Review Article

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A REVIEW ON PHYTOCHEMICAL, ANALYTICAL, PHARMACOLOGICAL AND NUTRITIONAL SIGNIFICANCE OF *SOLANUM TUBEROSUM*

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ABSTRACT

Potato known as *Solanum tuberosum* belongs to Solanaceae family. The whole parts of the plant are meant for their medicinal use. The chemical constituents present in potato are having numerous pharmacological activities. The main chemical constituents of potato are phenolic compounds, flavonoids, anthocyanins, alkaloids. The reported pharmacological activities of potato are antibacterial, anti-obesity, anti-allergy, anti-inflammatory, anti-ulcer. Potato also contains vitamins such as vitamin-B6, vitamin-B3, pantothenic acid and minerals like potassium, manganese, phosphorous, copper, it also contains some amount of fiber. The geographical origin and distribution, nutritional value, phytochemical constituents have been mentioned in this present review article.

Keywords: *Solanum tuberosum*, Alkaloids, Pantothenic acid, vitamin B6.

INTRODUCTION

Potato, *Solanum tuberosum,* is an herbaceous perennial which grow up to 100 cm high, produce edible tuberous crops formed underground and it belongs to Solanaceae family. It is the part of every household and it is one of the most grown non-cereal crops. It has the ability to grow in harsh weather conditions. It is the fourth largest crop grown following wheat, rice, maize. Nearly; there are about 4000 varieties of potato. Apart from its use as a food material it also has other benefits. Plants are a very good source of antimicrobial agents. Potato also found to have antimicrobial agents against common pathogens[1]. Potato is an important source of bioactive compounds. Excluding starch, crude fiber, amino acids, vitamins (folic acid, ascorbic acid) and minerals, trace elements (magnesium, sodium, iodine, iron) the tubers of potato also contain various phenolic compounds. These amino acids and phenolics offer antioxidant protection against oxygen reactive species, tissue damage, and some diseases such as diabetes mellitus, cancer, atherosclerosis, renal failure[2].

PLANT PROFILE

Plant name: *Solanum tuberosum*
Synonyms: yam, Murphy, plant, spud, tater, tuber.[3,4]

TAXONOMY

Kingdom	Plantae
Sub kingdom	Viridaeplantae
Division	Tracheophyta
Class	Magnoliopsida
Subdivision	Spermatophytina
Family	Solanaceae
Order	Solanales
Genus	Solanum
Species	*Solanum tuberosum*

VERNACULAR NAMES

Telugu: Bangaladumpa, Urlagadda
Tamil: Urulaikkilanku
Kannada: Alugadde
Ayurvedic medicine: Diascorea bulbifera
Malayalam: Urulakizhangu
English: Potato.

Figure 1: Flowers

Figure 2: Potatoes

Figure 3: Tubers

Figure 4: Leaves of potato plant

NUTRITIONAL VALUE OF POTATO

Potatoes are rich in nutrients, a raw potato consists of 22% carbohydrates, 2% protein, 74% water and contains very less amount of fat (0.1%). It is also a very good source of vitamin B6 and folic acid, vitamin C. Potatoes mostly contain starch, which is complex carbohydrates in the form of sugars, free of fats and cholesterol[4]. They also contain minerals such as calcium, potassium, magnesium, Sulphur, copper, small amounts of fibers are also present. The starch of raw potato is not digested by humans. So raw potato was eaten rarely. Potatoes are also having high glycemic index (GI). Hence, they are excluded from the diet of individuals following low GI diet. Phenolics and other antioxidants are present in potato, these antioxidants are having free radical scavenging property.

VARIETIES AND CULTIVARS OF POTATO

Nearly there are more than 200 varieties of potato throughout the United States. Each of the variety fit into one of the seven potato type categories: russet, red, white, yellow, blue/purple fingerling and petite. The potato cultivars have a range of colors due to accumulation of anthocyanins, in the tubers. They also have coloured skin, many varieties with pink or red skin have white or yellow flesh, the yellow color, more or less marked, is due to the presence of carotenoids.

