v. 3, n. 10, 2023

International Journal of Biological and Natural Sciences

# PHYTOCHEMICAL, PHARMACOLOGICAL AND ANTICORROSIVE ASPECT OF MUCUNA PRURIENS: A BRIEF REVIEW

***Pablo Javier Maldonado Rivas***
Faculty of Chemical Biological Sciences, ``Universidad Autónoma de Campeche``
http://orcid.org/0000-0002-4542-7126

***Esteban Miguel García Ochoa***
``Centro de Investigación en Corrosión``, CICORR., ``Universidad Autónoma de Campeche``
http://orcid.org/0000-0002-9605-1210

***Francisco Eduardo Corvo Pérez***
``Centro de Investigación en Corrosión``, CICORR., ``Universidad Autónoma de Campeche``
http://orcid.org/0000-0000-7042-7382

***Luis Román Dzib Pérez***
``Centro de Investigación en Corrosión``, CICORR., ``Universidad Autónoma de Campeche``
http://orcid.org/0000-0002-8335-1142

***Carlos Armando Chan Keb***
Faculty of Chemical Biological Sciences, ``Universidad Autónoma de Campeche``
http://orcid.org/0000-0000-3494-9508

***Francisco Javier Aguirre Crespo***
Faculty of Chemical Biological Sciences, ``Universidad Autónoma de Campeche``
https://orcid.org/0000-0001-5562-2016

**Abstract:** *Mucuna pruriens*(L.) DC (Fabaceae) or picapica, is a species native to India and Southeast Asia and with a wide distribution in the tropics. It is known to have medicinal benefits such as aphrodisiac, antispasmodic, anticataleptic, antiepileptic, antidiabetic, antimicrobial, anti-inflammatory, analgesic and antiparkinsonian, which make it a valuable source of medicinal compounds, among other applications, such as organic extracts of this legume, which has been shown to inhibit corrosion reactions in some metals. This review work shows the analysis of scientific production and web content on the phytochemistry, pharmacological activity and anticorrosive behavior of M. pruriens.

## INTRODUCTION

Traditional medicine and its different uses are an important part of the culture of people and have been, for centuries, the only system used to restore health, so they play a fundamental role as a means to cure diseases in people. Currently, plants and their extracts represent a source of natural compounds with complex molecular structures and diverse chemical, biological and physical properties. Of the 422,000 plant species documented worldwide, approximately 12.5% have medicinal value and are environmentally acceptable.

*M. pruriens*It is a leguminous plant belonging to the Fabaceae family.. We can find it in the continents of North and South America, Asia, Africa and Oceania. In various countries such as Australia, India, Nigeria, China, South Africa, Brazil, USA, Venezuela and Mexico. It is considered a climbing weed and commonly known as picapica, mucuna bean, velvet bean, bengal bean, it is also called nescafé. During the last decades, there has been a growing interest in the study of the medicinal properties of this plant, and the antioxidant, antineoplastic, anticancer, antiviral, analgesic, antimicrobial, anti-inflammatory, antihypertensive, antiparkinsonian, neuroprotective, antidiabetic, antiepileptic power has been reported, cardioprotective and anticorrosive of this legume. It is possible that these effects are due to the content of proteins, amino acids, alkaloids, tannins, phenolic compounds, saponins and flavonoids present in the different organs and tissues of the plant.

On the other hand, derived from the chemical composition of M. pruriens, this plant has contributed to the potentialization of research on the corrosion inhibition capacity of naturally occurring compounds known as "green inhibitors", due to the extracts of Plants have become an excellent alternative to mitigate the corrosion process, so in the future it is expected that they can replace synthetic corrosion inhibitors, since the latter usually trigger health and/or environmental problems due to their toxicity.

