

Hog plums: Its importance, potentials and future prospects

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Abstract

Hog plums, scientifically known as *Spondias mombin* are medicinal plants that are rich in nutrients and antioxidants, and are of great importance in the food/agricultural industries and the health sector. In the food industries, it is an important fruit crop that can be eaten raw, juiced and processed for making jam, ice cream and jellies, and also provides farmers an alternative feeding material for lactating ruminants to help in galactogenesis and lactopoiesis. In the health sector, hog plums fruit, leaves and stem extract possess antimicrobial, cytotoxic, anti-tyrosinase, diuretic and febrifuge activities for the treatment of certain disease conditions, and it can be effectively preserved by wax coating of the fruits. Methanolic extract of *Spondias* contain methyl gallate, a substance that has the potential to facilitate apoptotic cell death in human glioblastoma, lung, and breast cancer Hog plums are also rich in vitamins, it strengthens the immune system, protects against heart disease, and stimulates the production of collagen which keeps the body healthy. It is a plant that has obvious and promising health benefits, and as such more research into its properties is advisable. Preservation of hog plum can be achieved by wax coating, retardation of ripening and senescence, and application of growth regulators.

Keywords: antimicrobial; antioxidants; anti-tyrosinase; cytotoxic; *Spondias mombin*

Introduction

Medicinal plants are rich in various phytochemical compounds that possess anti-oxidative properties (Sameh *et al.*, 2018), and are considered as healthy sources for the prevention of various oxidative-stress related diseases, inflammation and microbial diseases (Ayoka *et al.*, 2008). Hog plum as it is commonly called, is scientifically known as *Spondias mombin* is a deciduous tree with large panicles of small white flowers and yellow plum-like fruits, grown mainly during rainy season, between June and August (Adepoju and Oyewole, 2008). Fruits of the plant are ovoid, yellow, fleshy, drupe and are borne within a cluster of 10-15 fruits; unripe fruits taste sour, while ripe ones have sweet-sour taste. It belongs to the family Anacardiaceae (same family as Cashews, Mangoes and Pistachios) (Patathananone *et al.*, 2019), natively found in Central America and the Caribbean and in Southern Nigeria (Ayoka *et al.*, 2008). Hog plum, a medicinal plant and fruit crop has several common names; it is called 'iyeye'/'akika'/'ebo' in Yoruba, 'ngulungwu' in Ibo, 'isada'/'tsardamaster' in Hausa,

Received: 29 Nov 2020. Received in revised form: 10 Mar 2021. Accepted: 12 Apr 2021. Published online: 23 Apr 2021.

From Volume 13, Issue 1, 2021, Notulae Scientia Biologicae journal uses article numbers in place of the traditional method of continuous pagination through the volume. The journal will continue to appear quarterly, as before, with four annual numbers.

'chabbuh' in Fulani, 'oheeghe' in Edo, 'aginiran' in Ijaw, 'kakka' in Tiv, 'nuskakara' in Efik, 'bala' in Costa Rica, 'jobito' in Panama, 'jobo blanco' in Colombia, 'jobo corronchoso' in Venezuela, 'hoeboe' in Surinam, 'acaiba'/'caja'/'pau da tapera' in Brazil, 'ubo' in Peru and 'hobo' in Mexico (Gbile and Soladoye, 2002).

Nutritional Composition

Hog plums are composed of carbohydrates (13.80 g), fats (0.62 g), protein (1.06 g), ash (0.75 g), moisture (83.6 g), energy (65.4 g), dietary fibre (1.87 g), sodium (5.5 mg), iron (0.33 mg), potassium (287 mg), phosphorus (32.7 mg), manganese (0.03 mg), magnesium (15 mg), calcium (11 mg), copper (0.12 mg), lutein (634 µg), β-carotene (314 µg), α-carotene (340 µg), zeinoxanthin (550 µg), β-criptoxanthin (1700 µg) (Adepoju and Oyewole, 2008), while the seed kernel contains carbohydrate (40.56%), ash (8.09%), crude fibre (31.86%), moisture content (8.48%), crude protein (7.73%), crude fat (3.28%), calcium (1317 mg/kg), iron (839.08 mg/kg), magnesium (494.71 mg/kg), manganese (17.93 mg/kg), zinc (15.27 mg/kg), and copper (7.68 mg/kg) (Makinde *et al.*, 2016). Phytochemical analyses showed the presence of tannins (0.06%) and phytate (0.0022%) (Makinde *et al.*, 2016). The free radical scavenging activity against the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical was at the level of 15.09%, while total antioxidant capacity and total phenolic content were 856.7 ± 5.84 mg AAE/100g and 573.32 ± 11.5 mg GAE/100g respectively (Patathananone *et al.*, 2019). These antioxidants help to reduce oxidation stress caused by free radicals in the body that could damage the body's major organs (Nwidu *et al.*, 2017). The seed kernel of *Spondias mombin* has anti-anaemic and anti-diabetic properties as a result of iron and zinc content (Sameh *et al.*, 2018). It is a potential chemo-protective agent against the activities of the toxic reactive oxygen species (ROS) (Fred and Abo, 2009).