BOTANICAL DISTRIBUTION

Habit: The potato is an herbaceous (non-woody) plant and habit changes within the species. It is having rosette or semi rosette characteristics. Potato herbs are annual, biennial or perennial.

Tuber: Potato is an annual non-woody herbaceous plant, reproduce mainly vegetatively by tubers and typically by true potato seeds. The tuber of potato is an enlarged part of an underground stem from which new shoots are produced. Morphologically the tuber is a fleshy stem, contains buds and eyes in the axil of small scale like leaves. Eye number and distribution are characteristics of the variety.

Stem: The stem is erect in the early stage later it becomes proliferate and prostate.

Leaves: The leaves are alternate and compound, asymmetrically odd pinnate, with 6-8 pairs of leaflets and smaller, unequal interstitial leaflets; petiole consists of 2.5-5 cm long, ovoid shape. Buds formed in axil of the leaves produce rhizome which extends rapidly and develop into tubers at their extremities.

Roots: Fibrous or tuberous root.

Seed: Endospermic seed.

Flower: Two types of pollination occur in flowers one is self-pollination by themselves and cross pollination by insect, bees and birds.

Floral biology

The terminal bud forms lateral flowers, inflorescence consisting of 1-30 flowers depending on the maintenance and cultivation[5].

Phytochemical Analysis

Phytochemicals are the chemicals substances naturally occurring in the plants which are having a numerous medicinal use. Unlike pharmaceutical compounds phytochemicals do not have any side effects. Carotenoids and poly phenols are the two main groups of antioxidants present in the vegetables. Poly phenols include flavonoids, phenolic acids, anthocyanins[6].

Phenolic Acids

Phenolic compounds are extremely heterogeneous type of secondary plant metabolites which can widely categorized into phenolic acids (C6-C1 and C6-C3 structures). The major phenolic acids in potato are cinnamic acid and its derivatives, even though benzoic acids such as gallic and protocatechuic acid are also found to be present. The phenolic acid profile in potato is reported to contain chlorogenic acid (50.3%) caffeic acid (41.7%), gallic acid (7.8%), and protocatechuic acid (0.21%). Phenolic acid plays a notable function in the first line protection against insects and pathogenic microbes[34]. Other phenolic acids found in potato; the majority are cinnamic acid derivatives. These benzoic acids or cinnamic acids are synthesized in potato through the shikimate pathway.

Polyphenols have plentiful micronutrients in our diet, they protect cells and body chemicals against damage caused by free radicals. The antioxidant properties of polyphenols comes from their high reactivity as hydrogen or electron donors, and from the ability of the polyphenol derived radical to stabilize and de-localize the unpaired electron and their ability to chelate transition metal ions.[35] It accounts for 90% of the phenolic compounds in potato peels and exists in the form of three main isomers, chlorogenic acid (5-Ocaffeoylquinic acid), neochlorogenic acid (3-O-caffeoylquinic acid), and cryptochlorogenic acid (4-O-caffeoylquinic acid) caffeic acid[36].

