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# HEALTH BENEFITS AND THERAPEUTIC APPLICATIONS OF *IPOMOEA BATATAS*: A SYSTEMATIC REVIEW

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**ABSTRACT**

Sweet potatoes (Ipomoea batatas [L.] Lam) have emerged as a popular research focus in recent years due to their special nutritional and functional characteristics. It is a crop that is grown all over the world and has been accepted as a functional food because of several of its nutraceutical components. The leaves and roots of the sweet potato contain a variety of nutrients, including bioactive carbohydrates, proteins, carotenoids, flavonoids, anthocyanins, phenolic acids, and minerals. According to several experimental studies, sweet potatoes can generally be helpful in the prevention or treatment of chronic diseases due to their antioxidant, anti-inflammatory, immunomodulatory, anticancer/antitumor, antimicrobial, anti-diabetic, anti-obesity, cardioprotective, and antiulcer activities. These factors make it a subject that draws people's attention. This review contains information on the therapeutic uses of sweet potatoes, which will be helpful for new researchers and practitioners in their search for various health advantages of Ipomoea batatas.

**KEYWORDS:** Sweet potato, Chronic diseases, *Ipomoea batatas*, Phytochemical composition, *in vitro* and *in vivo* models.

## INTRODUCTION

The sweet potato, *Ipomoea batatas* (L.) Lam, is a perennial plant that is a member of the morning glory family, or *Convolvulaceae*.[1] It is a well-liked staple food of the tropical and subtropical regions, and its increased cultivation and consumption confirm to its nutritional benefits.[2] Mostly, sweet potatoes are picked for their tubers. The leaves are, nevertheless, occasionally used in place of other leafy vegetables. It is the sixth most significant food crop in the world and includes phytochemicals that are crucial for human health.[3,4] In addition to being a good source of dietary fibre, antioxidants, vitamins, and minerals, sweet potato root tubers also have no cholesterol or saturated fats. Sweet potato leaves have more polyphenols than any other commercial vegetable, including spinach, cabbage, and lettuce, according to a study by Islam *et*. According to him, sweet potato leaves contain six polyphenolic chemicals and at least 15 anthocyanins.[3]

**Figure 1: Sweet potato (Ipomoea *batata*).**

According to a number of reports, sweet potatoes contain phytochemicals that offer multiple health benefits for people. These benefits include being anti-oxidants, anti-mutagenic, anti-inflammatory, antibacterial, and anti-carcinogenic.[5] There are many distinct sweet potato types growing around the world, and they are all typically distinguished by having varied flesh colours and different phytochemical contents. Plant types can naturally vary in terms of their nutritional content and the bioactivities of the phytochemicals they possess.[6,7]

In 115 countries, there were 112.8 million tonnes of sweet potatoes produced in 2017. China was the largest producer, followed by Nigeria, Tanzania, Indonesia, and Uganda.[8] The production and consumption of sweet

potatoes has recently increased significantly throughout Africa, Asia, South America, and Caribbean islands. Since sweet potatoes naturally grow and are devoured by pitiful networks, especially by families headed by women, they are praised as a "helpless man's" crop.[9,10] According to reports, the sweet potato is an excellent source of polyphenols, terpenoids, saponins, glycosides, alkaloids, steroids, and other biologically active substances.[11] The main bioactive components are phenolic compounds such as phenolic acids (e.g., caffeic acid, monocafeoyl quinic (chlorogenic acid), caffeoylquinic acid (CQA) derivatives (primarily mono-CQA, di-CQA, and 3,4,5-triCQA), p-coumaric acid, sinapic acid, hydroxybenzoic acids, and p-anisic acids), flavonoids (e.g., quercetin, myricetin, luteolin, and apigenin, etc.), and anthocyanins (cyanidin-, peonidin- and pelargonidin-derivatives. Considering the fact that phenolic acids and flavonoids are often present in sweet potatoes of all flesh colours, anthocyanin is only present in purple-fleshed sweet potatoes.[12] Studies conducted in vivo and *in vitro* have shown that certain chemical components in sweet potatoes have the ability to both prevent and treat a variety of diseases. Sweet potatoes include phenolic, anthocyanin, and phytosterol substances that have been linked to biological activity. Phenolic compounds are secondary metabolites and naturally occurring substances that contain one or more phenol groups and are well-known for their antioxidant effects. They are thought of as potential medicinal agents because of their various and distinctive structural arrangements. However, there may not be a direct correlation between antioxidants and the biological activities of sweet potatoes that are related to their cardioprotective, anti-cancer, anti-diabetic, hepatoprotective, antitumor, antimicrobial, and anti-inflammatory biological activities.[13] The goal of this review is to give readers an updated picture of the therapeutic potentials of sweet potato.


