



A Review on Medicinal Importance of *Basella alba* L.

Roshan Adhikari, Naveen Kumar HN, Shruthi SD*

P.G. Department of Biotechnology, The Oxford College of Science, Bangalore 560102, Karnataka, India

ABSTRACT

The ethanobotanical properties of *Basella alba* have been reviewed in this article. Various parts of the plant are used for treatment of the diseases as well as for different healing activities of human beings as well as animals across the globe especially in India and China. Its use has been discovered as asperient, rubefacient and for catarrhl infections. Some of the compounds available especially in the plant are basellasaponins, kaempherol, betalin, etc. Several extracts like aqueous, chloroform, ethanol and petroleum has been used for different pharmaceutical activities.

Keywords: Asperient, *Basella alba*, basellasaponins, extract rubefacient.

INTRODUCTION

Medicinal plant is defined as any substance with one or more of its organ containing properties that can be used for therapeutic purposes or which can be used as precursors for the synthesis of various drugs. [1] Medicinal plants contain numerous biologically active compounds such as carbohydrates, proteins, enzymes, fats and oils, minerals, vitamins, alkaloids, quinones, terpenoids, flavonoids, carotenoids, sterols, simple phenolic glycosides, tannins, saponins, polyphenols etc. Traditional medicine refers to health practices, knowledge and beliefs incorporating plants, animals and mineral based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses or maintain well being. Over the years, medicinal plants have been found useful in the treatment and management of various health problems. Traditional medicine is undoubtedly a reliable alternative approach to health care delivery in the metropolis because it is cheap, easily accessible and efficacious. Herbal drugs are invariably single plant extracts of fractions thereof or mixtures of fractions/extracts from different plants. Traditional plant medicines might offer a natural key to treat various human ailments. In recent years, there has been an increasing interest by researchers in the use of naturally occurring biologically active compounds of medicinal value. [2] The use of plants for medical purposes dates back to antiquity. [1] Recent research has focused on natural plants product alternative for disease control in developing countries. The majority of rural dwellers do not have access to modern health care, so they mostly depend on

medicinal plant to prevent or eliminate diseases. Medicinal plants are cheaper, more accessible to most of the population in the world. Thus, there is need to encourage the use of medicinal plants as potential sources of new drugs. There has therefore been an upsurge in the interest in herbal remedies in several parts of the world with many of the herbal remedial being incorporated into orthodox medical practice. [3]

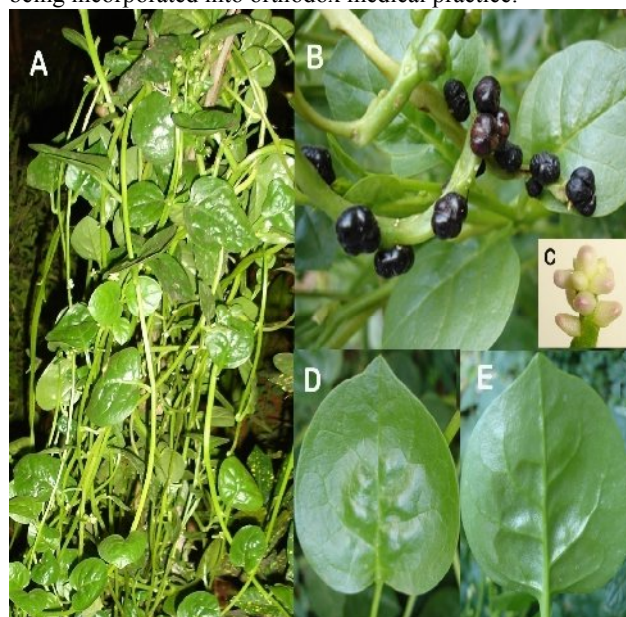


Fig. 1: Morphology of *Basella alba* plant (A), along with Fruits (B), Bud (C), adaxial (D) and abaxial (E) surfaces of the leaf.

*Corresponding author: Ms. Shruthi SD,

Assistant Professor, P.G. Department of Biotechnology, The Oxford College of Science, Bangalore- 560 102, Karnataka, India; Tel.: +91-9482774014; E-mail: sdshruthi@gmail.com

There are many plant species available all over the world which has been used for the multi beneficial activities. India and China are the two major countries that are richer in many of the medicinal plant species. In spite of millions of

chemically synthesized drug for a number of diseases; natural products of plant origin has got its own importance and has remained the most important source of new drugs. One such medicinal herb is *Basella alba*.