Table 2: Various extraction techniques

Extraction system	Analytical technique	Potato cultivar	Phenolic compounds described
Solid-liquid extraction	HPLC-DAD	'Kufri chandromukhi'	Chlorogenic acid, caffeic acid, gallic acid[7].
	HPLC-MS	'Ranger Russet' 'Norkotah Russet'	Neochlorogenic acid, chlorogenic acid, caffeic acid, quercetin-3-o-glu-rut, rutin, kaempferol-3-o-rutinoside, cryptochlorogenic acid, quinic acid[8].
	HPLC UV-Vis	9 Italian cultivars (Agata, Primura, Arinda, Merit, Marabel, Jelli, ' Frinka, Sponta, Agria)	Chlorogenic acid[9].
	HPLC-DAD, HPLC-MS, HPLC-FLD	23 Native Andean cultivars	Chlorogenic acid, neochlorogenic acid, cryptochlorogenic acid, caffeic acid, protocatechuic acid, vanillic acid, ferulic acid, petanin, rutin, kaempferol- rutinoside[10].
	HPLC-DAD	320 specialty potato genotypes	caffeic acid, gallic acid, catechin Chlorogenic acid[11].
	Not cited	'Russet Burbank'	Chlorogenic acid, ferulic acid, vanillic acid, caffeic acid, benzoic acid[12].
	HPLC-MS	'Jasim', 'Atlantic', 'Jawan', 'Superior', 'Jopung'	Chlorogenic acid, caffeic acid, ferulic acid, p-coumaric acid, trans-cinnamic acid[13].
	HPLC-DAD	'Nicola', 'Sieglinde F', 'Isci 4052', 'Isci 67'	Chlorogenic acid, caffeic acid, ferulic acid, catechin[14].
	HPLC	Not cited (Indian cultivar)	Gallic acid, caffeic acid, chlorogenic acid, protocatechuic acid[15].
	HPLC-DAD	13 native Andean genotypes	Neochlorogenic acid, cryptochlorogenic acid, chlorogenic acid, kaempferol-3-o-rutinoside, quercetin[16].
	HPLC	Karlena	'Gallic acid, neochlorogenic acid, protocatechuic acid, catechin, cryptochlorogenic acid, chlorogenic acid, vanillic acid, caffeic acid, ferulic acid, p-coumaric acid[17].
	HPLC UV-Vis	'Siecle', 'Purple Majesty', 'Dakota pearl', 'FL 1533', 'Vivaldi', 'Yukon gold'	Chlorogenic acid, caffeic acid[18].
	HPLC-DAD	8 cultivars	Chlorogenic acid, caffeic acid, epicatechin, p-coumaric acid, vanillic acid, quercetin[19].
	HPLC-DAD, HPLC-MS	'Goldrosh', 'Nordonna', 'Dakota Pearl', 'Norkotah', 'Red Nordland', 'Sangre', 'Viking', 'Dark Red Nordland'	Chlorogenic acid, caffeic acid, gallic acid, ferulic acid, catechin, p-coumaric acid, o-coumaric acid[20].
	HPLC-DAD	'Sava', 'Bintje'	Protocatechuic acid, gentisic acid, gallic acid, chlorogenic acid, salicylic acid, caffeic acid, ferulic acid, p-coumaric acid[21].
	HPLC-DAD/ APCI-MS	16 cultivars	Chlorogenic acid, caffeic acid, 3-o-caffeoylquinic acid, 1-o-caffeoylquinic acid[22].
	HPLC-DAD-MS	'Bintje', 'Piccolo', 'Purple Majesty'	Chlorogenic acid, neochlorogenic acid, cryptochlorogenic acid, kaempferol rutinose, rutin[23].
	HPLC-DAD-MS	13 Italian cultivars	5-o-caffeoylquinic acid, 4-o-caffeoylquinic acid, 3-o-caffeoylquinic acid, ferulic acid, anthocyanins[24].
	UPLC-MS	'Purple Majesty', 'Yukon gold', 'Atlantic'	Chlorogenicacid, caffeic acid, ferulic acid, sinapic acid[25].
	UPLC-DAD	'Vitelotte', 'Luminella', 'Charlotte', 'Bintje'	Chlorogenicacid, neochlorogenic acid, cryptochlorogenic acid, caffeic acid, ferulic acid, p-coumaric acid, syringic acid, vanillic acid, catechin, rutin, kaempferol-3-o-rutinoside[26].
	HPLC-DAD-MS	50 cultivars	chlorogenic acid, rutin, kaempferol-3-rutinose[27].
	HPLC-DAD	Not cited	Chlorogenic acid, neochlorogenic acid, cryptochlorogenic acid, coumaric acid, genistin, quercetin-3-β-D-galactoside, naringin, naringenin, luteolin, genistein, kaempferol, flavan-3-ol[28].
	HPLC-DAD	'Sava'	Gallic acid, protocatechuic acid, gentisic acid, chlorogenic acid, vanillic acid, syringic acid, caffeic acid, salicylic acid, p-coumaric acid, ferulic acid[29].
	UPLC-MS	Not cited	chlorogenic acid, quinic acid, caffeic acid, methyl caffeate[30].
	HPLC-DAD-MS	15 Colombian cultivars	Chlorogenic acid, neochlorogenic acid, cryptochlorogenic acid, caffeic acid[31].
	HPLC UV	'Valfi', 'Blaue Elise', 'Bore Valley', 'Blue Cango'	Chlorogenic acid, caffeic acid, ferulic acid, coumaric acid, cryptochlorogenic acid, neochlorogenic acid, p-coumaric acid[32].
	HPLC UV	'Agria'	Chlorogenic acid, ferulic acid, gallic acid[33].

