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A pharmacognostic and pharmacological review on *Vigna aconitifolia* (Moth bean)

Sushmita Singh and Imtiyaz Ansari

Abstract
Vigna aconitifolia is generally known as mat bean, moth bean, matki, Turkish gram or dew bean. The pods, sprouts and protein rich seeds of this crop are normally consumed in India. Moth bean can be grown on many soil types, and can also act as a field legume. Due to its famine resistant merits, its capacity to fight soil erosion and its high protein content, moth bean has been identified as possibly a more significant food source in the future. It has been recommended that its correctness as a grain legume in semi-arid Africa should be further investigated. In the present study, phytochemical contents of moth bean (*Vigna aconitifolia*) seed accessions were evaluated. This includes protease inhibitors, phytic acid, radical scavenging activity, and tannins. The studies publicized important deviation in the contents of theses phytochemicals. Presence of photochemical composition was linked with seed storage proteins like albumin and globulin. The seeds of *Vigna aconitifolia* is analysed for proximate composition, minerals, seed protein fractions, amino acids, fatty acids, and antinutritional factors. The pulse is found to be rich sources of proteins and minerals like Ca, Mg, Fe, Zn, and Mn. Vigna aconitifolia seeds exhibited quite high levels of crude lipid. The most limiting necessary amino acids in both the pulses were the sulphur-amino acids, cystine, and methionine. Threonine in *V. aconitifolia* occurred in higher quantities when compared with WHO/FAO requisite pattern. Oleic acid and palmitic acid in *V. aconitifolia* is found to be the predominant fatty acids. The other antinutritional factors like total free phenols, L-DOPA and haemagglutinating activity were also analysed/assayed.

Keywords: *Vigna aconitifolia*, moth bean, haemagglutinating, phytic acid

Introduction
Belonging to the family Fabaceae (sub-family Papilionaceae), the moth bean is an herbaceous creeping annual that creates a low-lying soil cover when fully grown [1]. The natural antioxidants, more recently, have fascinated the considerable concentration of users and researchers. In this context, medicinal plants are being viewed as an easily accessible and potent source of antioxidants as they contain a mixture of different chemical compounds [2]. Antioxidants are having a key role in the prevention of human diseases and may function as scavengers of free radicals. These are capable even in small quantities, to prevent or reduce the oxidative destruction of biologically important compounds such as lipids, proteins, and nucleic acids [3]. Herbs can be used as an alternative remedy for different neurological disorders. Different bioactive compounds isolated from herbs are being successfully used for the treatment of neurological disorders [4]. The past decade has also witnessed an intense interest in herbal medicines that have long-term health-promoting qualities [5]
Over the years and the latest, there have been numerous studies documenting the antibacterial, antifungal, antiviral, anticancer and anti-inflammatory properties of plant ingredients. Therefore, herbal derived substances stay the source for a large proportion of commercial medications used today in developing countries. When we refer to plants of medicinal value, we often list their active ingredients, which might include alkaloids, glycosides, essential oils, polyphenolic compounds and some other unusual substances [6]. Phytochemicals are the bioactive compounds that occur naturally in plants. Leguminous seeds are important source of proteins and source of natural antioxidants. Legumes contain a number of phenolic compounds such as flavonoids, phenolic acids, and tannins. There is a considerable interest in finding natural phytochemicals and antioxidants from plants due to their role in the treatment and/or prevention of various diseases. Trypsin inhibitors decrease the occurrence of certain cancers and potent anti-inflammatory nature. A number of studies have reported on the antioxidant and antiradical activity of tannins. Therefore, description of seed proteins, nutritional consequence and phytochemical compositions has augmented to a great extent [7].

Moth bean (*Vigna* Moth bean (*Vigna aconitifolia L.*) is a breeze resistant legume, fitting to the family Fabaceae, commonly grown in arid and semiarid regions of India. It is unusually vigorous legume and known by various other names including mat bean, matki, Turkish gram, or dew bean. India's dehydrated state, Rajasthan, is the major moth bean growing state contributing almost 86% area of the nation [8].