The present study is focused towards compiling the ethanobotanical and scientific importance of above mentioned plant.

Taxonomy of the plant

Kingdom : Plantae
Phylum : Magnoliophyta
Class : Magnoliopsida
Order : Caryophyllales
Family : Basellaceae
Genus : *Basella*
Species : *alba*

Basella alba is a widely cultivated, cool season vegetable with climbing growth habit. It is a succulent, branched, smooth, twining herbaceous vine, several meters in length. Stems are purplish or green. Leaves are fleshy, ovate or heart-shaped, 5 to 12 cms long, stalked, tapering to a pointed tip with a cordate base. Spikes are axillary, solitary, 5-29 cm long. Fruit is fleshy, stalkless, ovoid or spherical, 5-6 mm long, and purple when mature. Mainly leaves and stems are used for the medicinal purpose.^[4]

Vernacular Names

English: Ceylon spinach, Malabar spinach, Indian spinach, Hindi: lalbachlu, po, Bengali: Puishak, Oriya: Poi saga, Konkani: Valchibhaji, Kannada: Basalesoppu, Telugu: Bachhali, Tamil: Kodippasali, Tulu: Basale, Marathi: Mayalu, Portuguese: Bertalha, Filipino: Alugbati, Vietnamese: Môngtoi, Sinhalese: VelNiviti (Sudu), Sanskrit name: Upodika, Indian name: Poi

Ethanobotany

Basella alba has been used for many of its useful product from ancient times. Nowadays its properties have been utilized for the extraction of some useful material so that it can be used for the beneficial human activities. Some of the uses of this plant parts in the cure of certain problems occurred to humans has been explained here:

Daily consumption of *Basella alba* has a positive effect on total-body vitamin A stores in men.^[5] The paste of root of red *B. alba* along with rice washed water is taken in the morning in 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.^[2] A paste of the root is applied to swellings and is also used as a rubefacient. Sap is applied to acne eruptions to reduce inflammation. Decoction of leaves used for its mild laxative effects. Pulped leaves applied to boils and ulcers to hasten suppuration. Sugared juice of leaves is useful for catarrhal afflictions. 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 aperients 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.^[4] This plant serves as a Thai traditional vegetable. The fruit provides dark violet color for food colorant. *Basella* mucilage has been used in Thai traditional medicine as topical application for irritant, bruise, ringworm and laboring. Stem and leaves are used as mild laxative, diuretic and antipyretic.^[6] In India, it has been used for antipruritis and burn^[7], and has been used in Bangladesh for acne and freckle treatment.^[8] The Ayurvedic treatment in India has been used *B. alba* leaves and stem for anticancer such as melanoma, leukemia and oral cancer.^[9]

Root and leaves has been used for the removal of after birth, stomach pains and increase milk production.^[10] *Basella alba* is administered orally for the treatment of anal prolapsed or hernia. Ground leaves of *Basella alba* are rubbed on the human hand to introduce the whole preparation into the animal vagina every morning for the treatment of sterility.^[11] 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.^[12] *Basella alba* has been used for the treatment of Anemia in women, coughs, cold (leaf with stem), cold related infections.^[13] Maceration is taken orally for infertility, pelvic inflammatory disease, orchitis, epididymitis, threatened abortion, spurious labour.^[14] Leaves are used in constipation, poultice for sores, urticaria and gonorrhea. It is also used in poultice local swellings, intestinal complaints etc.^[15] The mucilaginous liquid obtained from the leaves and tender stalks of plants is popular remedy for headaches.^[16]

Pharmacognosy and Phytochemistry

The relevant work has not been carried out on *B. alba* till date, and hence research focusing on pharmacognostic profile is undertaken in near future. 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 *Basella alba* at a concentration of 1.4mg/100g.^[17] *Basella* mucilage is viscous with low swelling capacity. Its pH is good for skin (5.3-5.4). 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. *Basella alba* contains basellasaponins^[18], amino acid such as arginine, leucine, isoleucine, lysine, threonine and tryptophan^[19], peptide, phenolic compounds in various extracts.^[20] *Basella* fruit contains gomphrenin derivative which is betalain pigment.^[21] The mucilage of *B. alba* consists of mixture of polysaccharides^[22], and starch-type glucan which can be separated by starch iodine complex.^[23] Plant mucilage is composed of water soluble polysaccharide, which functions as water retention, germination, food reservoir and secondary metabolite storage. For the pharmaceutical aid, the mucilage can be used as thickener, water-retention agent, gelling agent, suspending agent, and

film former.^[24] *Basella* mucilage was also proposed for the applications of medicine and cosmetics. The antityrosinase which was accorded to traditional used for anti freckle is tested. Antioxidant activity related to the inflammation mechanisms caused by free radicals is assayed. Then formulation of gel from *Basella* mucilage was prepared which can be used for further development of cosmetic and anti-inflammatory purposes as topical usage. Anthocyanins are a natural pigment which is responsible for the blue, purple, violet and red colours in fruits, flowers, stem and leaves.^[21]