Flavonoids

Flavonoids are the most common group of plant phenolic compounds and their presence effect the flavor and color of fruits and vegetables. The six main subclasses of flavonoids are the flavones, flavanones, flavan-3-ols, flavonols, anthocyanidins, and isoflavones.[37] Catechins belong to flavan-3-ols which are regularly determined in tea or fruits such as apple and grape (mainly in the skins). Catechins are strong antioxidants which had been associated with many of the potential health benefits. Catechin is only a minor constituent in potato (10-13 mg/100 g FW), observed in some cultivars. Flavonols such as quercetin and kaempferol are close to ubiquitous, and are extremely essential phytochemical group in our diets[38,39].

Anthocyanins

Anthocyanins are a sub-division of pigmented flavonoids. Cultivated varieties of potato include various amounts of anthocyanins and carotenoids within the skin of tuber and flesh[40]. Anthocyanin compounds in fruits most probably exist in glycosidic forms and the colour of a specified anthocyanin compound depends upon the hydroxylation or methoxylation patterns on the B ring. The anthocyanin composition is complex in pigmented potatoes, with acylation in the glycoside ring. Recently, potato anthocyanins have been recognized for their contributions to health, as they have been shown to have strong antioxidative activity, anti-influenza virus activity and anti-stomach cancer activity. The carotenoid present in cultivars such as white and yellow-fleshed potatoes (*Solanum tuberosum*) was identified by antheraxanthin, violaxanthin, Zeaxanthin and lutein, are present in various proportions, whereas β-Cryptoxanthin, β-carotene and neoxanthin, are minor constituents[41].

Alkaloids

Glycoalkaloids are the plant secondary metabolites which are toxic to microorganisms, viruses, insects, animals and humans. The primary glycoalkaloids present in potatoes are α-solanine and α-chaconine, which share the equal aglycons, solanidine. Structurally, these compounds vary in the saccharide moiety in that α-solanine contains the trisaccharide solatriose, whereas in α-chaconine the aglycone is attached to chacotriose. Stepwise removal of a sugar moiety from the trisaccharides results in the formation of β and γ-glycoalkaloids and finally to solanidine, which show a lower toxicity compared to the parent compounds.[42,43]

Therapeutic uses

- Potato is well known for its pharmacological activities; all parts of the plant contain active constituents which are used in traditional medicine.
- The poly phenols and flavonoids of potato are responsible for antioxidant property. The tuber of potato is used for anti-ulcer, anti-gout, anti-arthritic, anti-inflammatory, anti-scurvy activities also increase milk production in lactating mothers[44].
- The Consumption of good quality potatoes help in reducing the LDL-oxidation which is the main reason for atherosclerosis, this action is due to the antioxidative nature of polyphenols of potato.
- Potatoes are abundant source of iron and folic acid which find application in aiding treatment of different forms of anaemia[45].

CONCLUSION

Potato is one of the most important food crops of the world. It contains a variety of phytochemicals, along with carbohydrates, proteins, and vitamins. Potatoes have proved to be used in food production, pharmacy, medicinal applications. Potatoes are the rich source of phenolics, flavonoids, anthocyanins, alkaloids, which are having a great role in the pharmacological activities such as antimicrobial, anti-ulcer, antidiabetic, anti-cancer, antioxidant. Polyphenols are having free radical scavenging property. The phytochemicals of potato are potent anti-cancer, anti-ulcer, anti-LDL peroxidation and glycemic index lowering agents.

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