. This then polymerises further to give highly-coloured pigments of unknown structure[11].

Ascorbic acid

The investigation with ascorbic acid is a qualitative one. If the students place the samples in order of increased delay period, they will see that delay period increases with increasing concentration of ascorbic acid. Ascorbic acid is a reducing agent. It acts by reducing the quinone back to the hydroquinone. It is itself oxidised in the process. No pigment forms until all the ascorbic acid is oxidised[12,13]. The enzyme activity slowly drops as it catalyses the reaction. If there is enough ascorbic acid, the enzyme loses its activity before all the ascorbic

acid is oxidised and no discolouration occurs. Ascorbic acid is known as vitamin C and is widely distributed in nature, controlling the redox systems in living cells. It is a micronutrient and so is a very useful antioxidant in the food industry[14].

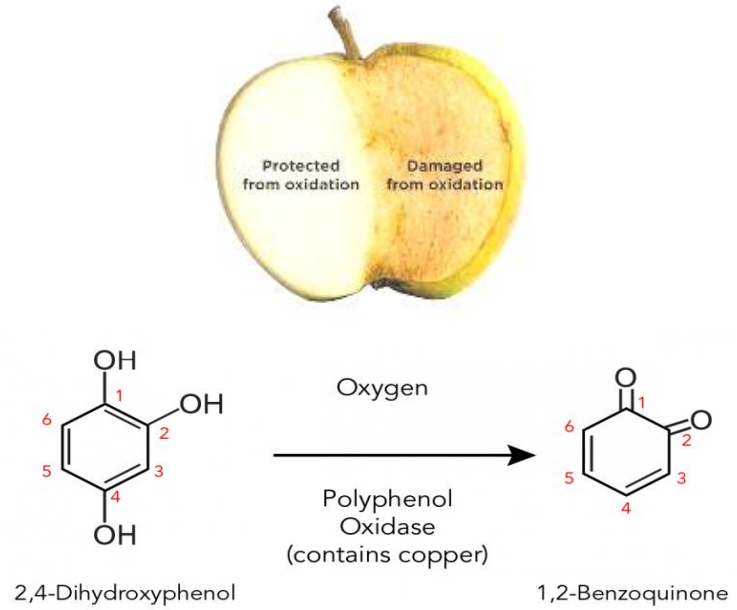

Figure 2. Chemical reaction in oxidation of *Malus Domestica*

Neuroprotective Activity

The benefits of apples shows that drinking apple juice could keep Alzheimer's away and fight the effects of aging on the brain. The mice in the study that were fed an apple-enhanced diet showed higher levels of the neurotransmitter acetylcholine and did better in maze tests than those on a regular diet[15]. Research has shown that people who eat fruits and other high-fiber foods may be protected against Parkinson's disease, a condition characterized by a breakdown of the brain's dopamine-producing nerve cells. Scientists have linked this to the free radical-fighting power of the antioxidants contained therein[16].

Reduces the risk of cancer:

Scientists from the American Association for Cancer Research, among others, agree that the consumption of flavonol-rich apples could help reduce your risk of developing pancreatic cancer by up to 23 per cent. Researchers at Cornell University have identified several compounds-triterpenoids-in apple peel that have potent anti-growth activities against cancer cells in the liver, colon and breast. Their earlier research found that extracts from whole apples can reduce the number and size of mammary tumors in rats. Meanwhile, the National Cancer Institute in the U.S. has recommended a high fiber intake to reduce the risk of colorectal cancer[17].

Hypoglycemic Activity

One who eat apples at least one a day are 28 per cent less likely to develop type 2 diabetes than those who don't eat apples. The health benefits of apples are because this fruit is loaded with soluble fiber, the key to blunting blood sugar swings[18].

