

Review

Efficient pharmacognostical, phytochemical and pharmacological survey on *Basella alba* L. An ethno therapeutic plant

*Kishore Subhas, Mohan Kapoor and Akshay R. P

Department of Pharmacognosy and Phytochemistry, Faculty of Pharmacy, Jiwaji University, Gwalior, India.

Accepted 21 April, 2019

The ethno medicinal plant *Basella alba* belongs to the family Basellaceae, and commonly known as malabar spinach, indian spinach, ceylon spinach and vine spinach. Although it has been reported in ancient systems of medicine, it did not gain much importance and has always remained controversial. It has been found to be a good source of calcium, iron, vitamin A and vitamin C. In the Indian system of medicine, the plant has immense potential in androgenic activity, antiulcer activity, antioxidant, cytotoxic and antibacterial activity, anti-inflammatory activity, central nervous system (CNS) depressant activity, nephroprotective and wound healing properties etc. The present is therefore, an effort to give a detailed survey of literature on pharmacognostical, phytochemical, ethnopharmacology as well as the pharmacological activities of the plant.

Key words: Nephroprotective, cytotoxic, androgenic, antiulcer activity, antioxidant, spinach.

INTRODUCTION

To cure human disease, medicinal plants have been a major source of therapeutic agents since ancient times. The revival of interest in natural drugs started in last decade mainly because of the wide spread belief that natural medicine is healthier than synthetic product. Nowadays, there is manifold increase in medicinal plant based industries due to the increase in the interest of use of medicinal plant throughout the world which is growing at a rate of 7 to 15% annually. Despite the major advances in the modern medicine, the development of new drugs from natural products is still considered important. Since 1980, World Health Organization (WHO) has been encouraging countries to identify and exploit traditional medicine and phytotherapy.

The main Indian traditional system of medicine namely Ayurveda and Siddha, are primarily plant based system. The evaluation of new drugs especially phytochemically obtained materials has again opened a vast area for research and development. As per WHO, about 80% of

the population in the world relays on the traditional medicine for the treatment of various diseases. Therefore, the evaluation of rich heritage of traditional medicine is essential. In this regard, one such plant is *Basella alba* which is a fast-growing, soft-stemmed vine, reaching 10 m in length. Its thick, semi-succulent, heart-shaped leaves have a mild flavour and mucilaginous texture. The stem of the cultivar *B. alba* 'Rubra' is reddish-purple. It is popularly known as Malabar spinach, Indian spinach; native of Southern Asia. It is a plant which is used in every household in the eastern and southern parts of India. The leaves and stem part of the plant are used in cooking. The plant is found to be versatile in properties. It has been found to be a good source of calcium, iron, vitamin A and vitamin C.

In the Indian system of medicine, the plant has immense potential in androgenic activity, antiulcer activity, antioxidant, cytotoxic and antibacterial activity, anti-inflammatory activity, central nervous system (CNS)



Figure 1. Plant with green stem.



Figure 2. Plant with purple stem.

depressant activity, nephroprotective and wound healing properties etc. The aim of present review is to highlight the pharmacognostical, phytochemical, ethnopharmacology as well as the pharmacological investigation carried out on the plant so that the more pharmacological studies could be conducted to investigate the unexploited potential.

Plant profile

B. alba (Family: Basellaceae); Synonym: *Basella cordifolia* Linn. *Basella lucida* Linn. is a perennial climber. It is also known as Malabar spinach, Indian spinach, Ceylon spinach and vine spinach. The stem is succulent with tender leaves. Both stem and leaves are used in

Culinary practice in Southern parts of India. It is found to be a good source of calcium, iron, vitamin A and Vitamin C (Palada and Chang, 2003; Sir Ghillean and Mark, 2005). (Figures 1 and 2).

Other names of the plant include: (1). English: Malabar spinach, Ceylon spinach, Indian spinach; (2). Hindi: Poi ki Bhaji; (3). Bengali: Pui shak; (4). Oriya: Poi saga; (5). Konkani: Valchi bhaji (Vauchi bhaji); (6). Kannada: Basale soppu; (7). Telugu: Bachhali; (8). Tamil: Kodip pasaLi; (9). Marathi: Mayalu.