**Figure 2: Health Benefits of Ipomoea batatas.**

**Anti-cancer activity**

Modern chronic diseases, particularly cancer, are among the most common health conditions with significant fatality rates worldwide. One in six fatalities globally are caused by cancer, which also claims about 70% of lives in low- and middle-income nations. Alongside conventional medical therapies, the use of complementary and alternative medicine for cancer treatment has increased. A lot of people utilise complementary therapy to help manage conditions like depression, arthritis, asthma, and cancer.[14] Several studies employing various cancer cell lines have suggested that sweet potatoes have anticancer effects by preventing cancer cell growth and promoting apoptosis.[13]

Lam Chenfeng Ji *et al.*, reported the isolation of a new glucan PSPP-1(Purple sweet potato polysaccharide) (18.3 kDa) from the foot tuber of the purple sweet potato *Ipomoea Batatas (L.) Lam* and they found Hydroxycamptothecin inhibited the growth on the MCF-7, SGC-7901, HGC-27, LOVO, and HepG2 cells by 74.9%, 60.1%, 64.4%, 70.8%, and 59.6%, respectively. Sweet potatoes may have partial anti-cancer properties because PSPP-1 treatment had dose-dependent inhibitory effects on human hepatoma cell HepG2 (24% at 125 g/mL), human colonic carcinoma cell line LOVO (30% at 125 g/mL) and human breast carcinoma cell line MCF-7 (25% at 125 g/mL). Human normal colon epithelial cell NCM460, human normal breast epithelial cell line MCF-10A, and human normal hepatocyte LO2 did not respond to PSPP-1. These findings suggested that PSPP-1, with a broad safe dosage range, would be useful in treating human liver, colon, and breast malignancies, but not gastric cancer.[15]

Meng Meng *et al.*, evaluated extract from purple sweet potato, a polysaccharide known as PSP was isolated and purified using hot water extraction, ethanol precipitation, deproteinization with Sevag reagent, and column chromatography using Sephadex G-100. Then *in vitro* antitumor efficacy of PSP was investigated using HT-29

cells. SEM, AO staining, MDC staining, and hoechst 33342 staining were also carried out to investigate the impact of PSP on the apoptosis of HT-29 cells. They found that the PSP can dramatically reduce HT-29 cells' ability to proliferate by inducing apoptosis.[16]

