



## Phytochemical constituents and pharmacological activities of *Ipomoea batatas* L. (Lam) – A review

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### ABSTRACT

*Ipomoea batatas* L. (Lam), is an important food crop in many countries, also cultivated for its use as animal feed and as a medicinal plant. The root is commonly known as sweet potato and has been used extensively in traditional medicines for various ailments. The roots and skin of *Ipomoea batatas* contain high levels of polyphenols such as anthocyanins and phenolic acids and are a good source of vitamins A, B and C, iron, calcium and phosphorus. *Ipomoea batatas* has been reported to possess anti oxidant, anti-diabetic, wound healing, anti-ulcer, anti-bacterial, and anti-mutagenic activities. It is also used as an immune booster and for relief of gastrointestinal and upper respiratory symptoms. The boiled roots of *Ipomoea batatas* are believed to relieve diarrhea, and crushed leaves are used to treat acne and boils. This review highlights the phytochemical and pharmacological aspects of *Ipomoea batatas*.

**Keywords:** Anthocyanins; anti-oxidant; anti-diabetic; *Ipomoea batatas*; wound healing

### INTRODUCTION

Sweet potato, *Ipomoea batatas* L. (Lam.) from the family Convolvulaceae, is world's sixth largest food crop which is widely grown in tropical, subtropical and warm temperate regions (Scott., 1992). The sweet potato plant originated in Central America but China is considered the leading producer of sweet potatoes, producing about 80% of the yearly global output (Li et al., 1992). About 40% of China's annual sweet potato production is destined for animal, particularly pig feed use (Scott, 1992). The plant is widely cultivated and consumed throughout the world. It is an herbaceous perennial vine with alternate heart-shaped, lobed leaves and medium-sized flowers. The root is edible and is often long and tapered. The skin may be red, purple, or brown and white in color. The flesh may be white, yellow, orange or purple. The leaves and shoots are eaten as vegetables (Zhao et al., 2005).

In comparison to other major staple food crops, sweet potato has the following positive attributes: wide production geography, adaptability to marginal conditions, short production cycle, high nutritional value and sensory versatility in terms of flesh colors, taste and texture (Truong et al., 2010). It is commonly used as food, to feed livestock and as a medicinal plant.

### SCIENTIFIC CLASSIFICATION

Kingdom: Plantae  
(unranked): Angiosperms  
(unranked): Eudicots  
(unranked): Asterids  
Order: Solanales  
Family: Convolvulaceae  
Genus: *Ipomoea*  
Species: *I. batatas*

### CONSTITUENTS AND PROPERTIES

Sweet potato roots are a good source of carbohydrates, an excellent source of vitamin A (in the form of beta-carotene), a very good source of vitamin C and manganese, and a good source of copper, dietary fibre, vitamin B<sub>6</sub>, potassium and iron (Cardenas et al., 1993).

The roots and skin contain high levels of polyphenols such as anthocyanins and phenolic acids (eg, caffeic acid) (Konczak et al., 2003). Caffeoylquinic acid derivatives like chlorogenic, dicaffeoylquinic, and tricaffeoylquinic acids are found in the roots that protect them from fungal diseases and have potential cancer chemoprotective effects (Konczak et al., 2003; Konczak et al., 2004)

The numerous acylated anthocyanins (Goda et al., 1997) are the major color constituents in the storage roots and are important in the plant's use in diabetes (Matsui et al., 2004). Structural properties of the anthocyanins important for bioactivity include phenolic

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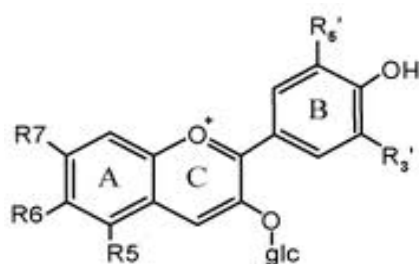
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esters of the sugar, presence of 2 hydroxyl groups on the aromatic ring, and the presence of an unsaturated alkyl chain in the acylated moiety (Wilson et al., 1979).

