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Sweet Potato (*Ipomoea batatas*[L.] Lam) – A Reviewon Its Bioprospecting

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Abstract:*Sweet potato (Ipomoea batatas (L) Lam.), a member of the Convolvulaceae family is very challenging to be explored for bioprospecting. The tuber of this plant, which contains primary and secondary metabolites, i.e. alkaloids, flavonoids, phenols, anthocyanins, carotenes, vitamins, minerals, carbohydrates, hence it can be used as processed products for human consumption, industrial use as a natural dye, and also an important source of animal feed. Sweet potato can be distinguished into orange-fleshed sweet potato (OFSP), white-fleshed sweet potato (WFSP) and purple-fleshed sweet potato (PFSP). Sweet potato also exerts biological activity such as antioxidant, anti-inflammatory, antimicrobial, antidiabetic, antimutagenic and many more benefits for health. In addition to human consumption, sweet potato can be used as dietary protein and energy source for fish and livestock which can also influence for growth performance. Of the three types, PFSP is the most potential bioprospecting for human as well as animal health. Its anthocyanin-rich contents play important role in this benefit.*

Keywords:*Sweet potato, human consumption, biological activity, dietary ingredient, energy source, fish livestock*

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I. Introduction

Sweet potato (*Ipomoea batatas*(L) Lam.) is a perennial vine crop grown originated from the Northwest of South America as well as in Asia and Africa due of its high yield potential and wide adaptability[1]. Sweet potato can survive in stressed environments, such as in drought condition, and has strong abilities to protect itself against pathogens and insect attacks [2].

[3]reported that sweet potato, cultivated in over 100 developing countries, ranks among the five most important food crops in over than 50 of those countries. Sweet potato accounts for about 107 million/tons in production per year, accounting for about 81% of total world production [4]. In addition, it is produced largely in Asia, with over 82% of the world's production, followed by Africa, with 13.98% (FAO, 2009 in [5]). Itholds first rank in nutrition among vegetables and it has a high nutritional content that varies withthe color of the tuber root[6,7].Sweet potato can be used as raw material for many industrialized products, given its composition, agricultural potential and has positive role in food security[8,9]. It iswidely used as processed products for human consumption, industrial use as a natural dye, and also an important source of animal feed [10].

There are three major categories of sweet potato cultivars, e.g. white, red/purple skinned with white/cream flesh, and are characterized by their high starch content [11]. The type of sweet potato can be distinguished into orange-fleshed sweet potato, yellow-fleshed sweet potato, white-fleshed sweet potato and purple-fleshed sweet potato.

II. Methods

This literature study was obtained from online journal-based such as Pubmed - NCBI, Elsevier, Springer, and Google Scholar. The keywords used to search data are related to "sweet potato", "sweet potato morphology", "primary and secondary metabolites", "sweet potato compound" and "the biological activity of sweet potato". Thus, a theoretical framework can be arranged in accordance with the subject matter of the discussion

III. Result

The type of sweet potato can be distinguished into orange-fleshed sweet potato, yellow-fleshed sweet potato, white-fleshed sweet potato and purple-fleshed sweet potato. Each type of sweet potato have many compound that benefit for human health. Instead of for human health, sweet potatoes are also reported can be used for as dietary protein and energy source for animal. Brief explanation of biological activity in several type of sweet potato and utilization of sweet potato for animals shown in Table no 1 and Table no 2.

Table no 1: Biological Activity in Several Type of Sweet Potato

Biological Activity	Cultivar colour description	Compound	References
Antioxidant activities	WFSP, OFSP, PFSP	Phenolic	12
Anti-cancer activity	PFSP	Phenolic	13,14; 15,16
Coronary heart disease	PFSP	Anthocyanin	17
Blood vessel	PFSP	Anthocyanin	17
Degenerative disease	PFSP	Anthocyanin	17
Anti-microbial	OFSP, PFSP	β-carotene &anthocyanin	18
Antifungal activity	PFSP	Anthocyanin	19
Anti-Inflammatory	PFSP	Anthocyanin	20
Hepatoprotection	PFSP	Anthocyanin	21
Supportive intake during pregnancy and lactation	OFSP	ß –carotene	22
Body's immune system	OFSP	ß –carotene	23
Blindness	OFSP	ß –carotene	24
Antidiabetic activity	WFSP	Lycopene	25