Growing conditions

Growth is most approving at a sturdy temperature [9]. Moth bean, a short-day crop, is one of the most famine resistant pulses in India. Matured at altitude up to 1300m above sea level, it has a broad pH range (3.5–10) and can endure small salinity [10]. While dry sandy soil is most appropriate for production, moth bean can bear a diversity of soil types [10]. The low lying soil cover the crop and helps to avoid soil erosion by preventing humidity loss [7]. Optimum production of moth bean occurs between 24–32 °C, but has been revealed to tolerate up to 45 °C during the day [10]. While most favourable annual rainfall for production is 500–750 mm, it is capable to cultivate with 200–300 mm annually, and some yield has been prominent at rainfall levels as low as 50–60 mm per year [10]. Reproduction of moth bean is done by seed, preferably on a equipped seedbed, at an optimum temperature of 25–27 °C. [10]. Application of Fertilizer to moth bean are rare in India [10].

Habitat and distribution

Vigna aconitifolia is inhabitant to India and Pakistan, developed for food production and as a scavenge and cover crop [9]. It is predominately grown in India, even though it has been cultured in the Thailand, Australia, United States, and other parts of Asia [10]. 1.5 million hectares of terrain is used in India for moth bean manufacture, producing around 0.4 million t/ha of seeds. Whereas its existence in Somalia, Sudan and other tropical countries of Africa has been renowned, it has not been a crop of huge significance to this province. The prospective of increased production in this province in the future has been recommended [10].

Morphology

Vigna aconitifolia stem can raise up to 40 cm in height, with its bushy and intense-packed twigs reaching a duration of up to 150 cm [10]. Yellow flowers build up into a brown pod 2.5 to 5 cm in length, which seize 4 to 9 seeds within [10]. The rectangular seeds exist in a variety of colours as well as, yellow-brown, whitish green and stippled with black [9].

Taxonomical classification [11]

Kingdom: Plantae
Sub kingdom: vascular
Order: Fabales
Family: Fabaceae
Subfamily: Faboideae
Tribe: Phaseoleae
Genus: Vigna
Species: *V. aconitifolia*
Binomial name: *Vigna aconitifolia* (Jacq.) Marechal
Synonyms: Phaseolus aconitifolius Jacq.

Nomenclature [12]

Moth Bean, Mat Bean, Turkish Gram

- Hindi: bhringga, matki, mot, मोठ moth
- Kannada: madaki, madike, saabara hesara kaalu, thuruku hesaru, tutuku hesaru
- Marathi: mat, math, matha, matki
- Tamil: payaru, tulkapayir
- Telugu: kunkumapesalu, minumulu.

Phytochemical composition

The seeds of *Vigna Aconitifolia* enclose 0.20 % of L-dopa [13]. Fully grown, unprocessed moth bean seed contain per 100 g edible portion: water 9.7 g, energy 1435 kJ (343 kcal), protein 22.9 g, fat 1.6 g, carbohydrate 61.5 g, Ca 150 mg, Mg 381 mg, P 489 mg, Fe 10.9 mg, Zn 1.9 mg, vitamin A 32 IU, thiamin 0.56 mg, riboflavin 0.09 mg, niacin 2.8 mg, vitamin B_6 0.37 mg, folate 649 µg and ascorbic acid 4.0 mg. The essential amino-acid composition per 100 g edible portion is: tryptophan 147 mg, lysine 1248 mg, methionine 220 mg, phenylalanine 1028 mg, valine 734 mg, leucine 1541 mg and isoleucine 1138 mg. The principal fatty acids are per 100 g edible portion: linoleic acid 485 mg, palmitic acid 313 mg, linolenic acid 265 mg, oleic acid 129 mg and stearic acid 51 mg (USDA, 2005) [14]. *Vigna Aconitifolia* consists of trypsin inhibitor; tannins phytic acid; and antioxidant activity [15, 16]. Condensed tannins are placed primarily in the testa and play an significant function in the defense system of seeds. Their concentration varies depending on a number of factors such as altered genotype, agronomic practices, seasonal variations, and postharvest storage. The moth bean is one of the most famine resistant pulse in India, requiring little irrigation for manufacture [17]. *Vigna aconitifolia* seeds have maximum concentration of trypsin inhibitor in Jwala and minimum concentration in I.C. #39756 [18].