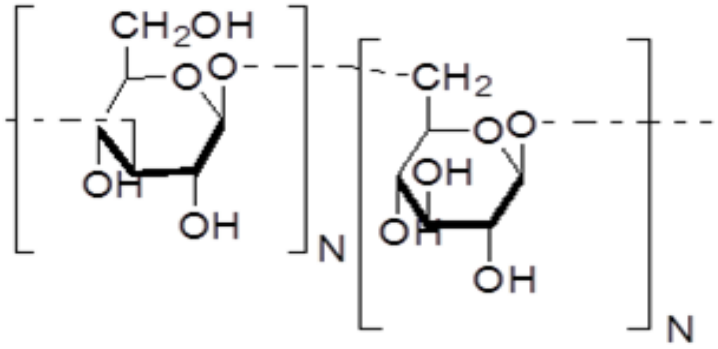


**Figure 3: Basic molecular structure of glucan molecule- PSPP.**

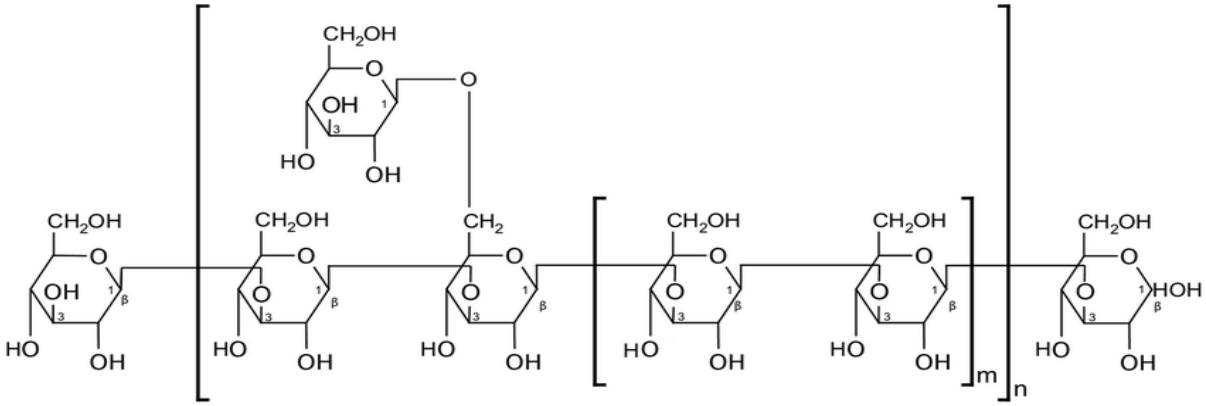


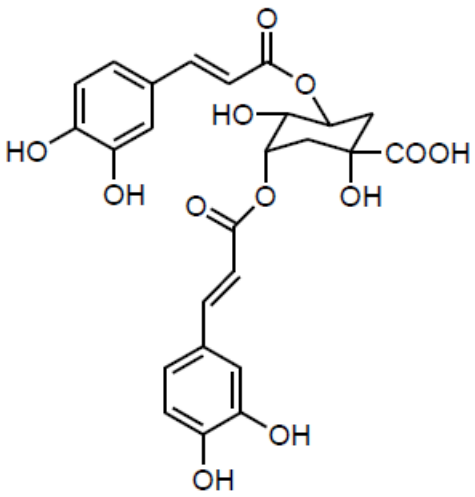
**Figure 4: Structure of Partial Soluble Polysaccharide (PSP).**

Cheng Tian *et al.*, investigated through the sequential processes of heating precipitation, dialysis, and DEAE-52 cellulose chromatography purification, a novel small molecule glycoprotein SPG-8700 with potential anticolorectal cancer activity was first isolated from a novel sweet potato variety by homogenate. And they further research was done on HCT-116 cells and nude mice in order to confirm the anti-colon cancer activity and investigate potential mechanisms of sweet potato glycoprotein. Comparing the therapy group of mice to the tumor-controlled group, the three serum tumour markers decreased after SPG-8700 treatment. By triggering apoptosis, SPG-8700 dramatically reduced the tumour growth in nude mice bearing the HCT116 gene.[17]

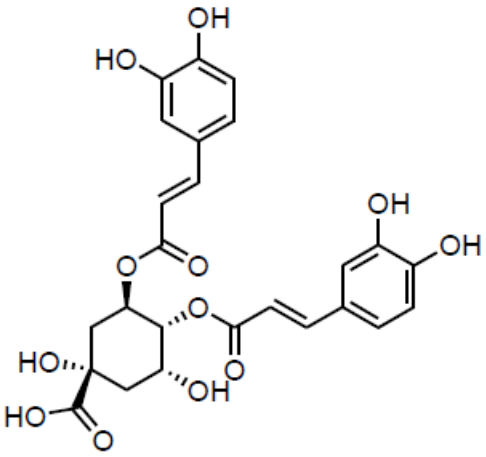
**Anti diabetic activity**

Hyperglycemia (high blood glucose levels) and glucose sensitivity are symptoms of type 2 diabetes mellitus (T2DM), a metabolic disorder that impairs insulin secretion or the ability of insulin to increase glucose uptake. T2DM can be brought on by a variety of circumstances, including obesity, stress, a sedentary lifestyle, and genetics that affect insulin secretion or resistance.[18] The 2019 International Diabetes Federation report estimates that 450 million adults globally have diabetes, with an additional 700 million cases anticipated by 2045.[19] Sweet potatoes can be efficiently used as a possible agent for controlling T2DM because they have showed promise as inexpensive anti-diabetic medicines. Phytochemicals like flavonoids, phenolic acids, anthocyanins, saponins, alkaloids, glycosides, terpenes, etc. help them to achieve this.[20,21]