Hog plums are also rich in vitamin C, a natural antioxidant, which strengthens the immune system, protects against heart disease, and stimulates the production of collagen which keep the body healthy (Nwidu *et al.*, 2017). A 100 g portion of hog plums contains 46 mg of vitamin C, and a 100 g serving of hog plums has 2.8 mg of iron, this provides 15 - 35% of the recommended intake of iron per day (Patathananone *et al.*, 2019). Iron is essential for the production of haemoglobin and myoglobin, which carry oxygen through the body. Saronee *et al.* (2019) reported on the antioxidant content and effectiveness of hog plums in rat hearts. The study showed that hog plums were high in antioxidants when compared to the heart medication, ramipril and they also discovered that *Spondias mombin* reduced overall cholesterol levels and its effect on heart health was comparable to that of ramipril (Saronee *et al.*, 2019). Hog plums are fat free, cholesterol-free, rich in vitamin K (which aids blood clotting, strengthen bones and prevents bone fractures) and thiamine (which prevents muscle contraction and promotes conduction of nerve signals) (Nwidu *et al.*, 2017). *Spondias* also possess sedative, anxiolytic, anti-helminthic, antimicrobial and anti-inflammatory properties (Abo *et al.*, 1999).

Uses

Medical and antimicrobial use

In traditional medicine, hog plum leaves are used to make tea for stomach ache, biliousness, urethritis, cystitis, inflammation, treatment of gonorrhoea, diabetes and psychiatric disorders (Kasote *et al.*, 2015), expulsion of placenta in goats (Kasote *et al.*, 2015), an oxytocic agent; (Aiyeloja and Bello, 2006), and in wound treatment (Kasote *et al.*, 2015). The fruit has been used as a diuretic (to effectively reduce blood pressure by removing salts and unwanted fluid from the body through urine) and febrifuge (used as a substitute for fever medication due to the presence of flavonoids, anthraquinones, sesquiterpenes and quinolone). The bark is an astringent and used as an emetic (Sameh *et al.*, 2018), for diarrhea, dysentery, hemorrhoids, gonorrhoea, and leukorrhoea (Aiyeloja and Bello, 2006). The leaf extract has antimicrobial properties, can be used in making antiseptic soap, and is active against bacterial, fungal and parasitic infections (Kasote *et al.*, 2015).

Organ repair

Ubah *et al.* (2018), reported that the administration of methanolic leaf extract of *Spondias mombin* was potent in ameliorating the effects of zidovudine induced oxidative stress on the liver histology of rats.

A study was carried out on the hypothalamus, pituitary, and adrenal glands (HPA axis) of Zidovudine stress induced Wistar rats and showed that the administration of methanolic leaf extract of *Spondias mombin* proved a restorative effect on the HPA axis when exposed to oxidative stress (Ubah *et al.*, 2018). Another researcher carried out a study on the hepatoprotective and anti-oxidant effects of *Spondias mombin* leaf and stem extracts upon carbon tetrachloride induced hepatotoxicity and oxidative stress (Nwidu *et al.*, 2017). The study showed that extract of *Spondias mombin* may serve as a promising herb for the treatment of hepatic damage (Nwidu *et al.*, 2017).

Assessment of methanolic extract of *Spondias mombin* leaves on blood glucose and glycosylated haemoglobin using male rats showed that *Spondias mombin* possess anti-diabetic and hypoglycaemic properties (Saronee *et al.*, 2019). Phytochemicals present in hog plums reduce blood glucose through stimulation of insulin from residual beta cells; (Fred and Abo, 2009) enhancement of glucose transport to body tissues; (Saronee *et al.*, 2019) and inhibition of gastrointestinal absorption of glucose (Sameh *et al.*, 2018).