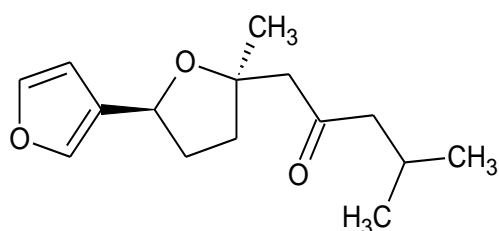
**Table 1: Characteristics and Properties of *Ipomoea batatas***

Sweet potato	
Scientific name	<i>Ipomoea batatas</i>
Common names	Sweet potato, caiapo, nyamis (Africa), yam, kumara (New Zealand), camote (southwest United States)
Flower character	Monoecious
Edible parts	Storage root
Shape	Short, blocky, tapered ends
Number per plant	4–10
External texture of edible storage organ	Smooth, thin skin
Dry matter	22–28%
Mouth feel	Moist
Taste	Sweet
Propagation	Transplants/vine cuttings
Growing Season	90–150 days
Climate required	Tropical, temperate tropical



**Structure of Anthocyanins**

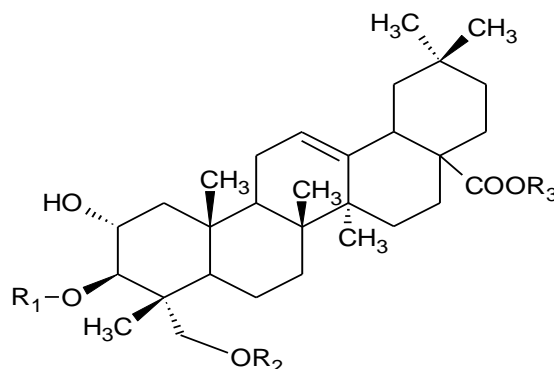
Roots also contain sesquiterpenoids which include 6-myoporol, 4-hydroxydehydromyoporone and ipomeamarone. Usually the most abundant sesquiterpenoid found in stressed sweet potato tissue is ipomeamarone (Wilson et al., 1979).



**Ipomeamarone**

Two storage proteins, saponin 1 and 2, account for more than 80% of the total proteins isolated from the roots of sweet potato (Dini et al., 2006). Their structures have been characterized on the basis of UV, MS, polarimetry and NMR data as: oleanolic acid-3-O-[β-d-

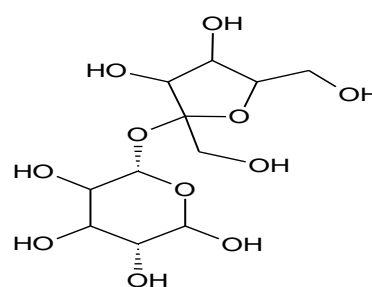
glucopyranosyl-(1→2)-β-d-galactopyranosyl-(1→2)-β-d-glucuronopyranosyl]-28-O-β-d-glucopyranoside (sandrosonin IX) (1) and oleanolic acid-3-O-[β-d-galactopyranosyl-(1→3)-β-d-glucuronopyranosyl]-28-O-β-d-glucopyranoside. The total contents of saponin 1 and 2 are 200.01 mg/100 g dry weight. The saponin 1 content is: 161.20 mg/100 g dry weight and saponin 2 content is: 14.67 mg/100 g dry weight (Dini et al., 2006).



**Structure of Saponin**

On the basis of 1D, 2D NMR, and mass spectrometry data the polar extracts of sweet potato are found to contain seven aminoacyl sugars. The structures of the compounds have been elucidated as (Dini et al., 2006).

- β-d-fructofuranosyl-(2 → 1)-α-d-[2-O-valyl]-glucopyranoside,
- β-d-fructofuranosyl-(2 → 1)-α-d-[2-O-tyrosyl]-glucopyranoside,
- β-d-fructofuranosyl-(2 → 1)-α-d-[2-O-threonyl]-glucopyranoside,
- β-d-fructofuranosyl-(2 → 1)-α-d-[2-O-histidyl]-glucopyranoside,
- 2-β-d-fructofuranosyl-(2 → 1)-α-d-[2-O-alanyl]-glucopyranoside,
- β-d-fructofuranosyl-(2 → 1)-α-d-[2-O-tryptophanyl]-glucopyranoside,
- β-d-fructofuranosyl-(2 → 1)-α-d-[2-O-glycyl]-glucopyranoside.