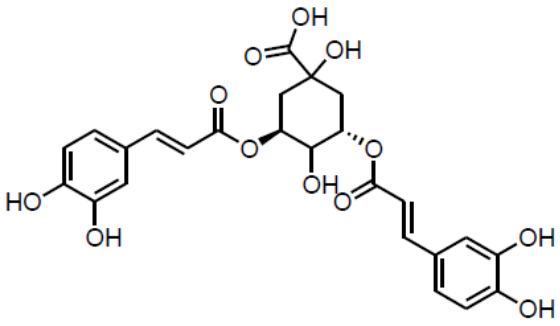
Chae Young Hong *et al.*, evaluated 80% (v/v) methanol-water extract of sweet potato tips and tubers. Acarbose was used as a positive control to test the α -glucosidase inhibitory activity. An anti-diabetic drug called acarbose which was employed in the experiment displayed 84.49% activity at 1 mg/ml. They observed that the anti-diabetic activity considerably increased as extract concentration was raised; it shown inhibitory activity between 36.17% and 69.57% at 1 mg/ml. Also, for Pungwonmi tips and acarbose, antidiabetic activity reached as high as 69.57% and 82%, respectively. 3,4-dicaffeoylquinic acid, 3,5-dicaffeoylquinic acid, and 4,5-dicaffeoylquinic acid were found to have excellent inhibitory effects on maltase and 3,4,5-triCQA in diabetic model mice in a study by Matsui et al. (2004).[22]



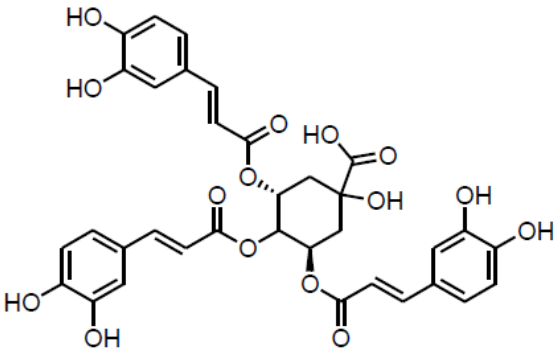
4,5-Di- caffeoylquinic acid



3,4-Di-caffeoylquinic acid



3,5-Di-caffeoylquinic acid



3,4,5-Tri-caffeoylquinic acid

**Figure 5: Structures of Di and Tri caffeoylquinic acid (phenolic acids).**

Naheed Akhtar *et al.*, studied methanolic extracts of *Ipomoea batatas* root and Peel-off from white skinned sweet potatoes (WSSP; *Ipomoea batatas L.*) was chosen to investigate the antidiabetic potential and effects on specific biochemical markers in Wistar rats which has diabetics induced by alloxan. They concluded that due to the presence of bioactive substances such glycoprotein, anthocyanins, alkaloids, and flavonoids, which function as insulin-like molecules or insulin secretagogues elements in sweet potatoes peel-off, WSSP extract has the potential to treat diabetes. These antidiabetic proteins were extracted out in more concentration in methanol due to its organic nature.[23]

Rui Zhao *et al*., isolated flavone from the water extract of *Ipomoea batatas* leaf material. A one touch II micro blood glucose instrument measured the serum glucose. Blood from the rats' eyes was taken at the end of the experiment. Finally, they observed the flavone derived from *ipomoea batatas* leaves regulate blood sugar levels and glucose metabolism.[24]

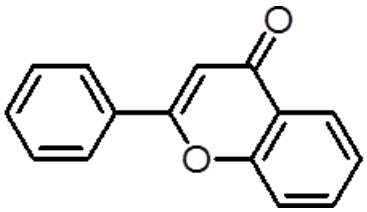


**Figure 6: Structure of Flavone.**

**Anti-microbial activity**

Based on a variety of variables, including bacterial strains, sweet potato genotypes, extracting solvent (water or ethanol-based extract), and methodologies for evaluating *in vitro* antimicrobial activity, different portions of the sweet potato had varying levels of antimicrobial activity.[25,26]

Obum-Nnadi *et al.*, extracted by using a Soxhlet extractor, the extract of homogenised Ipomoea batatas L. leaves was produced and the agar-well diffusion method was used to test the antibacterial effectiveness. Additionally, the extracts' Minimum Bactericidal Concentration (MBC) and Minimum Inhibitory Concentration (MIC) were calculated. They found that antibacterial activities of cold extracts were more potent than those of hot extracts. *Ipomoea batatas L.*

tuber cold extracts have antibacterial action against *Escherichia coli*, *Staphylococcus aureus*, and *Streptococcus pyogenes*. *Ipomoea batatas L*. bark hot extracts (HE) exhibit antibacterial action against *Serratia marcescens*.[27]

