Review Article

A Systematic short review on *Clitoria ternatea*: Pharmacological activities and Phytochemicals

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ABSTRACT

Clitoria ternatea is perennial herbaceous plant from family Fabaceae. It has potential applications in modern medicine as well as agriculture. Ita is also used as natural food colorants and antioxidant. The present review contains the information related to Clitora ternatea phytochemicals and its pharmacological activity. This paper reviews plant distribution, phtyconstituents like - flavonaols-kaempferol, kaempferol 3-glucoside, kaempferol 3-robinobioside-7-rhamnoside, Quercetin, anthocyanins, etc. It also includes the different pharmacological acivities were shown by Clitoria ternatea like anti-inflamatory, antioxidant, catheratics, insecticides etc.

Keywords: *Clitoria ternatea*, pharmacological activity, phytoconstituents, antidiabetic, antioxidant

INTRODUCTION

Plant and herbs have play important rolein human life for thousands of years. Most of them are well known medicinal herbs [1]. Butterfly pea or blue pea (clitoria ternatea) is from family fabaceae and sub-family papilionaceae[2].It is perennial herbaceous plant, which originated from tropical region of India ,Sri Lanka, Malaysia, Burma, and Philippine islands[3,4]. Clitoria ternatea flower are commercially known as Bungatelang by the locals and are Widely used as the food dyes in Nasikerabu (It is an the local dish in Kelantan, Malaysia) and a Baba and Nyonya kueh known as kuehtekan[1]. The newly obtained C. ternatea anthocyanins termed “ternatins” which render C. ternatea flowers with their vivid blue color, were first isolated in 1985[8,17]. Study of flowers suggested that it having health beneficial properties, such as tranquilizing effect, anti-inflamatory and antipyretic activities [7,15]. The difference parts extract of Clitoria ternatea had different efficacy against the tested microorganisms. These obtained differences could be due to the nature and level of the antimicrobial agents present in the extracts and their mode of action on the different test microorganisms [1,16]. This plant have been used in Sri Lankan traditional system of medicine and in folklore ton treat variety of disorders such as anasarca, ascites, liver problems, hemicrania, irritarion of urethra and bladder, and enlargement of abdominal viscera [9].Clitoria ternatea flower is a source of natural blue food and beverage colorant worldwide[10]. Butterfly pea is one of the major sources of natural color used in food and cosmetics. Anthocyanins are present in its petals which is main coloring constituent and could be extracted easily with water. We found that the ph of medium, temperature, and light affect stability of the color aqueous extract from butterfly pea petals.[13]. Due to their high reactivity, non-hazardous and better efficiency are reason behind their wider applications than the human-made compounds, the natural compounds have many interdisciplinary applications also[3]. Evaluation of chemical diversity among genotype of medicinal plants plays a crucial role in improvement and large-scale cultivation. Chemical variability of bioactive principles viz. taraxerol and beta-sitosterol are analyzed in 11 populations of clitoria ternatea L., it is an important memory enhancer used in Ayurveda [14].

COMMON NAME

Bengali:Aparajita,
English:Butterfly pea , blue pea vine , mussel- shell climber, pigeon wings, Sanskrit: Sankhapushpi , aparajita, saukarnika, adrakarni , girikarnikasupuspi , mohansini , vishadoshaghani , shwetanama , vishnukranta , Kannada ashwakhura ,
Hindi:Koyala ,
Telgu: Dintena,
Malyalam: sangupushpam: Nagar hedi,
Mrathi: Gokarna,
Portuguese: Fulacriqua,

Synonyms
Clitoriaalbiflora Mattei
ClitoriabracteatePoir.
Clitoria coelestrissieberts and Voss
Clitoria parviflora Raf.
Clitoria phillippensis Per.
Clitoria pilosulaBenth.
Clitoria ternatensium Crantz
Ternatea vulgaris Kunth
Ternatae vulgaris Kuntze

PHYTOCHEMICALS

A. Flavonols

Clitoria ternatea seeds contain flavonol glycosides as well as phenolic aglycones, cinnamic acid, and a range of other compounds . there are different flavonols were present in C. ternateaflavonols, namely kaempferol, kaempferol 3-glucoside, kaempferol 3-robinobioside-7-rhamnoside, quercetin, and quercetin 3-glucoside Subsequent studies reported the isolation of flavonol glycoside from C. ternatea leaves and flowers [15-17].
Following are some flavones with their structure.