In this context, this study began with a review of the literature onthe phytochemistry, pharmacological activity and anticorrosive behavior of M. pruriensThis work is divided into several sections. Section 1 provides a brief overview on the importance of medicinal properties and chemical composition of M. pruriens. Section 2 presents the generalities of M. pruriens. Section 3 and 4 describe the phytochemical constituents and pharmacological properties, respectively. Subsequently, a discussion is presented on the use of extracts from this plant as a green corrosion inhibitor as a solution to the problems associated with its conventional counterparts. Finally, the conclusions are presented in section 6.

## GENERALITIES OF M. PRURIENS

### TAXONOMY

*Mucuna pruriens*(L.) DC. belongs to the Domain: Eukaryota, Kingdom: Plantae, Class: Magnoliopsida, Order: Fabales, Family: Leguminosae, Subfamily: Fabaceae, Tribe: Phaseoleae, Genus: Mucuna, Species: Pruriens (Duke, 1981, Donati, 2005; Shelley & Arthur, 1955).

### PLANT MORPHOLOGY

This legume has stems approximately 18 meters long, leaflets 5 to 12 centimeters wide and 7 to 15 centimeters long. Its white or purple flowers are self-fertilized and are found in axillary clusters up to 32 centimeters long. The pods are produced in groups, 0.5 to 1 to 2 centimeters wide, 4 to 13 centimeters long, and are covered with fine white or light brown hairs. Each pod contains 2 to 7 seeds, with a width of 0.8 to 1.3 cm and 1 to 1.9 cm long (Brunner et al. 2011, as cited in Anadón Navarro et al. 2016; Duke, 1981). The seeds can be black, white, reddish, brown or mottled (Brunner et al., 2011, as cited in Anadón Navarro et. al., 2016; Vázquez Encalada & Segura Campos, 2020). The morphology of the plant is shown in figure 1.

**Figure 1**. Mucuna pruriens (L.) DC (Fabaceae).

### COMMON NAMES

It is considered a climbing weed and is commonly known as picapica, mucuna bean, velvet bean, bengal bean, nescafé(Stevens et al. 2001; Martínez, 1979; Nwaoguikpe et al. 2011; Anaya, 1999).

### GEOGRAPHICAL DISTRIBUTION

We can find this plant in tropical regions, on the continents of North and South America, Asia, Africa and Oceania. In various countries such as Australia, India, Nigeria, China, South Africa, Brazil, USA, Venezuela and Mexico (Anaya, 1999; Ashidi et al. 2019; Rai et al. 2020; Fujii et al. 1991; Nwaoguikpe et al, 2011, Fung et al. 2011). In Mexico, it has been reported that this weed is present in the state of Campeche, Chiapas, Oaxaca, Puebla, Quintana Roo, Tamaulipas and Veracruz (Villaseñor and Espinosa, 1998; Anaya, 1999). Figure 2 shows the global distribution of the plant.