Sri Agung Fitri Kusuma *et al*., investigated ethanolic extract of sweet potato leaves by using the maceration technique. Then agar diffusion method was used to conduct the antibacterial activity test. Macro dilution was used to conduct the MIC test. The sweet potato leaves extract underwent phytochemical examination, which identified the presence of flavonoids, tannin, steroids, and polyphenolic compounds. They concluded that the *Shigella dysenteriae* ATCC 13313 was significantly inhibited by an ethanol extract of sweet potato leaves with a dose-dependent zone of inhibition, and the MIC ranged from 10% to 20% w/v.[28]

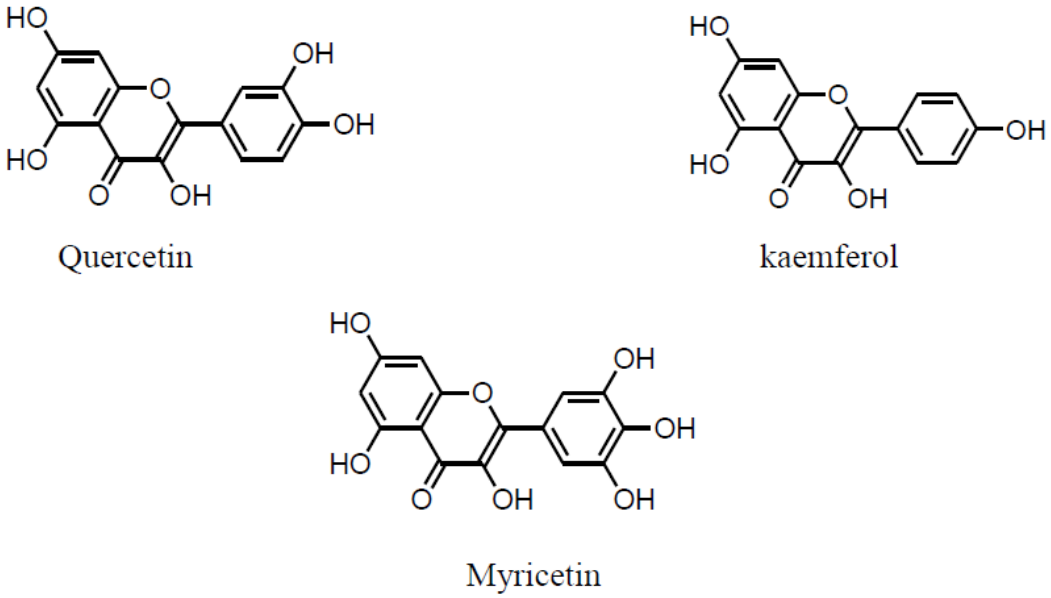



**Figure 7: Structures of Flavanoids.**

**Cardioprotective activity**

The prevalence of cardiovascular diseases (CVDs) is increasing, and they have spread throughout the world. The World Health Organisation (WHO) (2017) states that CVDs are one of the greatest threats to public health, accounting for 17.9 million fatalities in 2016 (or 31% of all deaths worldwide), with more than 75% of those deaths occurring in low- and middle-income nations. CVDs place a heavy strain on people, communities, and nations because they not only result in significant morbidity and mortality but also severe impairments and lower patient living conditions. A set of chronic, non-infectious disorders known as cardiovascular diseases (CVDs) are brought on by serious, complex risk factors include high blood pressure, hyperlipidemia, diabetes, obesity, metabolic syndrome, smoking, excessive alcohol use, an imbalanced diet, and a sedentary lifestyle.[29]

Fidele Ntchapda *et al*., evaluated the aqueous extract of *Ipomoea batatas* leaf and studied in a rat model of diet-induced hypercholesterolemia. The aqueous extract of *Ipomoea batatas* leaves was found to have hypolipidemic and anti-atherosclerogenic activities. Treatment with the extract reduced these changes and returned blood sugar and blood lipid levels to normocholesterolemic levels in hypercholesterolemic rats. This indicate that the leaves of *Ipomoea batatas* are hypolipidemic and anti-atherosclerogenic.[30]