**β-d-fructofuranosyl)-α-d-glucopyranoside**

**Table 2: Nutritional value per 100 g (3.5 oz) of Sweet Potato. (Percentages are relative to US recommendations for adults)**

Nutritional content	value per 100 g (3.5 oz)	Nutritional content	value per 100 g (3.5 oz)
Energy	360 kJ (85 kcal)	Vitamin A equiv.	709 µg (79%)
Protein	1.6 g	- beta-carotene	8509 µg (79%)
Carbohydrates	20.1 g	Thiamine (Vit. B <sub>1</sub> )	0.1 mg (8%)
- Starch	12.7 g	Riboflavin (Vit. B <sub>2</sub> )	0.1 mg (7%)
- Sugars	4.2 g	Niacin (Vit. B <sub>3</sub> )	0.61 mg (4%)
- Dietary fibre	3.0 g	Pantothenic acid (B <sub>5</sub> )	0.8 mg (16%)
		Vitamin B <sub>6</sub>	0.2 mg (15%)
		Folate (Vit. B <sub>9</sub> )	11 µg (3%)
Fat	0.1 g	Vitamin C	2.4 mg (4%)
Calcium	30.0 mg (3%)	Vitamin E	0.26 mg (2%)
Iron	0.6 mg (5%)	Potassium	337 mg (7%)
Magnesium	25.0 mg (7%)	Sodium	55 mg (2%)
Phosphorus	47.0 mg (7%)	Zinc	0.3 mg (3%)

Leaves contain a large amount of protein, showing high amino acid store. All the parts of sweet potatoes are rich in dietary fibre and in particular, leaves contain soluble dietary fibre and stems contain insoluble dietary fibre (Ishida *et al.*, 2000).

Leaves also contain vitamins such as carotene, vitamin B<sub>2</sub>, vitamin C and vitamin E (Ishida *et al.*, 2000). The mineral content, particularly iron is found in higher proportions in the leaves in comparison with other vegetables. Furthermore, the polyphenol content in leaves is also comparatively high (Ishida *et al.*, 2000).

#### HISTORICAL USES

The boiled *Ipomoea batatas* roots were believed to relieve diarrhea, and crushed leaves were used to treat acne and boils. The effectiveness of sweet potatoes to treat these conditions has not been investigated.

#### PHARMACOLOGICAL PROPERTIES

Owing to the large variety of constituents, sweet potato has been implicated in the treatment of more than ten pharmacological conditions. Research studies on sweet potato have focused on the following major areas:

Antioxidant capacities, due to the presence of beta carotene, anthocyanins, caffeoylquinic acid and caffeoylquinic acid derivatives (Dini *et al.* 2006; Oki *et al.*, 2006; Oki *et al.*, 2002).

Antidiabetic properties due to flavones and proteins (Miyazaki *et al.*, 2005; Zhao *et al.*, 2007; Berberich *et al.*, 2005).

Antiviral activity, due to caffeoylquinic acid derivatives (Kwon *et al.*, 2000).

Anti-HIV, anti-diabetic, anti-inflammatory, hepatoprotective, gastro protective, hypolipidemic and anti-atherosclerotic effects due to triterpene saponins (Ka-

shiwada *et al.*, 1998; Banno *et al.*, 2004; Saraswat *et al.*, 1996; Lee *et al.*, 2001; Min *et al.*, 1999).

Anti-tumor effect at various stages of tumor development, including tumorigenesis inhibition, tumor promotion, induction of tumor cell differentiation, angiogenesis and metastasis inhibition (Lee *et al.*, 2001; Somova *et al.*, 2003; Liu., 2005; Lee *et al.*, 1994; Cardenas *et al.*, 2004).