PHARMACOLOGICAL OF *MALUS DOMESTICA*

Antipyretic Activity

The antipyretic activity of apple juice was estimated by subcutaneously injecting 20% w/v brewer's yeast suspension (10ml/kg) into the animal's dorsum region[19]. The rectal temperature of each rat was measured using a thermometer before injection of the yeast. The apple juice and paracetamol (100mg/kg) was administered orally and the temperature was measured at 0, 1, 2, 3 and 4 h after administration. Apple is effective as antipyretic. However, describing the active constituent which is responsible for antipyretic effect and its mechanisms of action are required[20,21].

Cardiovascular Activity

Epidemiological evidence supports the concept that diets rich in fruits and vegetables promote health and attenuate or delay the onset of cardiovascular disease (CVD). In particular, a reduced risk of CVD has been associated with apple consumption, probably due to the cholesterol lowering effect of the main bioactive compounds, namely fiber and polyphenols[22,23]. This study describes for the first time the effect of three different apple varieties, namely Bravo de Esmolfe, Malápio da Serra and Golden, containing different amounts of bioactive compounds, on two relevant biomarkers of cardiovascular diseases in an animal model. The results show that both cholesterol- and LDL- lowering effects may be directly correlated with the phenolic contents, namely catechin, epicatechin and procyanidin B1, antioxidant activity and -carotene concentration of apples[24].

Antibacterial Activity

Synthetic antimicrobials are losing ground to their natural counterparts and therefore, the food industry has motivated to seek other natural alternatives. Apple pomace, a by-product in the processing of apples, is rich in polyphenols, and plant polyphenols have been used as food additives owing to their strong antimicrobial properties[25]. The study was conducted to screen the individual polyphenols with antimicrobial activities from the extracts (methanol, ethanol, acetone, ethyl acetate, and chloroform) of Golden Delicious pomace. Ethyl acetate was the best solvent of choice to extract natural products to obtain the maximum antibacterial benefits. Phloridzin and phloretin have the potential to be used as natural alternatives to antimicrobials[26].

Hyperlipidemic Activity

A healthy life style and a balanced diet, associated with a high fruit and vegetable intake, are linked to good health and the prevention of diseases. Apples contain bioactive compounds that help in the prevention and control of hyperlipidemia. The 15 and 25% apple diets showed significant reductions in the serum levels of total cholesterol and LDL-C and an increase in the level of fecal cholesterol in relation to the control group[27]. The 25% apple diet provided a significant reduction in the hepatic cholesterol levels compared to the control group. After 60 days, the serum levels of total cholesterol, LDL-C, HDL-C and triglycerides in rats fed with 5, 15 and 25% apple diets were similar to the control group. This probably happened due

to a reversion of the process. These results show the importance of Gala apples in the control of hyperlipidemia in rats. A diet rich in vegetables and fruits, including apples, associated to a healthy life style, over time, could prevent or reduce the risk of heart disease[28].