Table no 2: Utilization of Sweet Potato for Animals

Utilization of Sweet Potato	Animal	References
Energy source	*Tilapia zilli*	26
Dietary protein source	*Tilapia zilli, Clariasgariepinus, Cyprinuscarpio*	27
Energy supplements	Cow, Pig, all ruminant	28
Improved feed intake, feed conversion efficiency, digestibility, dressing percentage, carcass weight, and rib-eye muscle area.	Goat	29
Wound healing and antiulcer properties	Wistar Rat	30
Immune response after immunization.	Chicken	31

IV. Discussion

BOTANICAL ASPECTS

Morphological characterization in sweet potato is done by assessing variations characteristics in the root, leaf, stem, and storage root. The stem is cylindrical and its length depends on the growth habit of the cultivar and the availability of water in the soil. The leaves are simple and spirally arranged alternatively on the stem. Their color can be green, yellowish-green, or can have purple pigmentation in part or all of the leaf blades. The sweet potato plant forms one leaf (petioleand lamina) per node produced. The total number of leaves per plant was greatest in plants growing at 45-cm spacing between 4 and 18 weeks after planting (WAP)[32].

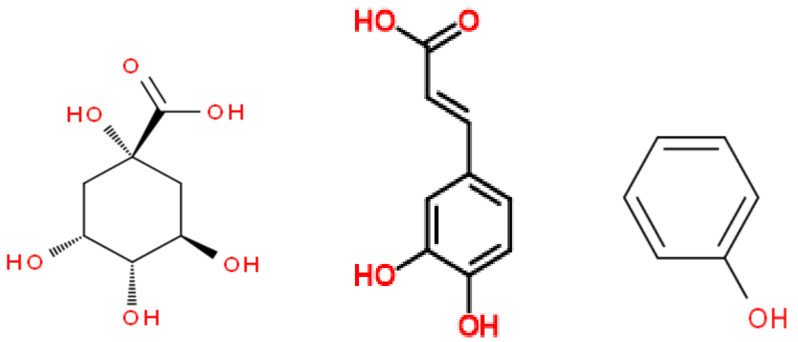
The colour of the stem and leaves varies from green to purple due to anthocyanin pigmentation with the petiole from 5-30 cm[33]. Smooth skin of the root tuber ranges between yellow, orange, red, brown, purple, and beige. Its flesh ranges from beige to white, red, pink, violet, yellow, orange, and purple [34], while the smooth storage root skin ranges from white to dark purple and the flesh colour vary from white to orange in various distributions[33].

The storage root is used in manufactured products such as starch, potential storage roots showed a relatively high starch concentration which is have important role in its utilization and starchy crop from sweet potato crops used in many tropical countries[35–37].The starch of sweet potato level ranged between 33% and 64% on the dry basis[38].

PHYTOCONSTITUENTS

The essential phytoconstituents that are generally present in sweet potato are flavonoids, terpenoids, tannins, saponins, glycosides, alkaloids, steroids and phenolic acids[11]. Other numerous active ingredients are present in sweet potato including triterpene in sweet potato leaf and root, sesquiterpenoid in sweet potato root, alkaloid in sweet potato tuber root and leaf, flavonoid, vitamin (vitamin A, vitamin B1, vitamin B2, vitamin B3, and vitamin C), essential mineral nutrients such as Ca, Cr, Co, Ni P, Mg, Na, K, S, Fe, Cu, Zn, Mn, A, enzyme, storage protein sporamins (sporamins A and B) being the major storage proteins in sweet potato roots, a high carbohydrate, a rich source of dietary fiber. Sweet potato leaves are excellent source of chlorophylls and carotenes, that supplies a variety of nutrients that cannot be supplied by other vegetables[39].