#### Antioxidant Properties

Sweet potatoes and preparations made from the leaves of the sweet potato plant are powerful antioxidants (Ching *et al.*, 2001). The plant's antioxidant activity is associated with its alpha-tocopherol content, which is the most common form of vitamin E, and comprises 25 mg per 100 g of sweet potato shoots (Ching *et al.*, 2001; Maeshima *et al.*, 1985).

The major phenolic components in a 70% methanol extract of sweet potatoes showed strong antioxidant activity in a linoleic acid-aqueous system (Hayase *et al.*, 1984).

Purple sweet potato color (PSPC) anthocyanic foods have been shown to offer protection against a variety of degenerative disease processes. Immature roots and leaves at the initial stages of growth have the highest concentration of phenolics and antioxidant activity.

Anthocyanins of purple sweet potato (PSP) have antioxidant activity (Kazuko *et al.*, 2010). The antioxidant activity of anthocyanins from an extract of the tuber of PSP was evaluated. The anthocyanins from PSP were found to show stronger DPPH (1,1-diphenyl-2-picrylhydrazyl) radical scavenging activity than anthocyanins from red cabbage, grape skin, elderberry, or purple corn. Eight major components of the anthocyanins from PSP showed higher levels of activity than ascorbic acid. DPPH radical scavenging activity in collected urine samples increased in PSP anthocyanin-

injected rats and in 6 PSP beverage-administered human volunteers (Kazuko et al., 2010).

In another study, elevation of plasma transaminase activities induced by carbon tetrachloride was depressed in rats that were administered PSP solution (Mitsuyoshi et al., 2005). The two components cyanidin 3-O-(2-O-(6-O-(E)-caffeoyl- $\beta$ -D-glucopyranocyl)- $\beta$ -D-glucopyranoide)-5-O- $\beta$ -D-glucopyranoside and peonidin 3-O-(2-O-(6-O-(E)-caffcoyl- $\beta$ -D-glucopyranocyl)- $\beta$ -d-glucopyranoide)-5-O- $\beta$ -D-glucopyranoside, which were detected in the plasma, protected low density lipoprotein from oxidation at physiological concentration. These results indicate that PSP anthocyanins have activity *in vivo* as well as *in vitro* (Mitsuyoshi et al., 2005).

### Hypoglycemic Activity

Sweet potato is also helpful in normalizing blood glucose levels. The extract of white skinned sweet potato (WSSP) called Caiapo reduces insulin resistance if administered in a high dose (Kusano et al., 2000; Kusano et al., 2001). The anti-diabetic activity of WSSP versus troglitazone was examined in rats over 8 weeks. After starting oral dosing with WSSP, hyperinsulinemia was reduced by 23%, 26%, 60% and 50%, at 3, 4, 6, and 8 weeks, respectively. WSSP also inhibited increases in blood sugar levels after administration of a glucose challenge test during the 7<sup>th</sup> week. Histology of the pancreas showed re-granulation of pancreatic islet beta cells (Kusano et al., 2000; Kusano et al., 2001).

Attenuating effects of the extract of WSSP on fasting plasma glucose, total, and low-density lipoprotein (LDL) cholesterol in type 2 diabetic patients were measured (Ludvik et al., 2002; Ludvik et al., 2003). A 6-week, prospective, placebo-controlled, randomized, double-blind study involving 18 male patients examined the effects of caiapo. Patients were randomized into 3 groups and received a total of 4 tablets daily containing placebo, caiapo 168 mg, or caiapo 336 mg. Outcome measures assessed included an intravenous glucose tolerance test and oral glucose tolerance test. Overall, only high-dose caiapo improved metabolic control by decreasing insulin resistance without affecting body weight. No serious side effects were observed (Ludvik et al., 2002; Ludvik et al., 2003).