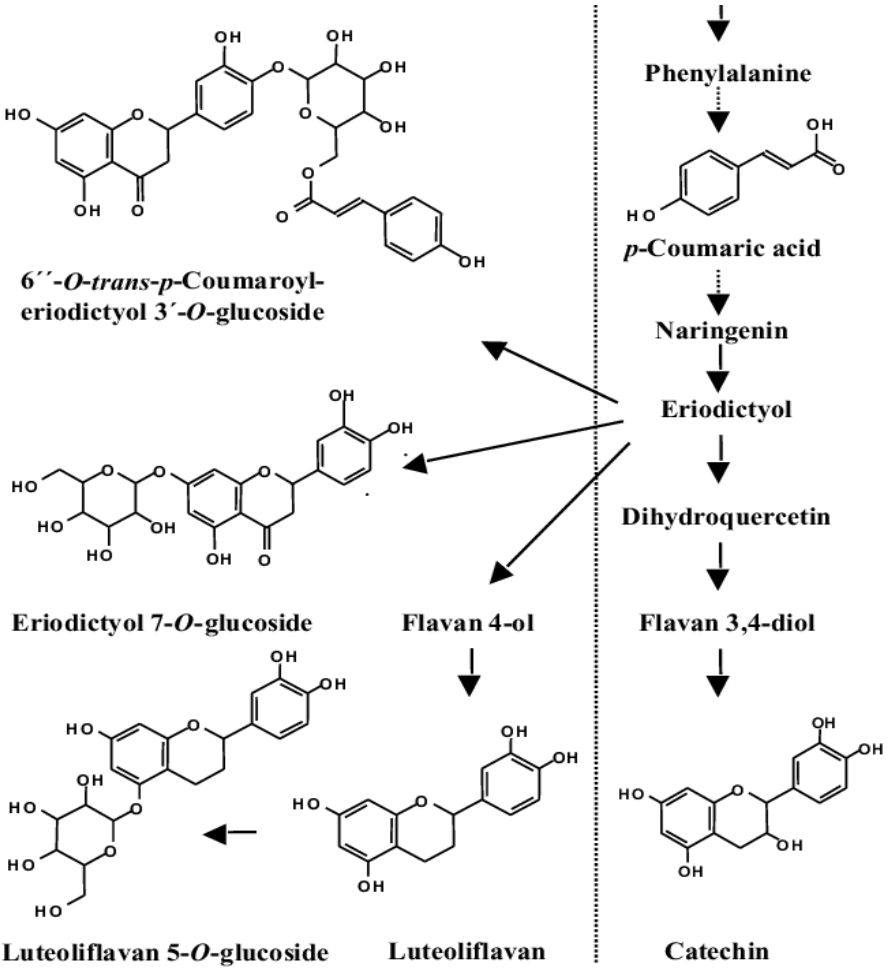

Figure 3. Chemical Constituents of Malus domestica

Anti-inflammatory Activity

The dietary consumption of fruit and vegetable is associated with a lower incidence of degenerative diseases such as cardiovascular disease. Most recent interest has focused on the bioactive phenolic compounds in vegetable products[29,30]. All varieties of apple contain several antioxidants and polyphenols that possess many biological activities, such as antioxidant and anti-inflammation properties.Contrasting results have been reported in obese and hypercholesterolemic patients. Additional human studies are needed to confirm the hypothesized antioxidant, antiinflammatory, and vascular protective effects of apples and derivatives in normal and pathological conditions[31,32].

Antihypertensive Activity

Apples or otherwise botanically known as Malus domestica is said to have originated in the mountains of Central and west Asia. It is one of the earliest and most commonly grown trees. In humans it is consumed in various forms and varieties; also it is eaten as a raw fruit. These flavonoids such as Quercetin, proanthocynadins, anthocynanins and pectin content of an apple directly or indirectly benefit the cardiovascular system and helps in lowering of blood

pressure[33-37]. Most of these flavonoids exhibits there action by inhibition of angiotensin converting enzyme , improving endothelial function of blood vessels, preventing oxidation of low density lipoprotein and improving high density lipoprotein in circulation, prevent atherosclerosis and are strong antioxidants.

Antioxidant Activity

A research showed that the concentration of polyphenolics content varied among the apple cultivars, with Pacific Queen containing 2.7 times the amount of polyphenolics found in Cox's Orange. Furthermore, there were significant differences in polyphenolic concentrations in fruit from different regions for some cultivars but not for others. To maximize the intake of apple polyphenols, it is necessary to consume apples of cultivars with high polyphenolic concentrations such as Pacific Queen and include the skin. The results also showed that there is potential for promoting apple fruit from specific geographical regions because they contained elevated concentrations of antioxidant polyphenolic compounds[38-40].

Anticancer Activity

The study was conducted to assess the likely effect of the resilience of apple polyphenols, with particular attention to the carcinogenic anthocyanin colon, slowing or reducing the appearance of various markers of precancerous. Main structural classes of apple constituents include hydroxycinnamic acids, dihydrochalcones, flavonols (quercetin glycosides), catechins and oligomericprocyanidins, as well as triterpenoids in apple peel and anthocyanins in red apples[41-43]. These include antimutagenic activity, modulation of carcinogen metabolism, antioxidant activity, anti-inflammatory mechanisms, modulation of signal transduction pathways, antiproliferative and apoptosis-inducing activity, as well as novel mechanisms on epigenetic events and innate immunity. Apple products have been shown to prevent skin, mammary and colon carcinogenesis in animal models.