Taxonomy of plant

- (i) Kingdom: Plantae;
- (ii) Unranked: Angiosperms;
- (iv) Unranked: Eudicots;
- (v) Unranked: Core eudicots;
- (vi) Order: Caryophyllales;
- (vii) Family: Basellaceae;
- (viii) Genus: *Basella*;
- (ix) Species: *Basella alba* Linn.

Description

It is a fast growing perennial climber, growing up to 9 m in length and belongs to the family Basellaceae. It is a valuable vegetable that can be cultivated from either seed or cutting.

The stem is green or purplish and quadrangular in shape, about 2 to 3 cm thick, with prominent nodes and internodes. The taste is bland and mucilaginous, with no odour.

The leaves are fleshy and ovate or heart shaped, chordate base, dark green in colour, glossy above and glaucous below. The size of the leaves varies from 3 to 9 cm in length and 4 to 8 cm in width. Taste was found to be bland, with no odour.

The flowers are inconspicuous, bisexual white flowers borne on axillary spikes or branching peduncles.

Its fruits are fleshy and stalk less, ovoid or spherical in shape, 5 to 6 mm, and purple when mature (Tropilab Inc. <http://tropilab.com/bas.html>. accessed on 31 July 2012).

The useful parts of the plant include its leaves, young stem, matured fruit, and roots (Plants for a future http://www.pfaf.org/database/plants_phb?Basella+alba. Accessed on 31 July 2012).

Chemical constituents

Dried leaves (per 100 gm) contains, protein 20%, fat 3.5%, carbohydrate 54%, fibre 9%, and ash 19%. The leaves contain a high level of calcium and are rich in vitamins like A, C, thiamine, riboflavin, niacin, and betacyanin, oxalic acid, flavonoid like acacetin, 4,7-dihydroxy kempferol and 4'-methoxyisovitexin and also

phenolic acids like vanillin, syringic and ferulic acid. The fruit contains betacyanins and gomphrenin (Daniel, 2006; Eliana et al., 2007).

Traditional use

The plant has been known to be a demulcent, a diuretic and an emollient action. The entire plant is used in Chinese medicine where it is claimed to reduce fever and neutralize poison. The pulped or bruised leaves are used as a poultice for ulcers and to hasten the maturation of abscesses. A decoction of the leaves is believed to have laxative properties, and is used to treat constipation in pregnant women and children. The extract mixed with *Hibiscus rosa-sinensis* is given to pregnant women as a safe aperients. The juice of the plant is used as a dye for official seals, as a rouge on the facial skin and food colouring (Daniel, 2006; Herbal Medicine Research Centre, 2002). In southern India, the plant is used for the treatment of Aphthae (Hebbar et al., 2004).

PHARMACOGNOSTICAL REVIEW

Pharmacognostical studies provide qualitative standard and reveal the type of cell, its arrangement, and cell content. Transverse section of the fresh stem revealed the following features (Vanaliya Saroj et al., 2012).

Epidermis

The epidermis is represented by a single layer of compactly arranged, barrel-shaped parenchyma cells. Intercellular spaces are absent. The cells are slightly thick walled. Externally, a thin transparent waxy covering called cuticle is found.

Hypodermis

Hypodermis is represented by a few layers of collenchyma cells with angular thickenings. The cells are compactly arranged without any intercellular spaces.

Cortex

Cortex comprises of 3 to 5 layers of compactly arranged parenchyma cells without intercellular spaces.

Stele

The stele comprises of pericycle, vascular bundles and pith.

Pericycle

It is represented by a 3 to 4 layers of compactly arranged sclerenchyma cells.

Vascular bundles

Vascular bundles are arranged in the form of a ring. The vascular bundles are conjoint, collateral and closed. Xylem is on the inner surface and phloem on the outer surface. Xylem is described as endarch.

Pith

Pith is made of many layers of loosely arranged parenchyma cells with intercellular spaces.