Method for Determination of Condensed Tannins and Phytic Acid

For tannin separation, four hundred mg of finely powdered defatted meal was assorted with 40 mL distilled water. The suspension was then boiled for 30 min cooled and later centrifuged at 2000 ×g for 10 min and used as a source for tannin evaluation. Tannins were estimated as tannic acid equivalent according to the process of Schandrel [19]. After extraction, 1 mL of the clear supernatant was used as a basis of tannins and to this 5 mL of Folin-Denis reagent, 10 mL of sodium carbonate solution was added followed by dilution to 100 mL with water. The tubes were incubated at room temperature for 30 min and the color thus developed was read at 700 nm using Systronics UV-Vis spectrophotometer.

For phytic acid, powdered 50 mg seed samples was extracted overnight in 0.4 mM HCl followed by centrifugation for 20 min at 10,000 ×g at room temperature. Supernatant was collected and used as a basis for phytic acid examination. 10 μL of sample was taken in a microtiter plate, diluted with 90 μL double-distilled water, and followed by addition of 100 μL colorimetric reagent (3 M H_2SO_4, 2.5% ammonium

molybdate, 10% (w/v) ascorbic acid, and distilled water in 1 : 1 : 1 : 2 ratio). The contents were incubated for 60 min at room temperature and absorbance was taken at 650 nm using Systronics UV-Vis spectrophotometer [20].

Method for determination of trypsin inhibitor (TI) activity
The inhibitor content was measured using *BAPNA* as a substrate [21]. For measuring trypsin inhibitory activity 10 μg of trypsin was mixed with suitable amount of the sample (to get 50–60% inhibition) and incubated at 25°C before measuring the remaining trypsin activity. 10 μL of seed extract was mixed with 80 μL of 50 mM Tris-HCl buffer, pH 8.2, containing 20 mM $CaCl_2$, and 10 μL of trypsin and incubated at room temperature at 30 sec interval between two wells on a microtiter plate. The residual activity was measured by adding 125 μL of *BAPNA* (40 mg/mL dimethyl sulfoxide, freshly diluted 1 : 100 in 50 mM Tris-HCl buffer, pH 8.2, and 20 mM $CaCl_2$ prewarmed to 37°C) and then incubated at room temperature for 30 min. Reactions were stopped by the addition of 25 μL of 3% (v/v) acetic acid. Liberated *p*-nitroaniline was measured at 410 nm. 100% trypsin activity was measured from the sample minus the inhibitor extract. One unit of trypsin activity was defined as the amount of enzyme which increases the visual density by one unit at 410 nm due to the release of *p*-nitroaniline. One trypsin inhibitor unit was defined as the amount of inhibitor that inhibited 1 unit of trypsin activity [21].

Method for determination DPPH radical scavenging assay
Scavenging activity on DPPH free radicals by the extracts was assessed according to the method reported by Awah *et al*. [22] with slight modifications of Gyamfi *et al*. [23] Briefly, a 2.0 mL solution of the extract, at different concentrations diluted twofold (2–125 μg/mL) in methanol, was mixed with 1.0 mL of 0.3 mM DPPH in methanol. The mixture was shaken strongly and allowed to stand at room temperature in the dark for 25 min. Blank solutions were equipped with each test sample solution (2.0 mL) and 1.0 mL of methanol while the negative control was 1.0 mL of 0.3 mM DPPH solution plus 2.0 mL of methanol. L-ascorbic acid was used as the positive control. Subsequently the absorbance of the assay mixture was measured at 518 nm against each blank with Systronics 2203 UV-Vis spectrophotometer. Lower absorbance of the reaction mixture indicated higher radical scavenging activity.
DPPH radical scavenging activity was calculated using the equation

$$DPPH\% = ((Ablank - Asample)\ Ablank) \times 100$$

Solubility
Dopamine is freely soluble in water, methanol, and hot 95% ethanol but is virtually insoluble in ether, petroleum ether, chloroform, benzene, and toluene [24].