Type 2 diabetic patients treated by diet were given Caiapo once daily for 12 weeks. Each patient underwent an oral glucose tolerance test (OGTT) at baseline and after 1, 2, and 3 months to assess 2-h glucose levels. Fasting blood glucose, HbA<sub>1c</sub>, total cholesterol, and triglyceride levels were also measured. After treatment with Caiapo, HbA<sub>1c</sub> decreased significantly, fasting blood glucose levels were significantly decreased, mean cholesterol was significantly lower, and no significant changes in triglyceride levels or blood pressure were observed when compared to patients receiving placebo (Ludvik et al., 2004; Holman et al., 1999; Saloranta et al., 2002).

### Wound healing Effect

The effects of aqueous, alcoholic and petroleum ether extracts of tubers of *Ipomoea batatas* on excision, incision and dead space wound healing were studied in rats (Chimkode et al., 2009). The petroleum ether extract exhibited significant closure of scar area for complete epithelization and scar area after complete epithelization when compared with control in excision model. It also showed significant increase in tensile strength when compared with control in incision and dead space models (Chimkode et al., 2009).

The healing effect of sweet potato fibre was evaluated for burns or decubital wounds in rats over 19 days. Outcome measures included reduction in size and changes in quality of the wounds. Rats treated with the sweet potato fibre covering had reduced wound areas when compared with controls (Suzuki et al., 1996).

### Antiulcer Activity

The effects of sweet potato fermentation filtrate (SPF) on ethanol induced gastric ulcer in rats were investigated (Kim et al., 2008). Fractions of SPF were orally treated 30 min before oral administration of absolute ethanol and intravenous injection of 1% Evan's blue. One hour later, the ulcer index (mm of ulcer lesions) was measured, and dye leakage on the gastric wall was quantified by extracting the dye with formamide. SPF and its liquid portion near-fully prevented the ethanol-induced gastric ulcer and significantly reduced the Evan's blue leakage, while the purified anthocyanins were ineffective.

Among subfractions, butanol fraction of SPF-liquid portion exerted substantial antiulcer activity which was superior to water and methanol fractions, thus, demonstrating that the butanol fraction of SPF-liquid portion contains active ingredients. Therefore, it is suggested that SPF or its butanol fraction could be a potential candidate for the attenuation of gastric ulcers induced by excessive drinking of alcohol, although the action mechanisms remain to be clarified (Kim et al., 2008).

### Anti-inflammatory Activity

Ipomotaosides A-D (1-4), the resin glycosides were isolated from the dried aerial parts of *Ipomoea batatas*. The structures of Ipomotaosides A-D (1-4) were elucidated by analysis of their spectroscopic data and by chemical derivatization and were tested for their anti-inflammatory activity against COX 1 and 2 (Kazuko et al., 2010). Ipomotaosides A-D (1-4) were found to have inhibitory activity against COX-1 and COX-2 (Kazuko et al., 2010).

### Antimutagenicity

Antimutagenicity of the water extracts prepared from the storage roots of sweet potato with different flesh colors was investigated using *Salmonella typhimurium* TA 98 (Yoshimoto et al., 1999). The extract from the

whole roots of the purple colored Ayamurasaki variety effectively decreased the reverse mutation induced by heterocyclic amines viz., Trp-P-1 (3-amino-1,4-dimethyl-5H-pyrido[4, 3-b]indole), Trp-P-2 (3-amino-1-methyl-5H-pyrido [4,3-b]indole), IQ (2-amino-3-methylimidazo[4,5-f]quinoline), B[a] P (benzo[a]pyrene) and 4-NQO (4-nitroquinoline-1-oxide) as well as by grilled beef. Comparison of the inhibitory activity of the extracts from the normal Ayamurasaki variety and its anthocyanin-deficient mutant suggested that the anthocyanin pigment in the flesh decreases the mutagenic activity induced by the above mentioned mutagens. Two anthocyanin pigments purified from purple-colored sweet potato, 3-(6,6'-caffeylferulylsophoroside)-5-glucoside of cyanidin (YGM-3) and peonidin (YGM-6) effectively inhibited the reverse mutation induced by heterocyclic amines, Trp-P-1, Trp-P-2, and IQ in the presence of rat liver microsomal activation systems (Yoshimoto *et al* 1999; Nakasuget *et al*, 2000).