Food and agriculture

Spondias mombin is an important fruit crop that can be eaten raw, juiced and processed for making jam, ice cream and jellies (Adepoju and Oyewole, 2008). Hog plum provides farmers with an alternative feeding material for lactating ruminants to help in galactogenesis and lactopoiesis (Sameh *et al.*, 2018), due to increase in the cost of grains used in the production of concentrate diets (Udeh and Oguike, 2008).

In food industries, the enzyme tyrosinase catalyses the browning reactions in food products due to loss in nutritional quality during storage (Patathananone *et al.*, 2019). Therefore, ripe hog plums fruits which possess anti-tyrosinase activity and low cytotoxicity with normal cells could be formulated as food additives for the inhibition of enzymatic browning of food products (Kim and Uyama, 2005).

Skin and cancer treatment

Aging which is a normal situation of life is influenced by intrinsic (decreasing hormone, increasing age, etc.) and extrinsic (sunlight, smoking, etc.) factors (Popoola *et al.*, 2015). Also, reactive oxygen species (ROS) production increases in cells associated with the UV radiation from sunlight (Garg *et al.*, 2017). ROS are a group of free radicals that enhance the activity of elastase, collagenase, and hyaluronidase enzymes. These enzymes can degrade the structural components of extracellular matrix (elastin, collagen, hyaluronic acid) in cells (Popoola *et al.*, 2015), changing the physiological and progressive structure of the skin (Garg *et al.*, 2017). Hyperpigmentation of the skin may be induced by the catalytic activity of tyrosinase enzyme (Kim and Uyama *et al.*, 2005). therefore, bioactive components (phenolics and flavonoids) in ripe hog plum can inhibit tyrosinase activity in the skin and prevent aging (Popoola *et al.*, 2015).

The methanolic extract of *Spondias* was found to contain methyl gallate (Sameh *et al.*, 2018), a substance that has the potential to facilitate apoptotic cell death in human glioblastoma, lung, and breast cancer (George *et al.*, 2017). Ripe hog plum fruits exhibit anti-tyrosinase, anti-elastase, and anticancer activity due to the presence of bioactive compounds (gallic acid and gallic glycoside) which are used in cosmetic, food preservation and as a cytotoxic agent (Sun *et al.*, 2016). Gallic acid and methyl gallate isolated from the ethyl acetate extraction of hog plum bark showed a cytotoxic effect on human glioblastoma cell line (U87) (George *et al.*, 2017). Gallic acid present in hog plums can also enhance G₀/G₁ phase arrest and apoptosis in human leukaemia HL-60 cells (Patathananone *et al.*, 2019), by inhibiting cyclin D and E and activating the mitochondria-dependent pathway (Kim, 2007).

Preparation of fruit and leaf extract

Fruits are washed with water including 70% v/v ethanol thrice and air dried. Peel and pericarp are collected, homogenized using a homogenization machine and frozen dry. 200 g of dried powder are placed into the chambers, and methanol added in a ratio of 1:4 w/v (Sameh *et al.*, 2018). The extracted chambers are shaken at 180 rpm for 72 h. The supernatant is collected and filtered with Whatman No. 1 filter paper. The precipitate is extracted using methanol, hexane, ethyl acetate, isopropanol or ethanol respectively (Aiyeloja and Bello, 2006).

Fresh leaves of *Spondias mombin* are dried at room temperature for a minimum of 14 days and extracted using the percolation method as described by Aiyeloja *et al.* (2006). The *Spondias mombin* leaves are grounded into powder, 8.8 kg of the powder is macerated with 98% methanol for three days, then filtered and concentrated using rotary evaporator at 40 °C (Kasote *et al.*, 2015). The obtained extract is kept in air tight containers and can be stored at room temperature before use.

Collection/Harvesting of fruits

Fruit harvested from 9 - 11 weeks after fruit set are found to be of optimum maturity, with high concentrations of spondiol and moderate levels of climacteric respiration (Li *et al.*, 2014). Hog plum fruit has a shelf life of 10 days (Bhakat *et al.*, 1997). Immature fruit show a rapid deterioration in their bioactive and biochemical constituents after harvest, and have a shorter shelf-life of 2 - 3 days. Over-mature fruit (i.e., fruit harvested \geq 11 weeks after fruit set), have a shelf-life of 8 - 10 days show a rapid decline in bioactive and biochemical constituents and shrinking of the peel and pulp from the endocarp, which renders the fruit unfit for fresh consumption or processing (Adepoju and Oyewole, 2008).