Shafe, M *et al*., isolated aqueous extract of *Ipomoea batatas* tuber and studied to see how it affected Wistar rat organ weights, cardiac enzyme levels, and lipid profiles. The collected serum was used to analyse the levels of triglyceride, total cholesterol, low density lipoprotein, and high-density lipoprotein activity, as well as creatine kinase (CK-MB), creatine kinase (CK), lactate dehydrogenase (LDH), and other enzymes. The serum creatine kinase (CK-MB) and lactate dehydrogenase activity were considerably (P 0.05) lowered after receiving the extract at doses of 200 and 800 mg/kg b w. The results point to the aqueous tuber extract of *Ipomoea batatas* has cardio-protective properties at the levels examined.[31]

**Anti-oxidant activity**

The antioxidant activity of sweet potatoes varies significantly depending on the plant's sections, such as the roots, leaves, and so forth, as well as the varieties, intensity of the flesh colour (such as purple, orange, yellow, or white), and the product sources (such as cooked, baked, fried, flour, emulsion). The extraction techniques used (both traditional and modern procedures) have an impact on the antioxidant properties of the produced crude extracts or sweet potato fragments, but other factors (such as the liquid to solid ratio, temperature, time, pH, particle size, solvent choice) also have a role.[13]

**Figure 8: white, orange and purple coloured sweet potatos.**

Gokhan Zengina *et al.*, discovered characteristics of *Ipomoea batatas* leaf extracts for the first time, measuring their total flavonoid and phenolic component concentrations as well as the anti-oxidant activity of three different extracts using four different techniques. In all experiments, the decoction extract had the highest concentration of phenolics (89.26 mg GAE/g extract), and as a result, it had greater antioxidant power than the Soxhlet and MW extracts.[32]

Marcia Thais Pochapski *et al*., investigated the hydroethanolic extract of *Ipomoea Batata* leaves, and the total antioxidant capacity was assessed using the phosphomolybdenum complex method in triplicate. The hydroethanolic extract from SP leaves has a relative antioxidant activity of 42.94 0.89% (RSD = 2.0%) when compared to ascorbic acid. It recommends sweet potatoes as a suitable substitute for other antioxidant sources.[33]

Seow-Mun Hue *et al*., studied the *Ipomoea batatas* leaf and carotenoid extracts, and their anti-oxidant activity was compared. The reducing capability of the Ipomoea batatas is tested using the reducing power assay. When compared to leaf extracts, the carotenoids extract was able to keep the majority of its antioxidant capacity.[34]

**Anti-inflammatory activity**

Inflammation is associated with the morbidity and mortality of a number of diseases. Inflammation is mediated by mediators including cytokines, tumour necrosis factor (TNF), interleukins (IL), prostaglandins (PGs), and thromboxanes. The most prevalent inflammatory-associated disorders worldwide include rheumatoid arthritis, various carcinomas, atherosclerosis, and asthma. Sweet potatoes is an excellent candidate for evaluation as a natural therapy for preventing and regulating inflammatory diseases due to their anti-inflammatory qualities.[35,13]

Mary H. Grace *et al*., reported methanolic extracts of lyophilized sweetpotato powder and then observed that the extracts from lyophilized powders of four sweet potato cultivars (NCPUR06-020, Covington, Yellow Covington, and NC07-847) displayed genotype-dependent anti-inflammatory effects in lipopolysaccharide-stimulated human neuroblastoma cells (SH-SY5Y). Phenolic content and DPPH radical scavenging activity have been linked to anti-inflammatory properties.[36]

Jian Suna *et al*., isolated alkali-soluble polysaccharide (ASPP) purified from Purple sweet potatoes. After that, they examined the anti-inflammatory effects of ASPP in mice treated with dextran sulphate sodium, and they measured the cytokine levels in the colon and serum of each group. According to the results, ASPP reduced inflammation in mice with DSS-induced colitis by blocking pro-inflammatory cytokines such IL-1 β, IL-6, and TNF-α.[37]

Rosita Handayani *et al*., reported the ethanolic extract of dried tubers of sweet potato and by testing the 5-Lipoxygenase (5 LOX) inhibitory activity, each extract from purple, orange, and white fleshed sweet potato roots was assessed for its anti-inflammatory characteristics. The relative IC50 values for extracts from purple, orange, and white sweet potato tubers are 46.09, 52.12, and 63.69 μg/mL[38]