The leaves of sweet potato plants are a rich source of caffeoylquinic acid (CQA) derivatives, esters of quinic acid (Fig. 1a) and caffeic acid (Fig. 1b)[40]. Moreover, based on[41] in a study of three sweet potato cultivars, phenols (Fig. 1c) from the leaves of this species were approximately 8, 16, and 18 times higher, respectively, than those found in the root coat, in the entire root, and in the root pulp, sweet potato leaves are source of phenolic compound, total phenolic content was highest in the leaves[42].



(a) (b) (c)

Figure 1.2D structure of (a) quinic acid (ChemspiderID10246715); (b) caffeic acid (ChemspiderID600426); (c) phenol (ChemspiderID10246715)

Phytoconstituents can vary depending on flesh and skin colours. purple sweet potato compound higher anthocyanin content than other varieties of sweet potato, while orange sweet potato are particularly rich in β-carotene [43]. It contains high levels of acylatedanthocyanins and other phenolics with antioxidant activities.

On the other hand, orange-fleshed sweet potato (OFSP) is an excellent source of the provitaminA[44] and contain antioxidant, polyphenolic, a blend of phenolic acids and have relatively high levels of carotenoids content wherein β-carotene was the most plentful[45,46]. In addition to being rich in b -carotene, OFSP contains significant amounts of protein, fat, carbohydrate, dietary fibre, other micronutrients and some phytonutrients[47].White-fleshed sweet potato colour was due to the presence of lycopene[48].

BIOLOGICAL ACTIVITY

Purple-fleshed Sweet Potato

Phytoconstituents contained in purple-fleshed sweet potato (PFSP) have many positive impacts on human health. Its high anthocyanins content possesses the highest scavenging activity level. It can react with free radicals in the body cells to reduce the capacity of free radicals that can cause damage in the body [49–51].Phenolics component were found to inhibit the growth of human colon-, leukemia, stomach-cancer cells and inhibit the growth of tumourcells[16,52]. Caffeoylquinic acid which is an intermediate of phenylpropanoid metabolism, is a precursor for structural polyphenols and many biologically active secondary compounds (Buchanan, 2000 in[53]).

Anthocyanins content display a wide range of biological activities display a variety of effects on blood vessels, platelets and lipoproteins. It can reduce the risk of coronary heart disease, preventing premature aging and inhibiting free radical, and protect against a variety of degenerative disease processes [17]. Antioxidant activities can be measured by oxygen radical absorbance capacity[12]. Antioxidants act as scavengers of reactive oxygen species inside the cell[54]. The antioxidant activity in purple fleshed sweet potato is relatively higher than other varieties of sweet potato[55].

The peonidin-based components in purple sweet potato anthocyanins showed good properties regarding scavenging radicals and superoxide anions, and had good potential in reducing the total power activity [56] and anthocyanin have the effect of unique on cure colorectal cancer [15].

Extracts of PFSP showed potential of anti-inflammatory and can inhibit inflammatory brain diseases by suppressing lipopolysacharide (LPS) induced inflammatory[20]. Many research revealed that PFSP have antifungal activities[19]hepatoprotection against oxidative stress[21], antimicrobial activity against *Esherichia coli* and *Staphylococcus aureus*[18], and then have ability in anticancer activities[13,14]. In term of anticancer activity, it can inhibit the growth of human breast cancer cells.

PFSPleaves was able to modulate T-lymphocyte functions, lytic activity of natural killer cell and antibody production[40]. It has been postulated that extracts from PFSP improve immune dysfunction possibly by modulating antioxidant defense systems[57].

Orange-fleshed Sweet Potato

Orange-fleshed sweet potato (OFSP) contained nutritional components such as high ß –carotene, will help eradicate the problem of vitamin A deficiency [58], which is nutritional problems such as malnutrition in children [59]. OFSP can improve vitamin A status and plays a significant role in developing countries as a viable long-term food-based strategy for controlling vitamin A deficiency in children[60]. Vitamin A is required for healthy development of the fetus and the newborn, besides that vitamin A as a supportive intake during pregnancy and lactation[22]. Malnutrition due to deficiency of micronutrients in the diet affects the health of over half the world's population can cause blindness and weaken the body's immune system in humans[23]. [24] reported that 125 g serving of boiled OFSP can supply the daily requirement of vitamin A for preschool children and protect them from night blindness. OFSP can be used as food-based supplements to reduce vitamin A deficiency[61]. Studies indicated that OFSP variety is a potentially good source of nutrients[62].