PHYTOCHEMICAL REVIEW

Phytochemical studies reveal the presence of steroids and phenolic compound (Phadungkit et al., 2012). The chemical composition of the leaf extract include proteins, fat, vitamin A, vitamin C, vitamin E, vitamin K, vitamin B9 (folic acid), riboflavin, niacin, thiamine and minerals such as calcium, magnesium and iron. Kaempferol is the flavonoid present in *B. alba* at a concentration of 1.4 mg/100 g (Yang et al., 2008). *Basella* mucilage is viscous, with low swelling capacity. Its pH is good for skin (5.3 to 5.4). Partial purification of *Basella* mucilage proved to be composed of polysaccharide, with D-galactose as a major compound. The cell toxicity to Chang liver cell shows tendency of mild toxicity. The gel preparation of *Basella* mucilage provide good stability that serve for further development as cosmetic and medicine for skin diseases (Toshiyuki et al., 2001). *B. alba* contains basellasaponins, amino acid such as arginine, leucine, isoleucine, lysine, threonine and tryptophan (Khare, 2007), peptide, and phenolic compounds in various extracts (Maisuthisakul and Ritthiruangdej, 2008). The fruit contains gomphrenin derivative which is a betalain pigment (Glassgen et al., 1993). The mucilage of *B. alba* consists of mixture of polysaccharides (Palanuvej et al., 2009) and starch-type glucan which can be separated by starch iodine complex (Haq et al., 1969). Anthocyanins are a natural pigment which is responsible for the blue, purple, violet and red colours in fruits, flowers, stem and leaves (Glassgen et al., 1993).

Ethnopharmacology

B. alba has been used for many of its useful products in ancient times. Nowadays, its properties have been utilized

for the extraction of some useful material so that it can be used for the benefit of human activities. Some of the uses of this plant parts in the cure of certain problems which occurred in humans has been explained here:

1. Daily consumption of *B. alba* has a positive effect on total-body vitamin A storage in men (Haskell et al., 2004).
2. The paste of root of red *B. alba* along with washed rice water is taken in the morning on empty stomach for one month to cure irregular periods by the rural people of Orissa, India. Leaves of *B. alba* is used for the treatment of hypertension by Nigerians in Lagos, and malaria in Cameroonian folk medicine. The plant has been reported for its antifungal, anticonvulsant, analgesic, anti-inflammatory and androgenic activities and for the treatment of anemia. The leaves of *B. alba* are traditionally used in Ayurveda system of medicine to bring sound refreshing sleep when it is applied on head about half an hour before bathing (Anandarajagopal et al., 2011).
3. A paste of the root is applied to swellings and is also used as a rubefacient. The sap is applied to acne eruptions to reduce inflammation. Decoction of leaves is used for its mild laxative effect. Pulped leaves are applied to boils and ulcers to hasten suppuration. Sugared juice of leaves is useful for catarrhal affections. Leaf-juice mixed with butter is soothing and cooling when applied to burns and scalds. In Ayurveda, it is used for hemorrhages, skin diseases, sexual weakness, ulcers and as laxative in children and pregnant women. The plant is febrifuge, its juice is a safe aperient for pregnant women and a decoction has been used to alleviate labour. It is also an astringent, and the cooked roots are used in the treatment of diarrhea. The leaf juice is a demulcent, used in cases of dysentery (Kumar, 2010).
4. This plant serves as a Thai traditional vegetable. The fruit provides dark violet colour for food colorant. *Basella* mucilage has been used in Thai traditional medicine as topical application for irritant, bruise, ringworm and labour. Stem and leaves are used as mild laxative, diuretic and antipyretic (Chou, 1997).
5. In India, it has been used for antipruritis and burns (Saikia et al., 2006), and has been used in Bangladesh for acne and freckle treatment (Akhter et al., 2008).
6. The Ayurvedic treatment in India used *B. alba* leaves and stem as anticancer such as melanoma, leukemia and oral cancer (Premalatha and Rajgopal, 2005). Roots and leaves has been used for the removal of after birth, stomach pains and increase milk production (Pascaline et al., 2010).
7. *B. alba* is administered orally for the treatment of anal prolapsed or hernia. Ground leaves of *B. alba* are rubbed on the human hand the whole preparation introduce into animal's vagina every morning for the treatment of sterility (Chifundera, 1998).
8. The leaf juice is used in Nepal to treat dysentery, catarrh and applied externally to treat boils. The

mucilaginous qualities of the plant make it an excellent thickening agent in soups, stews, etc. The purplish sap from fruits is used as a colouring agent in pasteries and sweets (Ramu et al., 2011).