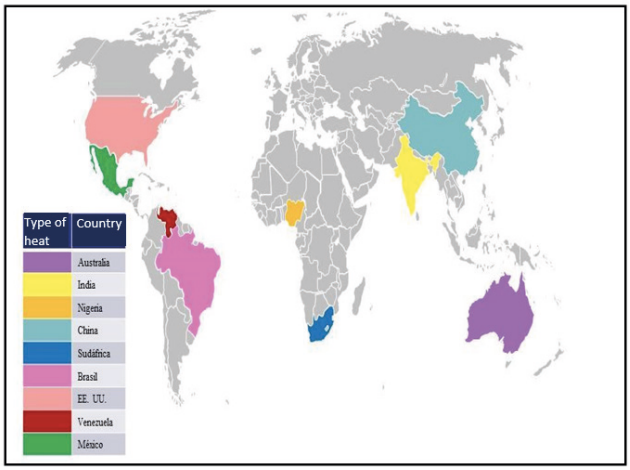



**Figure 2.**Worldwide distribution of M. pruriens. Own source.

## PHYTOCHEMICAL CONSTITUENTS PRESENT IN M. PRURIENS

The biologically active compounds identified in M. pruriens are: L-Dopa, adrenaline, phenylalanine, nicotinic acid, tetrahydroisoquinoline, mucunin, mucunadine, mucunadinin, prurienidine, serotonin, nicotine, dimethyl-tryptamine, 5-MeO-dimethyl-tryptamine, oxide dimethyl-tryptamine, saponins, anthraquinones, flavonoids, terpenoids, cardiac glycosides, tannins, inositol, myo-inositol, galactose glycosides, β-sitosterol, glutathione, lecithin, vernolic acid, gallic acid, stearic acid, oleic acid, linoleic acid, palmitic acid, selenium and magnesium (Adebowale et al. 2005; Bhat et al. 2008; Donati et al. 2005; Hope-Onyekwere et al. 2012; Manyam et al. 2004; Misra and Wagner, 2004; Shelley and Arthur, 1955; Akalezi et al. 2016; Duke, 1981; Turukmane, 2002; Siddhuraju et al. 2000; Sharma et al. 2005; Panikkar et al. al. 1987; Manyam et al. 2004; Misra and Wagner, 2006).

Some of the structures corresponding to the phytochemical constituents of M. pruriens are shown in table 1 (Duke, 1981; Turukmane, 2002; Siddhuraju et al. 2000; Sharma et. al., 2005; Panikkar et al., 1987; Manyam et al. 2004; Misra & Wagner, 2006).

## PHARMACOLOGICAL PROPERTIES OF M. PRURIENS

Various authors claim that different parts of the weed, known as M. pruriens, have medicinal properties, for example, Sathiyanarayanan & Arulmozhi (2007) state that it is one of the most popular and important medicinal plants in India, because all its parts They report medicinal properties and are in high demand nationally and in international pharmaceutical markets. Fujii et al. (1991) also report that the seeds and stems of this plant are used as medicine in Africa and China.

In various literatures, M. pruriens has been reported as an antioxidant, antineoplastic, anticancer, antiviral, analgesic, antimicrobial, anti-inflammatory, antihypertensive, antiparkinsonian, neuroprotective, antidiabetic, antiepileptic and cardioprotective agent (Adebowale and Lawal 2003; Adepoju and Odubena, 2009; Misra and Wagner, 2004; Majekodunmi et al. 2011; Uma and Gurumoorthi, 2013; Obogwu et al. 2014; Dhawan et al. 1980).

For their part, Nayak et al. (2017) report that the M. pruriens seed extract shows potent antihypertensive activity in vitro and in vivo, through the inhibition of the activity of the angiotensin I converting enzyme (ACE), likewise, they report in their literature that This plant has anti-ischemic potential, however, it points out that there is a need to test its clinical effectiveness.

In the research of Sinha et al. (2018) report that M. pruriens shows anticancer potential against human breast cancer cells through JAK2/STAT5A signaling. Another activity that is attributed to this fabaceae is that reported in the literature by Turukmane (2002), where they mention that the leaves of M. pruriens are considered an excellent blood stimulant, using them in cases of acute blood loss and diseases due to blood deficiency. Likewise, Anosike et al. (2019), reports that the methanolic extract of Mucuna pruriens shows erythrocyte stabilizing capacity, antioxidant potential and could be used for the treatment of sickle cell anemia.

In the work of Ulu et al. (2018) it is reported that M. pruriens improves altered inflammation pathways in the kidney of rats fed high fructose.