Preservation

Wax coating, an effective method for preserving fruits, helps in controlling transpiration and respiration rate (Sameh *et al.*, 2018). Retardation of ripening and senescence, and application of growth regulators can also minimise fruit weight loss and prolong storage of hog plum fruits (Bhakat *et al.*, 1997). A study showed that hog plums preserved with wax emulsion (%) coating could be stored well up to 2 weeks with minimum spoilage (33.3 %) and physiological loss in weight at room temperature (Li *et al.*, 2014).

Conclusions

Spondias mombin also known as Hog plum is one of the medicinal plants that are rich in various phytochemical compounds that possess antioxidants and phytochemicals, which include, tannins and phytate. It also has nutritional compositions which include carbohydrates, fats, protein, ash, moisture, energy, dietary fibre, sodium, iron, potassium, phosphorus, manganese, magnesium, calcium, copper, zinc, lutein, β -carotene, α -carotene, zeinoxanthin, and β -criptoxanthin.

In addition, it is used in traditional medicine for treating illnesses. For instance, hog plum leaves are used to make tea for treating stomach ache, biliousness, urethritis, cystitis, inflammation, gonorrhoea, diabetes and psychiatric disorders. Hog plums are also rich in vitamin C, a natural antioxidant, which strengthens the immune system, protects against heart disease, and stimulates the production of collagen which keeps the body healthy. It is a plant that has obvious and promising health benefits, and as such more research into its properties is advisable.

Authors' Contributions

Conceptualization: HAE-A; Data Curation: HAE-A, OFO; Formal analysis: HAE-A, WOT; Writing-original draft: HAE-A; Writing-review and editing: HAE-A, WOT and OFO.

All authors read and approved the final manuscript.

Acknowledgements

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

References

- Abo KA, Ogunleye VO, Ashidi JS (1999). Antimicrobial potential of *Spondias mombin*, *Croton zambesicus* and *Zygotritonia crocea*. *Phytotherapy Research* 13(6):494-497. [https://doi.org/10.1002/\(SICI\)1099-1573](https://doi.org/10.1002/(SICI)1099-1573)
- Adepoju OT, Oyewole OE (2008). Nutrient composition and acceptability study of fortified jams from *Spondias Mombin* (Hog Plum, Iyeye in Yoruba) fruit pulp. *Nigerian Journal of Nutritional Science* 29(2):180-189. <http://www.sciepub.com/reference/104872>
- Aiyelaja AA, Bello OA (2006). Ethnobotanical potentials of plants in Nigeria. A case study of Enugu State. *Educational Research and Review Science International Journal* 1(1):16-22. <https://www.scirp.org/>
- Ayoka AO, Akomolafe RO, Akinsomisoye OS, Ukponmwan OE (2008). Medicinal and economic value of *Spondias mombin*. *African Journal of Biomedical Research* 11(2):129-136. <https://doi.org/10.4314/ajbr.v11i2.50714>
- Bhakat SK, Hore JK, Sen SK (1997). Extension of storage life of hog plum (*Spondias dulcis*). *Indian Journal of Plant Physiology* 2(2):177-178.
- Esua OJ, Makinde OO, Arueya GL, Chin NL (2016). Antioxidant potential, phytochemical and nutrient compositions of Nigerian hog plum (*Spondias mombin*) seed kernel as a new food source. *International Food Research Journal* 23(5):179-185.
- Fred-Jaiyesimi A, Abo K (2009). Anti-diabetic activity of *Spondias mombin* extract in NIDDM rats. *Pharmaceutical Biology* 47(3):215-218. <https://doi.org/10.1080/13880200802462493>
- Garg C, Khurana P, Garg M (2017). Molecular mechanisms of skin photoaging and plant inhibitors. *International Journal of Green Pharmacy* 11(2):217-232. <http://dx.doi.org/10.22377/ijgp.v11i02.1031>
- George VC, Dellaire G, Rupasinghe HPV (2017). Plant flavonoids in cancer chemoprevention: role in genome stability. *Journal of Nutrient Biochemistry* 45:1-14. <https://doi.org/10.1016/j.jnutbio.2016.11.007>
- Gbile ZO, Soladoye MO (2002). Vernacular names of Nigerian plants (Yoruba). (2nd ed). Forestry Research Institute of Nigeria (FRIN) Press, Ibadan Nigeria pp 101. <https://www.scirp.org/>
- Kasote DM, Katyare SS, Hegde MV, Bae H (2015). Significance of antioxidant potential of plants and its relevance to therapeutic applications. *International Journal of Biological Sciences* 11(8):982-991. <https://doi.org/10.7150/ijbs.12096>
- Kim YJ, Uyama H (2005). Tyrosinase inhibitors from natural and synthetic source: structure, inhibition mechanism and prospective for the future. *Cellular Molecular Life Sciences* 62:1707-1723. <https://doi.org/10.1007/s00018-005-5054-y>
- Kim YJ (2007). Antimelanogenic and antioxidant properties of gallic acid. *Biological and Pharmacological Bulletin* 30:1052-1055. <https://doi.org/10.1248/bpb.30.1052>