9. *B. alba* has been used for the treatment of Anemia in women, coughs, cold (leaf with stem), and cold related infections (Rahmatullah et al., 2010).

10. Maceration is taken orally for infertility, pelvic inflammatory disease, orchitis, epididymitis, threatened abortion and spurious labour (Focho et al., 2009).

11. Leaves are used in constipation, poultice for sores, urticaria and gonorrhoea. It is also used in poultice local swellings, intestinal complaints etc (Yasmin et al., 2009).

12. The mucilaginous liquid obtained from the leaves and tender stalks of plants is a popular remedy for headaches (Jadhav et al., 2011).

PHARMACOLOGICAL REVIEW

Pharmacological review reveals the pharmacological activity and its therapeutic value of plant. The popularity of the plant was highly enhanced by ideological belief in the herb as a cure for multiple diseases. The detailed pharmacological activities of plant are thus given:

Androgenic activity

In this study, Leydig cells were purified from 70 day-old Sprague Dawley male rats and incubated with 10 and 100 µg/ml of methanolic extract of *B. alba* (MEBa) for 4 h, followed by the evaluation of cell viability, steroid (testosterone and estradiol) production, and the level of aromatase mRNA. The results showed that MEBa did not only affect Leydig cell viability but also significantly stimulated testosterone and estradiol production ($p < 0.01$ and $p < 0.03$, respectively), and enhanced aromatase mRNA level ($p < 0.04$). These observations suggest that MEBa directly stimulated testosterone, estradiol and aromatase mRNA levels in isolated Leydig cells (Edouard et al., 2011; Moun dipa et al., 2006).

Anti-inflammatory activity

The methanolic extract of *B. alba* (MEBa) and aqueous extract of *B. alba* (AEBa) were studied for its *in vitro* anti-inflammatory activities. The potency of the extracts was compared with standard Diclofenac sodium (50 and 100 µg/ml). The aqueous extract showed the most significant membrane stabilizing action on human red blood cell membrane (Vijender et al., 2011). In cotton pellet induced granuloma, the test drugs 50% (BLE 250 mg/kg) and 60% (BLE 500 mg/kg) were found to be less potent than phenyl butazone as a standard (Krishna, 2012).

Haematological and biochemical parameters studies

The effects of the aqueous leaf extract of *B. alba* on haematological and biochemical parameters were studied in Wistar strain albino rats and the results showed that *B. alba* significantly increased red blood cell count, white blood cell count, packed cell volume, haemoglobin concentration and platelet count. However, the extract significantly reduced the activity of the liver enzymes such as alkaline phosphatase (ALP), alanine aminotransferase (ALT) and aspartate aminotransferase (AST). In conclusion, adding *B. alba* leaves as part of daily diet may reduce anemia and maintain good health (Bamidele et al., 2010).

Anti ulcer activity

In the anti ulcer studies, parameters such as ulcer index, percentage of ulcer inhibition, gastric pH, pepsin content, thiobarbituric acid reactive substances, lipid hydro peroxides, superoxide dismutase (SOD), glutathione peroxidases (GPx), CAT, Glutathione (GSH), vitamin C, vitamin E have been analysed, and the results suggest that aspirin altered the parameters to considerable extent, which were restored to near normal with *B. alba* leaf extract (Venkatalakshmi and Senthamaraiselvi, 2012).

CNS depressant activity

Petroleum ether, methanol and aqueous extracts of dried aerial parts of *B. alba* were studied. CNS depressant activity of all the extracts of *B. alba* was evaluated by pentobarbitone induced sleeping time test, open field test and hole cross test in mice. Methanol extract (100 and 200 mg/kg, *p.o.*) showed highly significant ($p < 0.001$) CNS depressant activity than other extracts tested. All the results were compared with reference drug, diazepam (Anandarajagopal et al., 2011).