Antioxidant activities, total phenolic, flavonoid and ascorbic acid contents of *B. alba* commonly consumed in Nigeria are determined. A high and significant correlation existed between antioxidant activity and total phenolic content indicating that total phenolic content is the major contributor to the antioxidant activity of the plant. Ascorbic acid fairly correlated with antioxidant and phenolic content.^[25] *B. alba* contains β carotene.^[26] The phytochemical contents of the leafy vegetables serve as supplements for food and also have the potential to improve the health status of its users as a result of the presence of various compounds vital for good health. Their fiber content provides bulk in the diet and this helps to reduce the intake of starchy foods, enhances gastrointestinal function, prevents constipation and may thus reduce the incidence of metabolic diseases like maturity onset, diabetes mellitus and hypercholesterolemia. They are also potent antibiotics, antihypertensives and blood building agents and improve fertility in females when eaten in soups. Total oxalate, soluble oxalate and nitrate were determined for leaves of *Basella alba* L. grown on soils of medium and high fertility. Higher soil fertility resulted in increased total oxalate in *Basella*. Leaves grown on high-fertility soil had more nitrate than those from medium fertility.^[27]

Pharmacology

In vitro pharmacology

Mucilaginous substances from *Basella alba* was studied for *in vitro* glucose entrapment and compared to glucomannan powder. The mucilage solution showed gel-forming characteristics and concentration response on glucose entrapment activity.^[28] Anthocyanin pigments are reported to have many therapeutic benefits including vasoprotective and anti-inflammatory properties, anti cancer, chemo protective and anti-neoplastic properties, reversing age related deficits^[29] and useful in controlling oxidative stress during pregnancies complicated by intrauterine growth retardation.^[30] It has also been suggested that anthocyanins has got the ability to stabilize DNA triple helical complexes^[31] and can also protect the chloroplast against high light intensities.^[32]

In the present scenario, there is a rising demand for natural sources of food colorants with nutraceutical benefits with anthocyanins. Antioxidant assays were done by enzymatic assay methods like Super oxide dismutase, Catalase and Peroxidase, *Basella alba* showed higher activity.^[33] Crude aqueous extract possess mild antioxidant, and no tyrosinase inhibitory activity. *Basella alba* is used traditionally in Thailand for anti-inflammatory, cytotoxicity and antioxidant activities of anti-inflammatory remedies. This allowed the selection of leaf extracts for various ethnopharmacological researches by Nisarath *et al.*^[34] The methanolic extracts exhibited marked antimicrobial activity against gram positive

and gram negative bacteria and fungi. *Basella alba* showed good inhibitory activity against *Aspergillus niger*.^[35] The leaf extracts (methanolic extract and aqueous extract) of *Basella alba* Linn.var. *alba* were investigated for *in-vitro* anti-inflammatory activity by human red blood cell membrane stabilization method (HRBC). Aqueous extract showed significant *in vitro* anti-inflammatory activity compared to methanolic extract. The *in-vitro* anti inflammatory activity of the extracts were concentration dependent, with the increasing concentration, the activity is also increased. *Basella alba* L. leaf extracts exhibited membrane stabilization effect by inhibiting hypotonicity induced lysis of erythrocyte membrane. The erythrocyte membrane is analogous to the lysosomal membrane and its stabilization implies that the extract may as well stabilize lysosomal membranes. Stabilization of lysosomal membrane is important in limiting the inflammatory response by preventing the release of lysosomal constituents of activated neutrophil such as bactericidal enzymes and proteases, which cause further tissue inflammation and damage upon extracellular release.^[36] Antioxidant and antimutagenic activities of plant extracts act as functional foods for cancer prevention. Antioxidant activity was expressed as the ability of each extract to scavenge the free radicals 1, 1-diphenyl-2-picrylhydrazyl (DPPH). Antimutagenic activity was evaluated with the Ames test using *Salmonella typhimurium* strains TA 98 and TA 100. *Basella alba* Linn. extract had the strongest antimutagenicity with both strains of *S. typhimurium* with high percentage of inhibition value. Flavonoids and phenolic compounds from the herbal extracts are proposed to be antioxidant and antimutagenic agents, respectively. The apparent antioxidant and antimutagenic activities of the plant further suggests their potential usefulness in cancer prevention. The possible mechanisms may be classified as: Firstly, *B. alba* extracts might include the blocking of the mutagen transfer into the cytosol by phenolic binding or insertion into the transporters of the outer membrane of the cell.^[37] Secondly, *B. alba* extracts modified the permeability for mutagens across bacterial membranes.^[38]