Traditional Uses
Seed of *Vigna aconitifolia* is said to be a traditional source, used in healing of paralysis, for weight reduction, rheumatism, cough, fever and liver ailments [25].

Pharmacological activities
Antioxidant activity
The human body has a complex system of natural enzymatic and non-enzymatic antioxidant defenses which counteract the harmful effects of free radicals and other oxidants. Free radicals are responsible for causing a large number of diseases including cancer [26] cardiovascular disease [27] neural disorders [28] Alzheimer's disease [29], mild cognitive impairment [30] Parkinson's disease [31] alcohol induced liver disease [32], ulcer-ative colitis [33] aging [34] and atherosclerosis [35]. The antioxidant activity and free radical-scavenging potential of phenolics of raw and dry heated moth bean (*Vigna aconitifolia*) (Jacq.) Marechal seed extracts. The antioxidative characteristics and total phenolic contents of *Vigna aconitifolia* were evaluated. The raw and dry heated samples were separated with 70% acetone and the extracts were freeze-dried. The raw seeds consists maximum levels of total phenolics (6.54%) and tannins (1.91%) than the dry heated seeds. The extracts were screened for their potential antioxidant activities using, OH, ±, ±- diphenyl-²-picrylhydrazyl (DPPH), 2,22 -azinobis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS+), Ferric reducing/antioxidant power (FRAP), linoleic acid emulsion and Fe2+ chelating systems. At 1 mg of extract in the reaction mixture, the superoxide anion radical-scavenging activity in raw and dry heated seed extracts. The DPPH radical and ABTS cation radical scavenging activities were well proved and concurrent with the ferric reducing antioxidant capability of the extracts [36] conducted by Perumal *et al* 1988.

Anti inflammatory
Inflammation is a defense response of our body to hazardous stimuli such as allergens and/or injury to the tissues; on the other hand, uncontrolled inflammatory response is the main cause of a vast continuum of disorders including allergies, cardiovascular dysfunctions, metabolic syndrome, cancer, and autoimmune diseases imposing a huge economic burden on individuals and consequently on the society [37]. Thus, we need to apply natural anti-inflammatory factors within medication therapy to achieve increased pharmacological response and the lowest degree of unwanted side effects [37, 38]. Trypsin inhibitors were acceptable for reducing the incidence of certain cancers and potent anti-inflammatory properties [39] conducted by F. Roy, J. I. Boye *et al* 2010. Concentration of trypsin inhibitor in the seeds of moth bean is quantified. The maximum concentration of trypsin inhibitor that was found in Jwala is 0.078 TIU/mg and the lowest concentration that was found in I.C. #39756 is 0.041 TIU/mg. Differences in the concentration of inhibitor and their activity exist between pulse crop species and may be accredited to varietal differences [40] conducted by P.W. Franks, M.-Y. Wong *et al* 2002.

Neurodegenerative diseases
Several common themes have driven prevailing notions about neurodegenerative diseases and their underlying etiology. Pathologically, a fre-quent characteristic of these diseases is the accumulation and aggregation of abnormal or misfolded proteins, as with amyloid-β (Aβ) in Alzheimer's disease (AD) [41, 42], α-synuclein in Parkinson's disease (PD) [43], huntingtin protein in Huntington's disease (HD) [44], and transac-tive response DNA-binding protein 43 (TDP-43) in frontotemporal dementia (FTD) and amyo-trophic lateral sclerosis (ALS) [45]. The discovery of genetic mutations causing rare, early onset, familial forms of these diseases, as with *APP* (amyloid precursor protein) gene in AD [46] and the *SNCA* (α-synuclein) gene in PD [47], fur-ther focused attention on mechanisms directly connected to disease pathology.

However, most cases of AD, PD, and other neurodegen-erative diseases cannot be explained by simple Mendelian inheritance of genetic mutations in isolated disease-specific pathways. These late onset, sporadic forms of disease are thought instead to have a complex etiology, with sus-ceptibility influenced by lifestyle and environ-mental factors in addition to as-yet-uncharac-terized variants in numerous genes [48-52]. Protease inhibitors are recommended as potential drugs for treating various diseases such as human immunodeficiency virus (HIV), hypertension, and neurodegenerative disease, along with various infectious diseases [39] by F. Roy, J. I. Boye *et al* 2010. Most of the research on health benefits of protease inhibitors has been performed [53, 54] by A. R. Kennedy *et al* 1993, B. J. Xu *et al* 2007. However, research in this direction is in progress.