Cytotoxic and antibacterial activity

The methanolic extract shows the significant growth inhibition on human cancer cell lines and momentous zone of inhibition for microorganisms studied. The overall result of this study indicates that the methanolic extract from *B. alba* have interesting anticancer and antibacterial properties, and the traditional use of this plant may also derive from its antibacterial and anticancer properties (Rathee et al., 2010).

Antioxidant activity

B. alba fruit with dark blue skin and deep red violet flesh

is a potential source of natural colorant. This study were aimed to evaluate the total betacyanin content, total phenol and to analyse the antioxidant activity against 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical, superoxide anions, hydroxyl radical, metal chelating, hydrogenperoxide, fluorescence recovery after photobleaching (FRAP), 2,2'-azino-bis (ABTS) and deoxyribose degradation in a dose dependent manner. Betacyanin extracted from *B. alba* fruit exhibited excellent antioxidant activity (Reshmi et al., 2012; Sivasankar et al., 2011; Chanda and Dave, 2009).

Wound healing activity

The aqueous extract of leaves of *B. alba* were formulated as a gel and investigated for its physicochemical as well as for its burn wound healing activity. Different gel formulations of aqueous extract of *B. alba* (2% w/v) were prepared using polymers carbopol 934 and carbopol 940 by varying their concentration. Wound healing studies of aqueous extract revealed that *B. alba* treated animals were found to epithelise in 23 days while the solvent control and untreated rats epithelised within 35 and 39 days, respectively. The formulation 1.5% w/w carbopol 934 were found to be more promising as it shows better physicochemical characteristics, higher pharmacological activity and better stability compared to other formulations (Mohammed et al., 2012).

Nephroprotective effect

The nephroprotective effect of an ethanolic extract of *B. alba* L. on gentamycin (GM)-induced nephrotoxicity in Wistar albino rats were studied by administering GM only (100 mg/kg, *i.p.*) for 8 days. In drug treated groups, rats were pretreated with *B. alba* (250 and 500 mg/kg per day orally) for 14 days and co-treated with GM for 8 days. After 24 h of the last dose, blood, urine, and tissue samples were collected from the animals. GM when administered induced a marked renal failure characterized by a significant increase in serum and urine creatinine, urea, uric acid, gamma-glutamyl transferase (GGT), and protein levels. Besides, there were elevation of malondialdehyde (MDA) level and decrease in the concentration of total proteins (TPs) and sulphhydryl group (SH) free in kidney tissue, which are indicators of oxidative stress of kidney. The extract also significantly reduced the GM-induced elevated serum and urine levels of sodium, potassium, calcium, protein, creatinine, urea, uric acid, and GGT. The tissue MDA level was also significantly diminished; the decreased free-SH and TP levels were significantly replenished by an ethanolic extract of *B. alba* treatment (Saleh, 2011).