White-fleshed Sweet Potato

White-fleshed sweet potato (WFSP) affects human health, i.e. study by [63] shown that WFSP has antioxidant activity, however this activity is lower compared to PFSP. [64]also reported that remarkable antidiabetic activity and improve the abnormality of glucose and lipid metabolism by reducing insulin resistance. The variety of WFSP have a potential in antidiabeticactivities[25].

UTILIZATION IN ANIMALS

Fisheries

Sweet potato can be used as a dietary for fish. A study by [27] reported that an 8-week feeding trial was conducted to evaluate the potential of sweet potato leaf meal as dietary protein source in the diet of *Tilapia zilli* fingerlings. The fish were allowed to acclimatize for 10days, during this period, they were fed on commercial diet. Five isonitrogenous diets of 30% crude protein were formulated to contain 0,5%, 10%, 15% and 20% sweet potato leaf meal (Diets 1-5) to partially replace other protein ingredients in the tilapia diet. The present findings showed that sweet potato leaf meal have good potential for use as one of the protein sources in *Tilapia zilli* diet up to 15% level without compromising growth. Sweet potato can replace 50 to 100% of yellow corn energy without adverse effects on growth performance, feed utilization parameters with the advantage of reducing the costs of 1000 kg gross energy [65].

[66]explained that the different levels of sweet potato peel in the different experimental diets of crude protein to *Cyprinuscarpio* showed toleration up to 15% level of inclusion of sweet potato peel. This study finding that sweet potato peels can be incorporated into fish feeds in order to reduce the cost associated with production of farmed fish. [26]also reported that sweet potato leaf meal was an effective energy source for catfish up to the maximum level tested (230 g kg^{-1} diet). Sweet potatoes peel meal also can completely replace yellow maize meal in the diet of *Clariasgariepinus* fingerling; however, the growth is maximized at replacement level of 50 and 75%[67].

Livestock

Sweet potato is a valuable and good feed for all ruminant. They can be fed as fresh, chopped tubers, dried chips and silage[68]. Sweet potatoes can be fed to ruminants as energy supplements along with locally available grasses during the dry season for both fattening and milking animals[28]. Many researchers stated that fresh sweet potato foliage could serve as a sustainable cost-effective supplement to improve the nutritional quality of grasses[69–71]. Vine and foliage on sweet potato is a common feed for pig and other livestock[28].

A study reported that feeding of Bunanji and N'Dama cows in early lactation with sweet potato foliage had lower milk yield the the dried brewer grains and cottonseed meal, but the metabolizable energy intake were higher from the sweet potato foliage than other diets[70].

Other study by [29]also reported supplementation of sweet potato vine in goat fed a basal diet of natural grass hay improved feed intake, feed conversion efficiency, digestibility, dressing percentage, carcass weight, and rib-eye muscle area. Sweet potato vine could replace portion of the conventional concentrate and could be fed with poor quality hay to prevent body weight loss of goats in the absence of other supplement. Therefore, it can be concluded that sweet potato vine, which is harvested after the tubers are consumed, could be used as an alternative-supplements in natural pasture hay-based feeding for goats in places where sweet potato grows.

[31]reported that dietary supplementation of purple sweet potato improved immune response after immunization in chickens. [30] also reported that tuber flour of white flashed sweet potato examine on wistar rats shown wound healing and antiulcer properties

V. Conclusionand Future Perspectives

This review highlights the important biological activities of sweet potato (*Ipomoea batatas*(L) Lam.)which are highly influenced by its cultivar type, i.e. orange-fleshed sweet potato (OFSP), white-fleshed sweet potato (WFSP) and purple-fleshed sweet potato (PFSP). Of the three types, PFSP is the most potential bioprospecting for human as well as animal health. Its anthocyanin-rich contents play important role on this benefit. PFSP is suggested to be further explored for its potential role in bioprospecting and drug discovery.

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