Conclusion

Vigna aconitifolia is very useful habit for treating various types of diseases. Various studies have demonstrated that V.aconitifolia possess antioxidant, antiinflammatory, neurodegenerative activity. The chemical constituents such as phenolics, trypsin inhibitors, protease inhibitors are responsible for this activities. Review of the literature concluded that Vigna aconitifolia is considered to be a useful herbal medicinal plant.

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Conflicts of Interests

The authors declare that there is no conflicta of interests regarding the publication of this paper.

Authors contribution

We declare that this work done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be done by the authors. Miss Sushmita Singh collected the data, and analysed the data. Prof. Imtiyaz Ansari proof read the whole manuscript, and suggested the necessary changes, and helps in designing manuscript.

References

1. Springer US, Sathe SK, Venkatachalam M. Fractionation and biochemical characterization of moth bean (*Vigna aconitifolia*) proteins. LWT-Food Science and Technology. 2007; 40(4):600-610.
2. Halima Saiah, Rachida Allem, Fatima Zohra Kebir. Antioxidant and antibacterial ACtIVITIES of six algerian medicinal plants, International Journal of Pharmacy and Pharmaceutical Sciences ISSN- 0975-1491 Vol 8, Issue 1, 2016
3. Sudhanshu Sekhar Rout, Sovan Pattanaik, Sudam Chandra SI, Prakash Mohanty. Synthesis, Characterization and antioxidant activity of potassium cisdiaqua-bis (oxalato) chromate (III) with levodopa and Carbidopa, International Journal of Pharmacy and Pharmaceutical Sciences ISSN- 0975-1491, 2018, 1.
4. Pankaj Phukan, Meenakshi Bawari, Mahuya Sengupta. Promising Neuroprotective Plants from North-East India. International Journal of Pharmacy and Pharmaceutical Sciences ISSN- 0975-1491, 2015; 7:3.
5. Supriya Roy, Himani Awasth, Herbal Medicines AS. Neuroprotective Agent: A Mechanistic approach. International Journal of Pharmacy and Pharmaceutical Sciences ISSN- 0975-1491. 2014; 9:11.
6. Naili MB, Alghazeer RO, Saleh NA, Al-Najjar AY. Evaluation of antibacterial and antioxidant activities of Artemisia campestris (Astraceae) and Ziziphus lotus (Rhamnacea). Arabian J Chem. 2010; 3:79-84.
7. Roy F, Boye JI, Simpson BK. Bioactive proteins and peptides in pulse crops: pea, chickpea and lentil, Food Research International. 2013; 43(2):432-442.
8. National Academy of Sciences, NAS Tropical Legumes: Resources for the Future, National Academy of Sciences, Washington, DC, USA, 1979.
9. Adsule RN. Moth bean (*Vigna aconitifolia* (Jacq.) Marechal). In Food and Feed from Legumes and Oilseeds, 1996, 203-205.
10. Brink M, Jansen PCM. *Vigna aconitifolia* (Jacq.) Maréchal. [Internet] Record from PROTA4U. Brink, M. & Belay, G. (Editors). PROTA (Plant Resources of Tropical Africa / Ressources végétales de l'Afrique tropicale), Wageningen, Netherlands. <"Archived copy". Archived from the original on November 8, 2013. Retrieved October 20, 2013.>. Accessed 15 November 2013-2006.
11. https://en.wikipedia.org/wiki/Vigna_aconitifolia#Human_consumption
12. https://www.flowersofindia.net/catalog/slides/Moth%20Bean.html
13. Krishnan Marg KS. L-dopa bearing plants. Nat. Prod. Rad. 2003; 2(3):126-133.
14. USDA. USDA national nutrient database for standard reference, release 18. [Internet] U.S. Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory, Beltsville, Maryland, United States, 2005, http://www.nal.usda.gov/ fnic/foodcomp. September.
15. Mandal S, Mandal RK. Seed storage proteins and approaches for improvement of their nutritional quality by genetic engineering, Current Science, View at Google Scholar • View at Scopus. 2000; 79(5):576-589.
16. Millerd A. Biochemistry of legume seed proteins, Annual Review of Plant Physiology. View at Publisher View at Google Scholar. 1975; 26(1):53-72.
17. Amarowicz R, Pegg RB, Rahimi-Moghaddam P, Barl B, Weil JA. Free-radical scavenging capacity and antioxidant activity of selected plant species from the Canadian prairies, Food Chemistry, View at Publisher View at Google Scholar • View at Scopus. 2004; 84(4):551-562.
18. Franks PW, Wong MY, Luan J, Mitchell J, Hennings S, Wareham NJ. Non-esterified fatty acid levels and physical inactivity: the relative importance of low habitual energy expenditure and cardio-respiratory fitness, British Journal of Nutrition, View at Publisher • View at Google Scholar • View at Scopus. 2002; 88(3):307-313.
19. Schandrel SH. Method in Food Analysis. New York, NY, USA: Academic Press, 1970.
20. Wilcox JR, Premachandra GS, Young KA, Raboy V. Isolation of high seed inorganic P, low-phytate soybean mutants. *Crop Science*. 2000; 40(6):1601-1605. doi: 10.2135/cropsci2000.4061601x.[Cross Ref]