- Li NA, Li S, Zhang YJ, Xu XR, Chen YM, Li HB (2014). Resources and biological activities of natural polyphenols. *Nutrients* 6(1):6020-6047. <https://doi.org/10.3390/nu6126020>
- Nwidu LL, Elmorsy E, Yibala OI, Carter WG (2017). Hepato-protective and antioxidant effects of *Spondias mombin* leaf and stem extracts upon carbon tetrachloride induced hepatotoxicity and oxidative stress. *Journal of Basic and Clinical Pharmacy* 8(2):5-18. <https://doi.org/10.1016/j.jtumed.2018.03.006>
- Patathananone S, Daduang J, Koraneekij A, Li C (2019). Tyrosinase Inhibitory effect, antioxidant and anticancer activities of bioactive compounds in ripe hog plum (*Spondias pinnata*) fruit extracts. *Oriental Journal of Chemistry* 35(3):1-12. <http://dx.doi.org/10.13005/ojc/350302>
- Popoola OK, Marnewick JL, Rautenbanch F, Ameer F, Iwuoha EI, Hussein AA (2015). Inhibition of oxidative stress and skin aging-related enzymes by prenylated chalcones and other flavonoids from *Helichrysum teretifolium*. *Molecules* 20:7143-7155. <https://doi.org/10.3390/molecules20047143>
- Sameh S, Al-Sayed E, Labib RM, Singab AN (2018). Genus *Spondias*: A phytochemical and pharmacological review. *Evidenced Based Complementary and Alternative Medicine* (4):1-13. <https://doi.org/10.1155/2018/5382904>
- Saronee F, Bekinbo MT, Ojeka SO, Dapper DV (2019). Comparative Assessment of methanolic extracts of hog plum (*Spondias mombin* linn.) Leaves and turmeric (*Curcuma longa* L.) rhizomes on blood glucose and glycosylated haemoglobin in male Wistar rats. *Journal of Applied Science and Environmental Management* 23(9):1631-1636. <https://doi.org/10.4314/jasem.v23i9.4>
- Sun G, Zhang S, Xie Y, Zhang Z, Zhao W (2016). Gallic acid as a selective anticancer agent that induces apoptosis in SMMC-7721 human hepatocellular carcinoma cells. *Oncology Letters* 11(1):150-158. <https://doi.org/10.3892/ol.2015.3845>
- Ubah CO, Asuquo OR, Oko GE, Ewaa OI, Eluwa MA (2018). Evaluating the effects of methanolic leaf extract of neem plant and hog plum on the liver histology of zidovudine induced-oxidative stress Wistar rats. *Journal of Complementary and Alternative Medical Research* 6(4):1-6. <https://doi.org/10.9734/JOCAMR/2018/46306>
- Ubah CO, Asuquo OR, Oko GE, Eluwa MA (2018). Comparative effects of methanolic leaf extracts of *Azadirachta indica* and *Spondias mombin* on the hypothalamic-pituitary-adrenal axis of zidovudine stress induced Wistar rats. *Annual Research and Review in Biology* 29(5):1-15. <https://doi.org/10.9734/ARRB/2018/45293>
- Udeh NE, Oguike MA (2008). Influence of *Spondias mombin* l (hog plum) on colostrum, milk composition and growth in west African dwarf sheep. *Animal Production Research Advances* 4:3-4. <https://doi.org/10.4314/apra.v4i3-4.49779>



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