According to Wijeratne, 1987, as mentioned in Vadivel, V. & Janardhanan, K. (2000), Mucuna pruriens is also reported to have activity against arthritis. In the work of Manyam et al. (2004), M. pruriens is also reported as a medicinal plant to

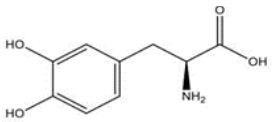
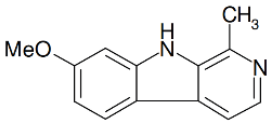
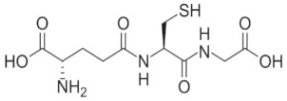
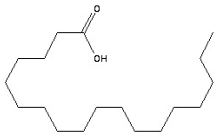
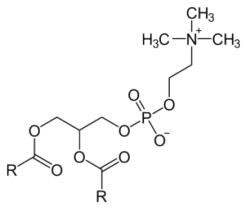
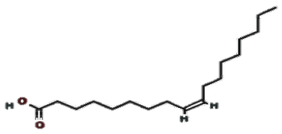
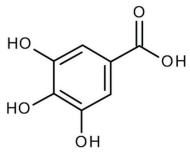
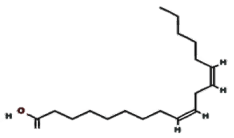
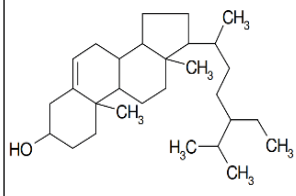
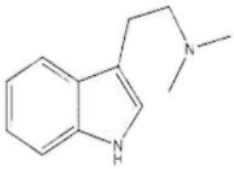
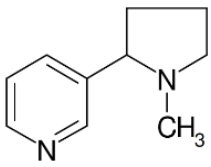
| | | | |
|---|---|---|---|
| **L-Dopa** |  | **6-methoxyharman** |  |
| **Glutathione** |  | **stearic acid** |  |
| **Lecithin** |  | **Oleic acid** |  |
| **Gallic acid** |  | **Linoleic acid** |  |
| **β –Sitosterol** |  | **palmitic acid** |  |
| **Indole-3-alkylamines-N, N-dimethyltryptamine** |  | **Nicotine** |  |

**Table 1.**Structures of the phytochemical constituents present in M. pruriens. Own source.

| Plant component evaluated | Metal | Half | Technique | Authors |
|---|---|---|---|---|
| **Seeds** | **Carbon Steel** | **H.C.l1M** | **Potentiodynamic Polarization, Electrochemical Impedance Spectroscopy and Gravimetric measurement technique.** | **Akalezi et al. (2016)** |
| **Seeds** | **Copper** | **$HNO_3$ 3M** | **Gravimetric Measurements, Potentiodynamic Polarization and Electrochemical Impedance.** | **Mourya et al. (2016)** |
| **Stems** | **Aluminum** | **$H_2SO_4$ 2M** | **Gravimetric Measurement.** | **Ahile et al. (2014)** |

**Table 2.**Evaluation of M. pruriens as a green corrosion inhibitor. Own source.

treat neurodegenerative diseases such as Parkinson's disease, thanks to the extract of levodopa (L-Dopa) extracted from velvet beans. Likewise, L-Dopa also repels insects.

Root and leaf extracts of the plant have been used in the treatment of snakebite and cancer (Alo et al. 2012).

M. pruriens has been shown to increase testosterone levels (Amin et al., 1996, as cited in Nebedum et al. 2010), leading to protein deposition in muscles and increasing muscle mass and strength. (Bhasin et al. 1996). On the other hand, Ashidi et. to the. (2019) report that in male albino rats their reproductive function improved with a dose of 0.75 g of Mucuna pruriens.

Mucuna species are aphrodisiac, emetic and poisonous (Duke, 1981; Pathania et al. 2020). The roots are bitter, sweet, thermogenic, emollient, stimulant, purgative, aphrodisiac and diuretic. The leaves are also aphrodisiac (Jayaweera, 1980, as cited in Siddhuraju et al. 2000). The seeds are astringent, laxative, anthelmintic, alexipharmaceutical and tonic (Taylor, 2005, as cited in Nebedum et al. 2010).

It has also been noted that casual skin contact with the pod of this legume produces erythema and pruritic macular lesions, the cause being the protease mucunain (Hope-Onyekwere, 2012).