The caffeoylquinic acid derivatives, 3-mono-*O*-caffeoylquinic acid (chlorogenic acid, ChA), 3,4-di-*O*-caffeoylquinic acid (3,4-diCQA), 3,5-di-*O*-caffeoylquinic acid (3,5-diCQA), 4,5-di-*O*-caffeoylquinic acid (4,5-diCQA) and 3,4,5-tri-*O*-caffeoylquinic acid (3,4,5-triCQA), and caffeic acid (CA) were isolated from the sweet potato (*Ipomoea batatas*) leaf (Yoshimoto M *et al.*, 2002). These caffeoylquinic acid derivatives effectively inhibited the reverse mutation induced by Trp-P-1 on *Salmonella typhimurium* TA 98. The antimutagenicity of these derivatives was in the order of 3,4,5-triCQA>3,4-diCQA=3,5-diCQA=4,5-diCQA>ChA. A comparison of the activities and structures of these compounds suggested that the number of caffeoyl groups bound to quinic acid played a role in their antimutagenicity (Yoshimoto *et al.*, 2002)

### Cardiovascular Effect

An extract of sweet potato was examined for relaxant activity on isolated rat vascular aortic preparations (Runnie *et al.*, 2004). Sweet potato showed 97% relaxation activity in endothelium-intact aortic ring preparations but only 35% in the mesenteric vascular bed. The mechanism of action of this vaso-relaxation is similar to that of the pharmacological agent acetylcholine (Runnie *et al.*, 2004).

### Hepatoprotective Effect

Many studies indicate that purple sweet potato anthocyanins exert hepatoprotective effects in healthy volunteers with borderline hepatitis and in rats treated with carbon tetrachloride (Suda, *et al.*, 2008). Another study was designed to explore whether purple sweet potato color (PSPC) protected mouse liver from D-galactose-induced injury by attenuating oxidative stress or suppressing inflammation (Zhang *et al.*, 2009). The histology changes of mouse liver were assessed by hematoxylin and eosin staining. The results showed that PSPC could effectively suppress the d-galactose

induced histology changes including structure damage and leucocyte infiltration in mouse liver. Oxidative stress and antioxidant status in mouse liver were also analyzed. The results showed that PSPC could largely attenuate the d-galactose-induced MDA (lipid peroxidation product malondialdehyde) increase, and could markedly renew the activities of Cu, Zn-SOD (superoxide dismutases), CAT (catalase) and GPx (glutathione peroxidase) in the livers of d-galactose treated mice. Furthermore, the results of western blot analysis showed that PSPC could inhibit upregulation of the expression of NF- $\kappa$ B (nuclear factor- $\kappa$ B) p65, COX-2 (cyclooxygenase-2) and iNOS (inducible NO synthase) caused by d-galactose. In conclusion, our data suggested that PSPC could protect the mouse liver from d-gal-induced injury by attenuating lipid peroxidation, renewing the activities of antioxidant enzymes and suppressing inflammatory response (Zhang *et al.*, 2009).

### Immunomodulatory Effect

The modulatory effect of dietary supplementation of purple sweet potato (*Ipomoea batatas* Poir, PSP) on the immune response in chickens was determined (Hanieh *et al.*, 2010). PSP was included in a basal starter diet at 1% or 3% concentration and continually fed to the chickens. Newcastle disease (NDV) vaccine, *Brucella abortus* (BA) and sheep RBC (SRBC) were used for chicken immunization. To estimate humoral immunity, antibody titres against these antigens were used. Ratios of CD4- and CD8-single positive and CD4-CD8-double negative cells in splenocytes and Concanavalin A (Con A)-induced proliferations of splenocytes, thymocytes and peripheral blood lymphocytes (PBL) were used to indicate cellular immunity. Relative weights of spleen, thymus and bursa and white blood cell (WBC) counts were studied. PSP increased anti-NDV, anti-BA, and anti-SRBC titres in response to secondary immunization. Proliferation of PBL, weights of lymphoid organs and WBC counts were not affected. These results suggested that dietary PSP supplementation could enhance the immune response after immunization in chickens (Hanieh *et al.*, 2010).