In-vivo pharmacology

The effects of the aqueous leaf extract of *Basella alba* on haematological and biochemical parameters were studied in Wistar strain albino rats. 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 ALP, ALT and AST. Totally, adding *B. alba* leaves as part of daily diet may reduce anemia and maintain good health.^[39] *Basella alba* is a plant used in traditional medicine in the West Cameroon region to treat sexual asthenia and infertility in man. Its methanol extracts stimulated testosterone production in testicular fractions and Leydig cell cultures, and in normal adult albino male rats. In Leydig cells, testosterone is partly metabolized into estradiol by aromatase. The stimulatory effect on estradiol level may result from its effect on aromatase gene transcription and translation into a biologically active enzyme.^[40] CNS depressant activity of the aerial parts of *B. alba* was determined by Anandarajagopal *et al.*^[2] Petroleum ether, methanol and aqueous extracts were prepared from dried aerial parts of *Basella alba* by cold maceration method and CNS (Central

Nervous System) depressant activity was evaluated by pentobarbitone induced sleeping time test, open field test and hole cross test in mice. Methanol extract showed highly significant CNS depressant activity than other extracts tested.^[2]

An attempt was made to screen the anti-inflammatory activity of *Basella alba* leaf in experimentally induced inflammations in rats. The aim was met by two methods, one is carrageenan induced paw edema and another is cotton pellet granuloma. *Basella alba* extract showed a significant activity at a dose of 500 mg/kg. *Basella alba* possesses a good anti-inflammatory activity and shows a dose depending activity.^[41]

Basella alba has been used from a long time back for the treatment of many diseases like dysentery, diarrhea, anemia, cancer etc. It has also been utilized for different kinds of healing activities. Various kinds of extract like aqueous extract, methanolic extract, petroleum extract, chloroform extract has been prepared from different parts of the plant has been utilized in the treatment of many diseases since time immortal all over the world. India and China are the two major countries harbouring this plant and utilizing it for the benefit of human being. It also consists of compounds that can be used for the preparation of medicine by pharmacological industry. The chemical composition of the leaf extract has been found to be: 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. Some unique constituents of the plant are basellasaponins, kaempherol and betalain. The pharmacological activities of *Basella alba* has been tested by both *in-vitro* as well as *in-vivo* methods. Antioxidant activity, antimutagenic activity has been carried out by the scientist to explore the dynamics of the plant for the advancement in the treatment of the diseases. CNS depressant activity, anti inflammatory activity has also been observed for this plant. Knowing that plants have a large number of chemical substances, which have several pharmacological actions, we should exploit more natural products, which in the future could show the cure for many illnesses. It is hoped that compilation of this review will serve as a guide to all those involved in this particular field of research.