Antiproliferative Activity

Apples have been shown to have potent antiiproliferative activity in several studies. When Caco-2 colon cancer cells were treated with apple extracts, cell proliferation was inhibited in a dose-dependent manner reaching a maximum inhibition of 43% at a dose of 50 mg/mL. The same trend was seen in HepG2 liver cancer cells with maximal inhibition reaching 57% at a dose of 50 mg/mL. Due to its unique combination of phytochemicals in the apples that are responsible for inhibiting the growth of tumor cells[44-47]. Apples had the third highest antiproliferative activity when compared to eleven other commonly consumed fruits Apples without peels were significantly less effective in inhibiting HepG2 cell proliferation when compared to apples with the peel, suggesting that apple peels possess significant anti-proliferative activity. It was concluded that apple peels alone inhibited HepG2 cell proliferation significantly more than whole apples[48].

Antimicrobial Activity

The total polyphenol content and partial phenolic composition of the pulp and skin were produced organically and conventionally Malus domestica. Organically grown apples show a higher content of polyphenols, both in the pulp and skin. The results of the study, the use of

Annurca apple peel extract grown organically, has antimicrobial activity against several food-borne bacteria such as entemorragic. E. coli. Meanwhile, conventionally produced apples showed good inhibitory effects against Bacillus Cereus[49-52].

Hypoglycemic Activity

Type 2 diabetes is the most common metabolic disorder worldwide and its prevalence is growing at an alarming rate in both developed and developing countries. It is characterized by abnormalities in carbohydrate, lipid and lipoprotein metabolism, which lead to hyperglycemia and many complications such as hyperlipidemia, hyperinsulinemia, hypertension and atherosclerosis[53-57]. In order to prevent diabetes, in addition to oral hypoglycemic drugs, the dietary component such as Apple cider vinegar seems to be promising for glycemic control in patients with type 2 diabetes as well as for diabetes related medical conditions. Apple cider vinegar is fermented juice from crushed apples. Acetic acid in vinegar seems to suppress disaccharides activity and increase glucose-6-phosphate levels in skeletal muscle[58-60].

Anti-Depressant Activity

Apple ripe with antioxidants and fiber. An apple a day could if eaten with the rest of these foods keep the psychiatrist away, at least for stretches of time. Like berries, apples are high in antioxidants, which can help to prevent and repair oxidation damage and inflammation on the cellular level[61]. Apple juice consumption may increase the production in the brain of the essential neurotransmitter acetylcholine. The researchers found that including apples in your daily diet may protect neuron cells against oxidative stress-induced neurotoxicity[62].

CONCLUSION

Apples (Malus domestica) are some of the most ancient and popular fruits in the world. China is currently the world's largest apple producer. While apples are mostly consumed fresh, they are processed into beverages, jam, jelly, and other forms of foods. Polyphenols are the bioactive compounds, and their stability, bioaccessibility, bioavailability, and the antioxidant and anti-inflammatory effects are affected by many factors. The consumption of apple and its processed products or extracts rich in polyphenols have been linked to reduced risk in cancer, cardiovascular disease, diabetes, and many other diseases although some of them require further confirmation. The above compiled information regarding the use of Malus domesticus in world is matched with available literature. Recent year, traditional and ethno-botanical use of natural origin drugs, most importantly plants received more attention as it’s a general belief that they are safe to human. The herbal products today symbolize safety in contrast to the synthetics that are regarded as unsafe to human and environment. The strategic favour of the medicinal virtues of plants requires systematic and scientific approach in exploration of the chemical constituents of plants. Apple possesses various phytoconstituent which have well established antioxidant potential and is used in treatment of various ailments. Apart from its various pharmacological activities it has very rich nutritional value. The toxicity study and safety pharmacology has yet to be established for malus species.

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