The purified sweet potato polysaccharide (PSPP) isolated from the roots of *Ipomoea batatas* was found to be a glucan (Zhao *et al.*, 2005). On the basis of methylation analysis, periodate oxidation, Smith degradation, infra-red spectroscopy, and  $^{13}\text{C}$  NMR, the polysaccharide was confirmed as a (1 $\rightarrow$ 6)- $\alpha$ -d-glucan. The effect of polysaccharide PSPP on the *in-vivo* immune function of mouse was evaluated (Zhao *et al.*, 2005). Mice were treated with the polysaccharide PSPP for 7 days and various parameters like phagocytic function, proliferation of lymphocytes, natural killer cell activity, hemolytic activity, and serum IgG concentration were evaluated. There were significant increments in proliferation of lymphocytes, serum IgG concentration and immunological indices. A dose-dependency was demonstrated in phagocytic function, hemolytic activity, and

serum IgG concentration, but not in proliferation of lymphocytes and natural killer cell activity. This suggests that PSPP improves the immune system and could be regarded as a biological response modifier.

### Anti-proliferative Activity

The anti-proliferative activity of sweet potato was studied *in vitro* using human lymphoma NB4 cells isolated from long-term cultures of leukemia blast cells on bone-marrow stromal fibroblasts (Huang *et al.*, 2004). NB4 cell proliferation was inhibited in a dose-dependent manner after exposure to different extracts of sweet potato. The water extract of the veins of sweet potato had higher anti-proliferative activity than the water and ethanol extracts of the storage root and leaf. The ethanolic extract of the veins had no anti-proliferative activity under the experimental conditions. The inhibition of tumor cell proliferation *in vitro* however, could not be solely explained by the concentration of phenolic/flavonoid compounds.

### Antifungal Activity

In sweet potatoes, research on antifungal compounds has focused on injury- and disease-induced compounds, particularly the furanoterpene and butenolide phytoalexins, which are found only in diseased tissues (Schneider *et al.*, 1984). However, caffeic acid and its derivatives have also been shown to increase in response to injury and infection (Uritani *et al.*, 1955; Akazawa *et al.*, 1961; Tanaka *et al.*, 1977). An investigation of the distribution of phenolics in healthy sweet potato roots using histo-chemical methods showed that they were localized in several tissues, including the periderm and tissue approximately 1 mm beneath it (Schadel *et al.*, 1981). A study on the chemical composition of the exterior 3 mm of sweet potato roots revealed that caffeic acid, chlorogenic acid, and two isomers of dicaffeoylquinic acid were the predominant phenolic compounds present (Son *et al.*, 1991).

*Rhizopus stolonifer* Vuill is a fungus that invades sweet potato roots and causes a disease called 'soft rot' (Harter *et al.*, 1918; Clark *et al.*, 1994). The soft rot is known to cause losses world-wide, and in the south eastern United States, it is generally the most serious post-harvest disease of the sweet potato crop (Clark *et al.*, 1988). The physiology of the disease is poorly understood (Srivastava *et al.*, 1959). Despite its prevalence, incidence of the disease is often erratic, even when roots are artificially wounded and inoculated. However, not all injuries are equally susceptible to infection; shallow injuries (1–2 mm deep) are less prone to infection than deeper injuries (>5 mm deep) (Stange *et al.*, 2001). To test this hypothesis, a quantitative bioassay for measuring the growth of *R. stolonifer* utilizing the vital stain 3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide (MTT) was developed by Stange *et al.* In their study, acetone extracts of the fresh interior flesh of sweet potato exhibited no antifungal activity, but extracts of the exterior 2 mm of the

root were inhibitory to *R. stolonifer*. Acetone extracts of fresh flesh, peel and cured flesh of sweet potato were prepared. Two active fractions of the above extracts were isolated. The active fraction obtained from the extract of the fresh interior flesh contained predominantly caffeic acid, but this compound was determined not to be the most biologically active component. The second active fraction obtained from the peel extract contained 3,5-dicaffeoylquinic acid (3,5-DCQA), and this compound was found to be active, with a higher EC<sub>50</sub> value. The presence of antifungal compounds in the external tissues thus, explains why injuries are resistant to fungal infection. Additionally, Stange *et al.* demonstrated that interior flesh tissues accumulate antifungal compounds when incubated under curing conditions (30°C and 90–95% RH) for 24 h (Stange *et al.*, 2001).