REFERENCES

1. Sofowora A. Medicinal Plants and traditional medicines in Africa. 2nd Edn. Karthala Ibadan Nigeria, 1993.
2. Anandarajagopal K, Sudhakar D, Ajaykumar TV, Muthukumaran G. Evaluation of CNS Depressant Activity of Aerial Parts of *Basella alba* Linn. IJPI'S Journal of Pharmacology and Toxicology 2011; 1:5.
3. Daniyan SY, Muhammad HB. Evaluation of the antimicrobial activities and phytochemical properties of extracts of *Tamarindus indica* against some diseases causing bacteria. African Journal of Biotechnology 2008; 7(14): 2451-2453.
4. Kumar P. INDIAN SPINACH, *Basella alba* (PUI) succulent, branched, smooth, twining herbaceous vine. Best Nutrition, 2010.
5. Haskell MJ, Jamil KM, Hassan F, Peerson JM, Hassain MI, Fuchs GJ, Brown KH. 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. 2004; 80(3): 705-714.
6. Chou CT. The anti-inflammatory effect of *Tripterygium wilfordii* Hook F on adjuvant-induced paw edema in rats and inflammatory mediators release. Phytother Res. 1997; 11:152-154.
7. Saikia AP, Ryakala VK, Sharma P, Goswami P, Bora U. Ethnobotany of medicinal plants used by Assamese people for various skin ailments and cosmetics. J Ethnopharmacol. 2006; 106:149-157.
8. Akhter S, Abdul H, Shawkat IS, Swapan KS, Mohammad SHC, Sanjay SS. A review on the use of non-timber forest products in beauty-care in Bangladesh. J Forestry Res. 2008; 19:72-78.
9. Premalatha B, Rajgopal G. Cancer-an ayurvedic perspective. Pharmacol Res. 2005; 51:19-30.
10. Pascaline J, Charles M, George O, Lukhoba C, Ruth L N, Solomon D M. Ethnobotanical survey and propagation of some endangered medicinal plants from south Nandi district of Kenya. Journal of Animal & Plant Sciences 2010; 8(3): 1016- 1043.
11. Chifundera K. Livestock diseases and the traditional medicine In the Bushi area, Kivu province, democratic Republic of Congo. African Study Monographs 1998; 19(1): 13-3.
12. Ramu G, Krishna Mohan K, Jayaveera KN. Preliminary investigation of patchaippasali mucilage (*Basella alba*) as tablet binder. IJGP 2011; 5(1):24-27.
13. Rahmatullah M, Rahman A, Haque Z, Mollik AH, Emdad Ullah Miajee ZUM, Begum R, Rahman M, Nasrin D, Seraj S, Chowdhury AR, Khatun Z, Khatun A. A Survey of Medicinal Plants used by Folk Medicinal Practitioners of Station Purbo Para Village of Jamalpur Sadar Upazila in Jamalpur district, Bangladesh. American-Eurasian Journal of Sustainable Agriculture 2010; 4(2): 122-135.
14. Focho DA, Nkeng EAP, Lucha CF, Ndam WT, Afegenui A. 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. Journal of Medicinal Plants Research. 2009; 3(4): 301-314.
15. Yasmin H, Kaiser MA, Rahman MM, Rahman MS, Rashid MA. Preliminary antibacterial activity of some indigenous plants. The Dhaka University Journal of Pharmaceutical Sciences 2009; 8: 61-66.
16. Jadhav VD, Mahadkar SD, Valvi SR. Documentation and ethnobotanical survey of wild edible plants from Kolhapur District. Recent Research in Science and Technology 2011; 3(12): 58-63.
17. Yang RY, Lin S, Kuo G. Content and distribution of flavonoids among 91 edible plant species. Asia Pac J Clin Nutr. 2008; 17(S1): 275-279.
18. Toshiyuki M, Kazuhiro H, Masayuki Y. Medicinal foodstuffs. XXIII. Structures of new oleananetype triterpene oligoglycosides, basellasaponins A, B, C, and D, from the fresh aerial parts of *Basella rubra* L. Chem Pharm Bull. 2001; 49:776-779.
19. Khare CP. Indian medicinal plants: an illustrated dictionary. USA: Springer Science Business Media, 2007.
20. Maisuthisakul P, Ritthiruangdej PS. Relationship between antioxidant properties and chemical composition of some Thai plants. J Food Compos Anal. 2008; 21:229-240.
21. Glassgen WE, Metzger JW, Heuer S, Strack D. Betacyanins from fruits of *Basella rubra*. Phytochemistry 1993; 33:1525-1527.
22. Palanuvej C, Hokputsa S, Tunsaringkarn T, Ruangrunsi N. *In vitro* glucose entrapment and alpha-glucosidase inhibition of mucilaginous substances from selected Thai medicinal plants. Sci Pharm. 2009; 77:837-849.
23. Haq QN, Awal A, Chowdhury MK, Khan NA. Water-soluble polysaccharides from the leaves of *Basella rubra*. Sci Res. 1969; 6:63-6.
24. Jani GK, Shah DP, Jain VC, Patel MJ, Vithalani DA. Evaluating mucilage from *Aloe Barbadensis* Miller as a pharmaceutical excipient for sustained release matrix tablets. Pharm Technol. 2007; 31:90-98.
25. Olajire AA, Azeez L. Total antioxidant activity, phenolic, flavonoid and ascorbic acid contents of Nigerian vegetables, African Journal of Food Science and Technology 2011; 2(2): 022-029.
26. Barbosa-Filho JM, Alencar AA, Nunes XP, Tomaz ACA, Sena-Filho JG, Athayde-Filho PF, Silva MS, Souza MFV, da-Cunha EVL. Sources of alpha-, beta-, gamma-, delta- and epsilon-carotenes: A twentieth century review, Brazilian Journal of Pharmacognosy 2008; 18(1): 135-154.
27. Schmidt DR, MacDonald HA, Brockman FE. Oxalate and Nitrate Contents of Four Tropical Leafy Vegetables Grown at Two Soil Fertility Levels. Agronomy Journal 1970; 63(4): 559-561.
28. Palanuvej C, Ruangrunsi N. *In Vitro* Glucose Entrapment of Mucilaginous Substances from Various Medicinal Plants. Sci Pharm. 2009; 77: 837-849.
29. Joseph JA, Shukitt-Hale B, Denisova NA, Bielinski D, Martin A, McEwen JJ, Bickford PC. Reversals of age-related declines in neuronal signal transduction cognitive and motor behavioral deficits