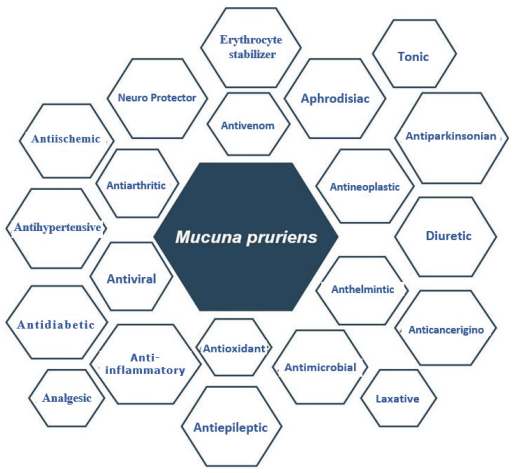



**Figure 3**. Biological and pharmacological activities of M. pruriens. Own source.

## *MUCUNA PRURIENS*AS A GREEN CORROSION INHIBITOR

Plants represent an interesting source class of chemical compounds that are currently being explored for use in metal corrosion protection in most systems, as a possible replacement for toxic synthetic inhibitors. The various chemical structures present in M.*Pruriens*, have allowed this plant to be studied as a green corrosion inhibitor.

Akalezi et al. (2016), evaluated the ethanolic extract of Mucuna Pruriens seeds for the corrosion of carbon steel in a 1 M HCL solution, with the electrochemical techniques of potentiodynamic polarization and electrochemical impedance spectroscopy (EIS), likewise, they used the gravimetric measurement technique. The results obtained by these authors indicate that the maximum inhibition efficiency of 91.01% for electrochemical techniques and 92.89% in gravimetric tests is reached at an optimal concentration of 1000 mg/L.

Mourya et al. (2016), evaluated the inhibition of copper corrosion, using a 3 M HNO3 solution, using gravimetric techniques, potentiodynamic polarization and electrochemical impedance, whose inhibition efficiencies obtained were 71.6%, 69.2%, and 70.1% at 0.2 g $L^{-1}$, respectively.

On the other hand, Ahile et al. (2014), evaluated the inhibition of aluminum corrosion, through the ethanolic extract of M. Pruriens stems, using a 2 M $H_2SO_4$ solution, with the gravimetric measurement technique, so that in their results they obtained an efficiency of inhibition of 62.90%, at a concentration of 0.5 g/$dm^3$.

## CONCLUSIONS

This review demonstrated that M. pruriens is a valuable medicinal plant based on its numerous therapeutic properties.

The result obtained in this study reported that M. pruriens contains an appreciable amount of organic compounds that could be forming chemical complexes, which when adsorbed on the metal surface block the passage of aggressive species from the medium to increase the inhibition efficiency.

This compilation positions M. pruriens as an object of study for research groups to obtain new organic corrosion inhibitors with industrial and technological applications.

## REFERENCES


1. Adebowale, K. O., & Lawal, O. S. (2003). Foaming, gelation and electrophoretic characteristics of mucuna bean (Mucuna pruriens) protein concentrates. Food chemistry, 83(2), 237-246.

2. Adebowale, Y. A., Adeyemi, A., & Oshodi, A. A. (2005). Variability in the physicochemical, nutritional and antinutritional attributes of six Mucuna species. Food chemistry, 89(1), 37-48.

3. Adepoju, G. K. A., & Odubena, O. O. (2009). Effect of Mucuna pruriens on some haematological and biochemical parameters. Journal of Medicinal Plants Research, 3(2), 73-76.

4. Agbafor, K. N., & Nwachukwu, N. (2011). Phytochemical analysis and antioxidant property of leaf extracts of Vitex doniana and Mucuna pruriens. Biochemistry Research International, 2011.

5. Akalezi, C. O., Ogukwe, C. E., Ejele, E. A., & Oguzie, E. E. (2016). Mild steel protection in acidic media using Mucuna pruriens seed extract. International Journal of Corrosion and Scale Inhibition, 5(2), 132-146.