### ANTIMICROBIAL ACTIVITY

The antimicrobial activity was studied on the crude extract of the leaves of the plant by agar disk and agar well diffusion tests (Pochapski *et al.*, 2011). The freeze dried extract of sweet potato leaf was dissolved in an aqueous solution of 50% (v/v) dimethyl sulfoxide (DMSO) in order to obtain 5%, 10%, and 15% sample solutions. These solutions were not able to inhibit the growth of *Streptococcus mutans*, *S. mitis*, *Staphylococcus aureus*, and *Candida albicans* in both agar disk and agar well diffusion tests (Pochapski *et al.*, 2011).

### Miscellaneous

Leaves and roots of *Ipomoea batatas* have a higher nutritional value than the common potato. *Ipomoea batatas* is a good source of vitamins A, B and C, iron, calcium and phosphorus. High in carbohydrates, tubers are used in starch and industrial alcohol production. There have been anecdotal reports of the use of *Ipomoea batatas* in dengue, with improvement in platelet counts.

As a nutraceutical, sweet potatoes can be made into liquid and semi-solid food products such as beverages, soups, baby foods, ice cream, baked products, restructured fries, breakfast cereals, and various snacks and desserts (Collins & Walter 1992).

Sweet potato also finds other applications. In South America, the juice of red sweet potatoes is combined with lime juice to make a dye for cloth. By varying the proportions of the juices, every shade from pink to black can be obtained. All parts of the plant can be used for animal fodder. Sweet potatoes or camotes are often found in Moche ceramics. Several selections are cultivated in gardens as ornamental plants for their attractive foliage, including the dark-leaved cultivars 'Blackie' and 'Ace of Spades' and the chartreuse-foliaged 'Margarita'. The species called wild sweet potato vine / man root / man-of-the-earth is not edible, but it is cultivated as an ornamental vine. Researchers at North Carolina State University are breeding sweet

potato varieties that would be grown primarily for bio-fuel production (Bowen 2010).

### CONTRAINDICATIONS, TOXICITY AND DOSAGE

Historical and clinical data document no serious adverse reactions. Patients with known hypersensitivity reactions to the plant may develop generalized urticaria, hypotension, and edema of the hands and face (Velloso *et al.*, 2004). Other case reports also document dizziness, loss of consciousness, nausea, vomiting, and a sensation of tickling and tightness in the throat (Velloso *et al.*, 2004).

Very little toxicity data is available for the plant. Animal studies document temporary neurological effects followed by extensive liver necrosis for 3 sesquiterpenoids in sweet potato with a median lethal dose varying from 184 to 266 mg/kg (Wilson *et al.*, 1979). Sweet potato consumption should be avoided by individuals hypersensitive to any of the chemical components in the plant species. No drug interaction data could be found in medical literature.

Clinical studies testing the efficacy of the nutraceutical caiapo used a total of 4 tablets daily, with each tablet containing caiapo 168 to 336 mg. Sweet potato (caiapo) is available in powder and capsule forms. Dosage regimens vary, but most commercial manufacturers suggest 2 capsules, 30 minutes before meals, up to a total of 6 capsules daily.

### CONCLUSION

*Ipomoea batatas* (sweet potato), a common food crop has many medicinal and historical uses. The plant contains a range of phytochemical substances credited with various pharmacological properties. Thus, it can be utilized as a potential agent for treatment of various ailments in the near future. Further research is to be done to unravel the hidden medicinal qualities of this plant.

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