21. Hammerstrand GE, Black LT, Glover JD. Trypsin inhibitor in soy products: modification of standard analytical procedures. *Cereal Chemistry*. 1981; 15:215-218.
22. Awah FM, Uzoegwu PN, Oyugi JO, *et al*. Free radical scavenging activity and immunomodulatory effect of *Stachytarpheta angustifolia* leaf extract. Food Chemistry. 2010; 119(4):1409-1416. doi: 10.1016/j.foodchem.2009. 09.020. [Cross Ref]
23. Gyamfi MA, Yonamine M, Aniya Y. Free-radical scavenging action of medicinal herbs from Ghana: *Thonningia sanguinea* on experimentally-induced liver injuries. General Pharmacology. 1999; 32(6):661-667. doi: 10.1016/s0306-3623(98)00238-9. [PubMed] [Cross Ref]
24. Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984, V15: 54.
25. Kushwah A, Rajawat P, Kushwah HS. Nutritional evaluation of extruded Faba bean (*Vicia faba* L.) as a protein supplement in cereals based diet in rats. J Exp Biol. 2002; 40(1):49-52.
26. Kinnula VL, Crapo JD. Superoxide dismutases in malignant cells and human tumors. Free Radic. Biol. Med. 2004; 36:718-744.
27. Singh U, Jialal I. Oxidative stress and atherosclerosis. Pathophysiology. 2006; 13:129-142.
28. Sas K, Robotka H, Toldi J, Vecsei L. Mitochondrial, metabolic disturbances, oxidative stress and kynurenine system, with focus on neurodegenerative disorders. J Neurol. Sci. 2007; 257:221-239.
29. Smith MA, Rottkamp CA, Nunomura A, Raina AK, Perry G. Oxidative stress in Alzheimer's disease. Biochim. Biophys. Acta. 2000; 1502:139-144.
30. Guidi I, Galimberti D, Lonati S, Novembrino C, Bamonti F, Tiriticco M. *et al*. Oxidative imbalance in patients with mild cognitive impair-ment and Alzheimer's disease Neurobiol. Aging. 2006; 27:262-269.
31. Bolton JL, Trush MA, Penning TM, Dryhurst G, Monks TJ. Role of quinones in toxicology. Chem. Res. Toxicol. 2000; 13:135-160.
32. Arteel GE. Oxidants and antioxidants in alcohol induced liver disease. Gastroenterol. 2003; 124:778-790.
33. Ramakrishna BS, Varghese R, Jayakumar S, Mathan M, Balasubramanian KA. Circulating antioxidants in ulcera-tive colitis and their relationship to disease severity and activity. J. Gastroenterol. Hepatol. 1997; 12:490-494.
34. Hyun DH, Hernandez JO, Mattson MP, de Cabo R. The plasma membrane redox system in aging. Aging Res. Rev. 2006; 5:209-220.
35. Upston JM, Kritharides L, Stocker R. The role of vitamin E in atherosclerosis. Prog. Lipid Res. 2003; 42:405-422.
36. Perumal Siddhuraju and Klaus Becker, The antioxidant and free radical scavenging activities of processed cowpea (*Vigna unguiculata* (L.) Walp). Seed extracts aagriculture, ecosystems &environment. 1988; 24(4):453-458. References and further reading may be available for this article.