REFERENCES

- Akhter S, Abdul H, Shawkat IS, Swapan KS, Mohammad SHC, Sanjay SS (2008). A review on the use of non-timber forest products in beauty-care in Bangladesh. *J. For. Res.* 19:72-78.
- Anandarajagopal K, Sudhahar D, Ajaykumar TV, Muthukumaran G (2011). Evaluation of CNS Depressant Activity of Aerial Parts of *Basella alba* Linn. *IJPI J. Pharmacol. Toxicol.* 1:5.
- Bamidele O, Akinnuga AM, Olorunfemi JO, Odetola OA, Oparaji CK, Ezeigbo N (2010). Effects of aqueous extract of *Basella alba* leaves on haematological and biochemical parameters in albino rats. *Afr. J. Biotechnol.* 9(41):6952-6955.
- Chanda S, Dave R (2009). *In-vitro* model for Anti-oxidant activity evaluation and some Medicinal plants possessing anti-oxidant properties. *Afr. J. Microbiol. Res.* 13(13):981-996.
- Chifundera K (1998). Livestock diseases and the traditional medicine In the Bushi area, Kivu Province, Democratic Republic of Congo. *Afr. Study Monogr.* 19(1):13-30.
- Chou CT (1997). The anti-inflammatory effect of *Tripterygium wilfordii* Hook F on adjuvant-induced paw edema in rats and inflammatory mediators release. *Phytother. Res.* 11:152-154.
- Daniel M (2006). Medicinal plants: chemistry and properties. Science publishers, New Hampshire, USA. p.198.
- Edouard AN, Carine T, Faustin-Pascal TM, Serge C, Thomas KM, Paul FM (2011). Effects of the Methanol Extract of *Basella alba* L (Basellaceae) on Steroid Production in Leydig Cells. *Int. J. Mol. Sci.* 12:376-384.
- Eliana FO, Paulo CS, Milton CC (2007). Stability of anthocyanin in spinach vine (*Basella rubra*) fruits, *Cien. Inv. Agr.* 34(2):115-120.
- Focho DA, Nkeng EAP, Lucha CF, Ndam WT, Afegeni A (2009). Ethnobotanical survey of plants used to treat diseases of the reproductive system and preliminary phytochemical screening of some species of Malvaceae in Ndop Central Sub-division, Cameroon. *J. Med. Plants Res.* 3(4):301-314.
- Glassgen WE, Metzger JW, Heuer S, Strack D (1993). Betacyanins from fruits of *Basella rubra*. *Phytochemistry* 33:1525-1527.
- Haq QN, Awal A, Chowdhury MK, Khan NA (1969). Water-soluble polysaccharides from the leaves of *Basella rubra*. *Sci. Res.* 6:63-66.
- Haskell MJ, Jamil KM, Hassan F, Peerson JM, Hassain MI, Fuchs GJ, Brown KH (2004). Daily consumption of Indian spinach (*B. alba*) or sweet potatoes has positive effect on total-body vitamin A store in Bangladeshi men. *Am. J. Clin Nutr.* 80(3):705-714.
- Hebbar SS, Harsha VH, Shripathi V, Hegde GR (2004). Ethno-medicine of Dharwad district in Karnataka, India-plants used in oral health care. *J. Pharmacol.* 94(2-3):261-66.
- Herbal Medicine Research Centre (2002). Institute for Medical research, Kuala Lumpur. Compendium of Medicinal plants used in Malaysia. 1:103-104.
- Jadhav VD, Mahadkar SD, Valvi SR (2011). Documentation and ethnobotanical survey of wild edible plants from Kolhapur District. *Recent Research in Science and Technology* 3(12): 58-63.
- Khare CP (2007). Indian medicinal plants: an illustrated dictionary. USA: Springer Science Business Media. 257-285
- Krishna CB (2012). Anti Inflammatory Activity of *Basella Alba* Linn. in Albino Rats. *J. Appl. Pharm. Sci.* 02(04):87-89.
- Kumar P (2010). INDIAN SPINACH, *Basella alba* (PUI) succulent, branched, smooth, twining herbaceous vine. Best Nutrition. (PR Log - Global Press Release Distribution).
- Maisuthisakul P, Ritthiruangdej PS (2008). Relationship between antioxidant properties and chemical composition of some Thai plants. *J. Food. Compos. Anal.* 21:229-240.
- Mohammed HKP, Anu A, Saraswathi R, Guru PM, Chandini N (2012). Formulation and Evaluation of Herbal Gel of *Basella alba* for wound healing activity. *J. Pharm. Sci. Res.* 4(1):1642-1648.