6. Alo, M. N., Okeh, O. C., Anyim, C., & Orji, J. O. (2012). The effects of ethanol extract of Mucuna pruriens leaves on aspartate aminotransferase, alanine aminotransferase and alkaline phosphatase in albino rats. Journal Natural Production Plant Resource, 2(4), 465-470.

7. Anadón Navarro, A., Toro Nozal, M., Arpio Santacruz, J., Izquierdo Carrasco, M., Díaz Méndez, C., & Martín Diana, A. B. (2016). Informe del Comité Científico de la Agencia Española de Consumo, Seguridad Alimentaria y Nutrición (AECOSAN) sobre el riesgo del uso de semillas de Mucuna pruriens en productos de artesanía (No. ART-2016-106096).

8. Anaya, A. L. (1999). Allelopathy as a tool in the management of biotic resources in agroecosystems. Critical reviews in plant sciences, 18(6), 697-739.

9. Anosike, C. A., Igboegwu, O. N., & Nwodo, O. F. C. (2019). Antioxidant properties and membrane stabilization effects of methanol extract of Mucuna pruriens leaves on normal and sickle erythrocytes. Journal of Traditional and Complementary Medicine, 9(4), 278-284.

10. Ashidi, J. S., Owagboriaye, F. O., Yaya, F. B., Payne, D. E., Lawal, O. I., & Owa, S. O. (2019). Assessment of reproductive function in male albino rat fed dietary meal supplemented with Mucuna pruriens seed powder. Heliyon, 5(10), e02716.

11. Bell, E. A., & Janzen, D. H. (1971). Medical and ecological considerations of L-dopa and 5-HTP in seeds. Nature, 229(5280), 136-137

12. Benedetti, C. M. (2012). Producción artesanal indígena y comercialización: entre los" buenitos" y los" barateros". Maguaré, 26(1), 229-262.

13. Bhasin, S., Storer, T. W., Berman, N., Callegari, C., Clevenger, B., Phillips, J., ... & Casaburi, R. (1996). The effects of supraphysiologic doses of testosterone on muscle size and strength in normal men. New England Journal of Medicine, 335(1), 1-7.

14. Bhat, R., Sridhar, K. R., & Seena, S. (2008). Nutritional quality evaluation of velvet bean seeds (Mucuna pruriens) exposed to gamma irradiation. International Journal of Food Sciences and Nutrition, 59(4), 261-278.

15. Buckles, D. (1995). Velvetbean: A "new" plant with a history. Economic Botany, 49(1), 13-25.

16. Daxenbichler, M. E., VanEtten, C. H., Hallinan, E. A., Earle, F. R., & Barclay, A. S. (1971). Seeds as sources of L-DOPA. Journal of medicinal chemistry, 14(5), 463-465.

17. Dhawan, B. N., Dubey, M. P., Mehrotra, B. N., & Tandon, J. S. (1980). Screening of Indian plants for biological activity: Part IX. Indian Journal of Experimental Biology, 18, 594-602.

18. Donati, D., Lampariello, L. R., Pagani, R., Guerranti, R., Cinci, G., & Marinello, E. (2005). Antidiabetic oligocyclitols in seeds of Mucuna pruriens. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives, 19(12), 1057-1060.

19. Duke, J. A. (1981). Legume species. In Handbook of legumes of world economic importance (pp. 166-169). Springer, Boston, MA.

20. Fujii, Y., Shibuya, T., & Yasuda, T. (1991). L-3, 4-dihydroxyphenylalanine as an allelochemical candidate from Mucuna pruriens (L.) DC. var. utilis. Agricultural and biological chemistry, 55(2), 617-618.

21. Fung, S. Y., Tan, N. H., Sim, S. M., Marinello, E., Guerranti, R., & Aguiyi, J. C. (2011). Mucuna pruriens Linn. seed extract pretreatment protects against cardiorespiratory and neuromuscular depressant effects of Naja sputatrix (Javan spitting cobra) venom in rats.