**Anti- obesity activity**

Obesity is a medical condition characterised by the build up of abnormal or excessive body fat brought on by an e nergy imbalance between calories consumed and burned off, which may have negative impacts on health.One of t he biggest preventable causes of death in the world today is obesity, which also raises the risk of a number of meta bolic disorders as T2DM, metabolic syndrome, and heart disease.[39] In 2016, 1.9 billion adults were deemed overweight, with more than 34% of this group categorised as obese.[40]

Hye-Jin Kim *et al*., studied methanolic extract of freeze-dried Purple-fleshed sweet potato. Researchers

investigated the anti-obesity properties of anthocyanin and carotenoid extracts from coloured potatoes using 3T3-L1 cells *in vitro* and obese mice induced by a high-fat diet (HFD) *in vivo*. Following differentiation induction, treatment of 3T3-L1 adipocytes with anthocyanin and carotenoid extracts, respectively, significantly inhibited fat accumulation by 63.1 and 83.5%. Studies on the prevention of adipogenesis revealed that the carotenoid extract influences all stages, anthocyanin extract works at intermediate stages.[41]

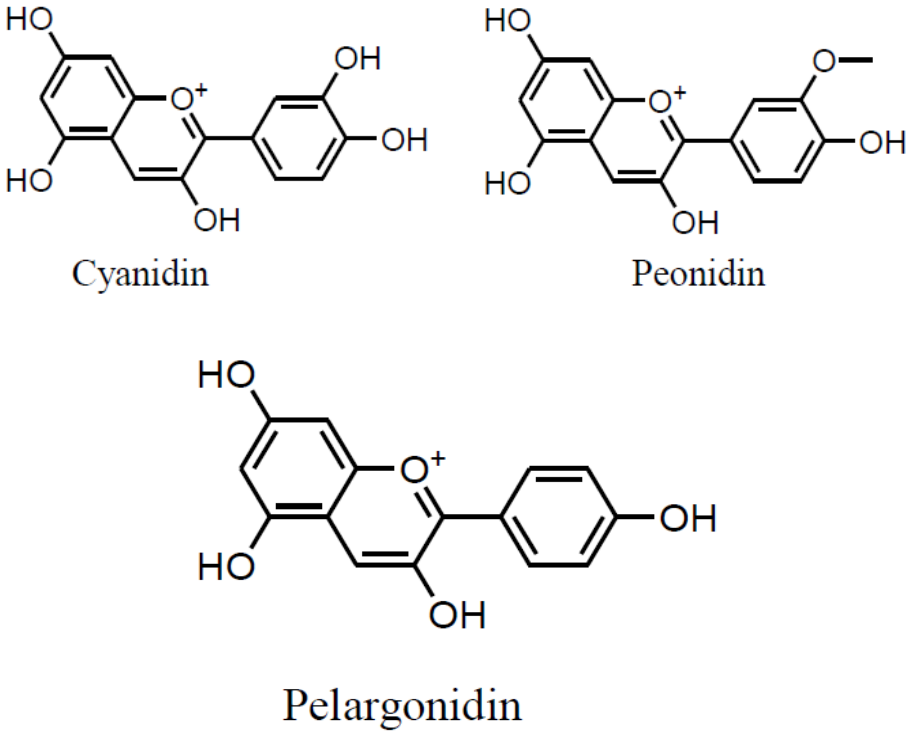



**Figure 9: Structures of Anthocyanins.**

Ronghui Ju *et al*., Studied the anti- obesity effect of purple-fleshed sweet potato by the mice were fed a high fat diet supplemented with purple-fleshed sweet potato, at concentrations of 15% and 30%, for 12 weeks. The results showed that supplementing with 30% purple-fleshed sweet potatoes decreased body weight and fat accumulation, improved lipid levels, and modulated intake of energy, all of which are correlated with high-fat diet-induced obesity and its risk factors.[42]

## CONCLUSION

Sweet potato is a worldwide food crop with nutritional and therapeutic significance that needs to be researched further. Sweet potato leaf has significant polyphenolic contents when compared to popular commercial vegetables like spinach, broccoli, cabbage, lettuce, etc. These polyphenolics are said to have immune-boosting, antimicrobial, antioxidant, anti-cancer, anti-diabetic, cardioprotective, and hepatoprotective activities. The majority of the research that was reviewed were in vitro studies; more in vivo studies involving clinical studies should be put up to validate the potential utility of sweet potatoes in treating degenerative disorders.This review highlights about the therapeutical potentials of the Ipomoea batatas.

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