- Paul FM, Silvère N, Pierre K, Etienne T, Félicité MT, Serge C (2006). Effect of extracts from *Hibiscus macranthus* and *Basella alba* mixture on testosterone *in vitro* in adult rat testes slices. *Asian J. Androl.* 8(1):111-114.
- Palada MC, Chang LC (2003). International Co-operators guide: "Suggested cultural practices for Basella", Asian vegetable research and development centre. (AVRDC News letter).
- Palanuvej C, Hokputsa S, Tunsaringkarn T, Ruangrunsi N. (2009). *In vitro* glucose entrapment and alpha-glucosidase inhibition of mucilaginous substances from selected Thai medicinal plants. *Sci. Pharm.* 77:837-849.
- Pascaline J, Charles M, George O, Lukhoba C, Ruth LN, Solomon DM (2010). Ethnobotanical survey and propagation of some endangered medicinal plants from South Nandi District of Kenya. *J. Anim. Plant Sci.* 8(3):1016- 1043.
- Phadungkit M, Somdee T, Kangsadalampai K (2012). Phytochemical screening, antioxidant and antimutagenic activities of selected Thai edible plant extracts. *J. Med. Plants Res.* 6(5):662-666.
- Plants for a future <http://www.pfaf.org/database/plantsphb?Basella+alba>. Accessed on 31 July 2012.
- Premalatha B, Rajgopal G (2005). Cancer-an ayurvedic perspective. *Pharmacol. Res.* 51:19-30.
- Rahmatullah M, Rahman A, Haque Z, Mollik AH, Emdad UM, Begum R, Rahman M, Nasrin D, Seraj S, Chowdhury AR, Khatun Z, Khatun A (2010). A Survey of Medicinal Plants used by Folk Medicinal Practitioners of Station Purbo Para Village of Jamalpur Sadar Upazila in Jamalpur District, Bangladesh. *Am. Eurasian J. Sustainab. Agric.* 4(2):122-135.
- Ramu G, Krishna MG, Jayaveera KN. (2011). Preliminary investigation of patchaippasali mucilage (*Basella alba*) as tablet binder. *Int. J. Green Pharm.* 5(1):24-27.
- Rathee S, Ahuja D, Rathee P, Thanki M, Rathee D (2010). Cytotoxic and Antibacterial Activity of *Basella alba* Whole Plant: A Relatively Unexplored Plant. *Pharmacologyonline* 3:651-658.
- Reshmi SK, Aravinthan KM, Suganya DP (2012). Antioxidant analysis of betacyanin extracted from *Basella alba* fruit. *Int. J. PharmTech Res.* 4(3):900-913.
- Saikia AP, Ryakala VK, Sharma P, Goswami P, Bora U (2006). Ethnobotany of medicinal plants used by Assamese people for various skin ailments and cosmetics. *J. Ethnopharmacol.* 106:149-157.
- Saleh A (2011). Protective effect of *Basella alba* L. on nephrotoxicity induced by gentamycin in rats. *Clin. Exp. Med. J.* 5(4):225-233.
- Sir Ghillean P, Mark N (2005). Cultural history of plants. Routledge, New York. p. 114.
- Sivasankar V, Moorthi A, Sarathi KD, Suganya DP (2011). Anthocyanin and its antioxidant properties in *Basella alba*. *J. Pharm. Res.* 4(3):800-806.
- Toshiyuki M, Kazuhiro H, Masayuki Y (2001). Medicinal food stuffs. XXIII. Structures of new oleananetype triterpene oligoglycosides, basella saponins A, B, C, and D, from the fresh aerial parts of *Basella rubra* L. *Chem. Pharm. Bull.* 49:776-779.
- Tropilab Inc. <http://tropilab.com/bas.html>. accessed on 31 July 2012.
- Vanaliya S, Priya SR, Shaival KR, Sameja K (2012). Pharmacognostical Study of *Basella alba* Stem. *Int. J. Res. Pharm. Biomed. Sci.* 3(3):1093-1094.
- Venkatalakshmi P, Senthamaraiselvi V (2012). Anti ulcer effect of *basella alba* leaf extract in aspirin induced albino rats. *Ijpsr*, 3(8):2539-2542.
- Vijender K, Bhat ZA, Dinesh K, Puja B, Sheela S (2011). In-vitro anti-inflammatory activity of leaf extracts of *Basella alba* linn. *Var. Alba. Int. J. Drug Dev. Res.* April-June, 3(2):176-179.
- Yang RY, Lin S, Kuo G (2008). Content and distribution of flavonoids among 91 edible plant species. *Asia Pac J. Clin. Nutr.* 17(S1):275-279.
- Yasmin H, Kaiser MA, Rahman MM, Rahman MS, Rashid MA (2009). Preliminary antibacterial activity of some indigenous plants. The Dhaka University *J. Pharm. Sci.* 8:61-66.