22. Haq, N. (1983). New food legume crops for the tropics. Better crops for food, 144-160.

23. Hope-Onyekwere, N. S., Ogueli, G. I., Cortelazzo, A., Cerutti, H., Cito, A., Aguiyi, J. C., & Guerranti, R. (2012). Effects of Mucuna pruriens protease inhibitors on Echis carinatus venom. Phytotherapy Research, 26(12), 1913-1919.

24. Kavitha, C., & Thangamani, C. (2014). Amazing bean Mucuna pruriens: A comprehensive review. Journal of Medicinal Plants Research, 8(2), 138-143.

25. Majekodunmi, S. O., Oyagbemi, A. A., Umukoro, S., & Odeku, O. A. (2011). Evaluation of the anti–diabetic properties of Mucuna pruriens seed extract. Asian Pacific Journal of Tropical Medicine, 4(8), 632-636.

26. Manyam, B. V., Dhanasekaran, M., & Hare, T. A. (2004). Neuroprotective effects of the antiparkinson drug Mucuna pruriens. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives, 18(9), 706-712.

27. Martínez, M. (1979). Catálogo de nombres vulgares y científicos de plantas mexicanas: Fondo de Cultura Económica. México, DF.

28. Misra, L., & Wagner, H. (2004). Alkaloidal constituents of Mucuna pruriens seeds. Phytochemistry, 65(18), 2565-2567.

29. Misra, L., & Wagner, H. (2006). Lipid derivatives from Mucuna pruriens seeds.

30. Mourya, P., Chaubey, N., Kumar, S., Singh, V. K., & Singh, M. M. (2016). Strychnos nuxvomica, Piper longum and Mucuna pruriens seed extracts as eco-friendly corrosion inhibitors for copper in nitric acid. RSC advances, 6(98), 95644-95655.

31. Musthafa, M. S., Asgari, S. M., Kurian, A., Elumalai, P., Ali, A. R. J., Paray, B. A., & Al-Sadoon, M. K. (2018). Protective efficacy of Mucuna pruriens (L.) seed meal enriched diet on growth performance, innate immunity, and disease resistance in Oreochromis mossambicus against Aeromonas hydrophila. Fish & shellfish immunology, 75, 374-380.

32. Nayak, V. S., Kumar, N., D'Souza, A. S., Nayak, S. S., Cheruku, S. P., & Pai, K. (2017). The effects of Mucuna pruriens extract on histopathological and biochemical features in the rat model of ischemia. Neuroreport, 28(18), 1195-1201.

33. Nebedum, J. O., Udeafor, P. C., & Okeke, C. U. (2010). Comparative effects of ethanolic extracts of Ficus carica and Mucuna pruriens leaves on haematological parameters in albino rats. Biokemistri, 22(2).

34. Nwaoguikpe, R. N., Braide, W., & Ujowundu, C. O. (2011). The effects of processing on the proximate and phytochemical compositions of Mucuna pruriens seeds (velvet beans). Pakistan Journal of Nutrition, 10(10), 947-951.

35. Obogwu, M. B., Akindele, A. J., & Adeyemi, O. O. (2014). Hepatoprotective and in vivo antioxidant activities of the hydroethanolic leaf extract of Mucuna pruriens (Fabaceae) in antitubercular drugs and alcohol models. Chinese journal of natural medicines, 12(4), 273-283.

36. Panikkar, K. R., Majella, V. L., & Pillai, P. M. (1987). Lecithin from Mucuna pruriens. Planta medica, 53(05), 503-503.

37. Pathania, R., Chawla, P., Khan, H., Kaushik, R., & Khan, M. A. (2020). An assessment of potential nutritive and medicinal properties of Mucuna pruriens: a natural food legume. 3 Biotech, 10(6), 1-15.