- with blueberry, spinach or strawberry dietary supplementation. The Journal of Neurosciences 1999; 8114-8121.
30. Pawlowicz P, Stachowiak G. Administration of natural anthocyanins derived from chokeberry retardation of idiopathic and preclimptic origin. Influence on metabolism of plasma oxidized lipoproteins: the role of autoantibodies to oxidize low density lipoproteins. Ginekol Pol. 2000; 71: 848-853.
 31. Mas T, Susperregui J, Berké B, Chèze C, Moreau S, Nuhrich A, Vercauteren J. DNA triplex stabilization property of natural anthocyanins. Phytochemistry. 2000; 53: 679-687.
 32. Pietrini F, Iannelli MA, Massacci A. Anthocyanin accumulation in the illuminated surface of maize Leaves enhances protection from photoinhibitory risk at low temperature without further limitation to photosynthesis. Plant, cell and environment, 2002; 25: 1251-1259.
 33. Sivasankar V, Moorthi A, Sarathi Kannan D, Suganya devi P. Anthocyanin, and its antioxidant properties in *Basella alba*. Journal of Pharmacy Research. 2011; 4(3): 800-806.
 34. Siriwatanametanon N, Fiebich BL, Efferth T, Prieto-Garcia JM, Heinrich M. Traditionally used Thai medicinal plants: In vitro anti-inflammatory, anticancer and antioxidant activities. J. Ethnopharmacol. 2010; 130(2): 196-207.
 35. Premakumari KB, Ayesha Siddiqua, Shanaz Banu, Josephine J, Leno Jenita, Bincy Raj. Comparative Antimicrobial Studies of Methanolic Extract of *Muntingia calabura*, *Basella alba* and *Basella rubra* Leaves. Research Journal of Pharmacognosy and Phytochemistry. 2010; 2(3): 246-248.
 36. Kumar V, Bhat ZA, Kumar D, Bohra P, Sheela S. *In-vitro* anti-inflammatory activity of leaf extracts of *Basella Alba* Linn. Var. Alba. International Journal of Drug Development and Research 2011; 3(2): 176-179.
 37. Haskell MJ, Jamil KM, Hassan F, Peerson JM, Hossain MI, Fuchs GJ, Brown KH. Daily consumption of Indian spinach (*Basella alba*) or sweet potatoes has a positive effect on total -body vitamin A stores in Bangladeshi men. The American Journal of clinical nutrition 2004; 80(3): 705-714.
 38. Phadungkit M, Somdee T, Kangsadalampai K. Phytochemical screening, antioxidant and antimutagenic activities of selected Thai edible plant extracts. Journal of Medicinal Plants Research 2012; 6(5): 662-666.
 39. Bamidele O, Akinnuga AM, Olorunfemi JO, Odetola OA, Oparaji CK, Ezeigbo N. Effects of aqueous extract of *Basella alba* leaves on haematological and biochemical parameters in albino rats. African Journal of Biotechnology 2010; 9(41): 6952-6955.
 40. Nantia EA, Travert C, Manfo Faustin-Pascal T, Carreau S, Monsees TK, Moundipa PF. Effects of the Methanol Extract of *Basella alba* L. (Basellaceae) on Steroid Production in Leydig Cells. Int J Mol Sci. 2011; 12: 376-384.
 41. Rodda R, Kota A, Sindhuri T, Kumar SA, Gnananath K. Investigation on anti-inflammatory property of *Basella alba* Linn leaf extract. International Journal of Pharmacy and Pharmaceutical Sciences 2012; 4(1): 452-454.