37. Bagad AS, Joseph JA, Bhaskaran N, Agarwal A. Comparative evaluation of anti-inflammatory activity of curcuminoids, turmerones, and aqueous extract of Curcuma longa. Advances in Pharmacological Sciences. 2013; 7. doi: 10.1155/2013/805756.805756 [PMC free article] [PubMed] [Cross Ref]
38. Ghasemian M, Owlia MB. A different look at pulsed glucocorticoid protocols; is high dose oral prednisolone really necessary just after initiation of pulse therapy? Journal of Case Reports in Practice. 2015;3(1):1–3
39. Roy F, Boye JI, Simpson BK. Bioactive proteins and peptides in pulse crops: pea, chickpea and lentil, Food Research International. 2010; 43(2):432-442.
40. Franks PW, Wong MY, Luan J, Mitchell J, Hennings S. Non-esterified fatty acid levels and physical inactivity: the relative importance of low habitual energy expenditure and cardio-respiratory fitness, British Journal of Nutrition. 2002; 88(3):307-313.
41. Higgins GA. Alzheimer's disease: the amyloid cascade hypothesis. Science Hardy. 1992; 256:184-185.
42. Karran E, Mercken M, De Strooper B. The amyloid cascade hypothesis for Alzheimer's disease: an appraisal for the development of therapeutics. Nat Rev Drug Discov. 2011; 10:698-712.
43. Taylor JP, Hardy J, Fischbeck KH. Toxic pro-teins in neurodegenerative disease. Science. 2002; 296:1991-1995.
44. Krainc D. Clearance of mutant proteins as a therapeutic target in neurodegenerative dis-eases. Arch Neurol. 2010; 67:388-392.
45. Rademakers R, Neumann M, Mackenzie IR. Advances in understanding the molecular basis of frontotemporal dementia. Nat Rev Neurol. 2012; 8:423-434.
46. Sleegers K, Lambert JC, Bertram L, Cruts M, Amouyel P and Van Broeckhoven C. The pur-suit of susceptibility genes for Alzheimer's dis-ease: progress and prospects. Trends Genet. 2010; 26:84-93.
47. Hardy J. Genetic analysis of pathways to Par-kinson disease. Neuron. 2010; 68:201-206.
48. Gandhi S, Wood NW. Genome-wide asso-ciation studies: the key to unlocking neurode-generation? Nat Neurosci. 2010; 13:789-794.
49. Bertram L, Tanzi RE. The genetic epidemi-ology of neurodegenerative disease. J Clin In-vest. 2005; 115:1449-1457.
50. McCarthy MI, Abecasis GR, Cardon LR, Gold-stein DB, Little J, Ioannidis JP, Hirschhorn JN. Genome-wide association studies for com-plex traits: consensus, uncertainty and chal-lenges. Nat Rev Genet. 2008; 9:356-369.
51. Chee Seng K, En Yun L, Yudi P, Kee Seng C. The pursuit of genome-wide association stud-ies: where are we now? J Hum Genet. 2010; 55:195-206.
52. Noorbakhsh F, Overall CM, Power C. Deci-phering complex mechanisms in neurodegen-erative diseases: the advent of systems biolo-gy. Trends Neurosci. 2009; 32:88-100.
53. Kennedy AR. Cancer prevention by protease inhibitors, Preventive Medicine. 1993; 225:796-811.
54. Xu BJ, Chang SKC. A comparative study on phenolic profiles and antioxidant activities of legumes as affected by extraction solvents, Journal of Food Science. 2007; 72(2):S159-S166.