38. Pugalenthi, M., & Vadivel, V. (2007). A non-protein toxic amino acid in Mucuna pruriens seeds. Food, 1, 322-343.

39. Rai, S. N., Chaturvedi, V. K., Singh, P., Singh, B. K., & Singh, M. P. (2020). Mucuna pruriens in Parkinson's and in some other diseases: recent advancement and future prospective. 3 Biotech, 10(12), 1-11.

40. Sathiyanarayanan, L., & Arulmozhi, S. (2007). Mucuna pruriens Linn.-A comprehensive review. Pharmacognosy Reviews, 1(1).

41. Sharma, P. C., Yelne, M. B., Dennis, T. J., & Joshi, A. (2005). Database on Medicinal plants used in Ayurveda and Sidha. New Delhi: CCRAS, Dept. of AYUSH, Ministry of Health and Family Welfare, Govt. of India, 1, 265-6.

42. Shelley, W. B., & Arthur, R. P. (1955). Studies on cowhage (Mucuna pruriens) and its pruritogenic proteinase, mucunain. AMA archives of dermatology, 72(5), 399-406.

43. Siddhuraju, P., Becker, K., & Makkar, H. P. S. (2000). Studies on the Nutritional Composition and Antinutritional Factors of Three Different Germplasm Seed Materials of an Under-Utilized Tropical Legume, Mucuna pruriens Var. U tilis. Journal of Agricultural and Food Chemistry, 48(12), 6048-6060.

44. Sinha, S., Sharma, S., Vora, J., Shah, H., Srivastava, A., & Shrivastava, N. (2018). Mucuna pruriens (L.) DC chemo sensitize human breast cancer cells via downregulation of prolactin-mediated JAK2/STAT5A signaling. Journal of ethnopharmacology, 217, 23-35.

45. Sridhar, K. R., & Bhat, R. (2007). Agrobotanical, nutritional and bioactive potential of unconventional legume–Mucuna. Livestock Research for Rural Development, 19(9), 126-130.

46. Stevens, W. D., Ulloa, C., Pool, A., & Montiel, O. M. (2001). Flora de Nicaragua. vol. 85, tomos I, II y III. Missouri Botanical Garden Press. St. Louis Missouri. Estados Unidos.

47. Turukmane, K. L. (2002). MUCUNA PRURIENS L.: A REVIEW. Advances in Plant Science Volume III, 59-65. https://www.bhumipublishing.com/wp-content/uploads/2022/01/Advances-in-Plant-Science-Volume-III.pdf

48. Ulu, R., Gozel, N., Tuzcu, M., Orhan, C., Yiğit, İ. P., Dogukan, A., ... & Sahin, K. (2018). The effects of Mucuna pruriens on the renal oxidative stress and transcription factors in high-fructose-fed rats. Food and chemical toxicology, 118, 526-531.

49. Uma, S., & Gurumoorthi, P. (2013). Dietary antioxidant activities in different germplasms of Mucuna. Journal of medicinal food, 16(7), 618-624.

50. Vadivel, V. & Janardhanan, K. (2000). Nutritional and anti-nutritional composition of velvet bean: an under-utilized food legume in South India. International Journal of Food Sciences and Nutrition, 51(4), 279-287

51. Vazquez Encalada, S., & Segura Campos, M. R. (2020). Mucuna pruriens fiber: nutritional, functional and biological properties. Food Science and Technology, 41, 120-126.

52. Villaseñor R., J. L. y F. J. Espinosa G., 1998. Catálogo de malezas de México. Universidad Nacional Autónoma de México. Consejo Nacional Consultivo Fitosanitario. Fondo de Cultura Económica. México, D.F.

53. Yang, X., Zhang, X., & Zhou, R. (2001). Determination of l-dopa content and other significant nitrogenous compounds in the seeds of seven Mucuna and Stizolobium species in China. Pharmaceutical biology, 39(4), 312-316.