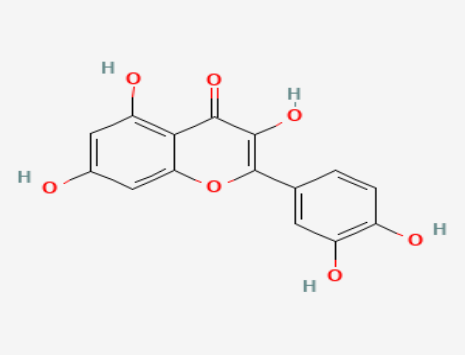

Fig. No. 1: Structure of Quercetin

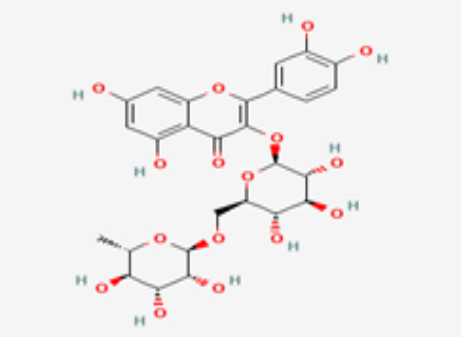

Fig. No. 2: Structure of Quercetin3-rutinoside

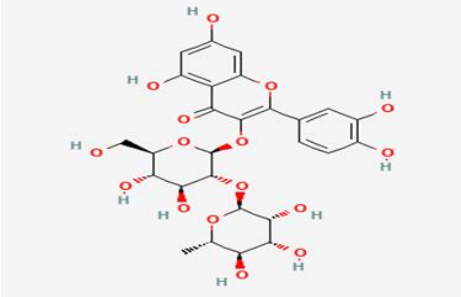

Fig. No. 3: Structure of Quercetin 3-neohesperidoside

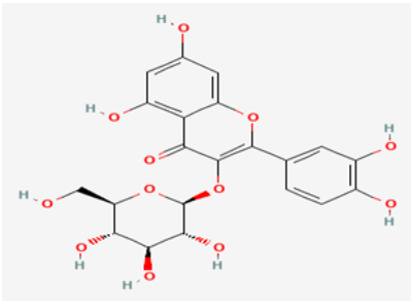

Fig. No. 4: Structure of Quercetin 3-glucoside

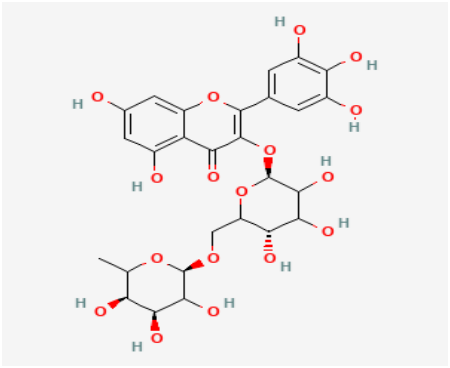

Fig. No. 5: Structure of Myricetin 3-rutinoside

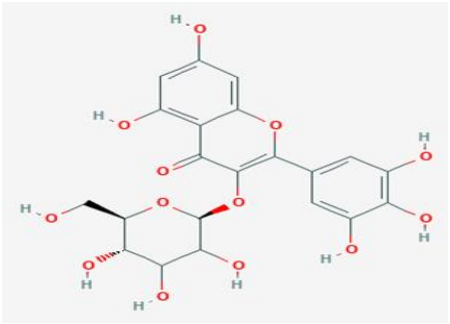

Fig. No. 6: Structure of Myricetin 3-glucoside

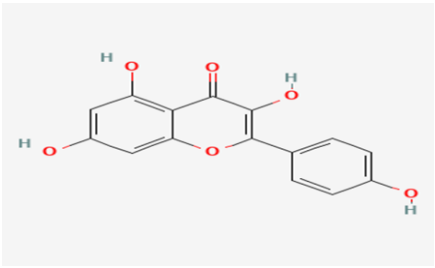

Fig. No. 8: Structure of Kaempferol

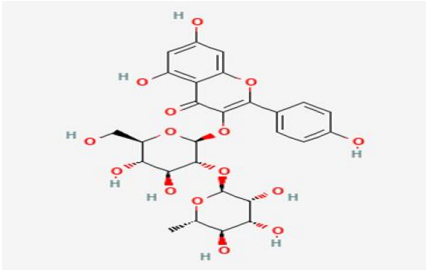

Fig. No. 9: Structure of Kaempferol 3-neohesperidoside

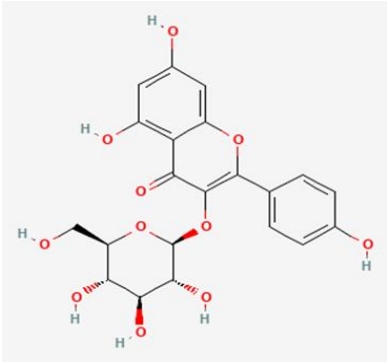

Fig. No. 10: Structure of Kaempferol 3-glucoside

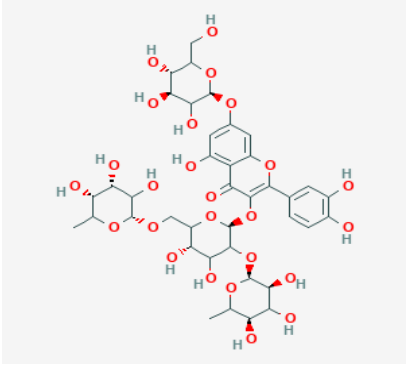

Fig. No. 11: Structure of Quercetin 3-(2g-rhamnosylrutinoside)

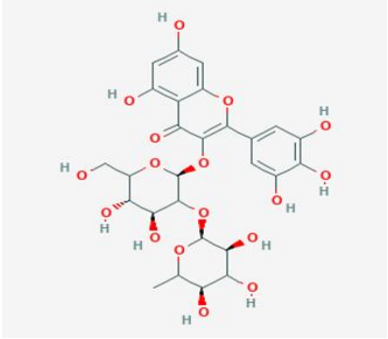

Fig. No. 12: Structure of Myricetin 3-neohesperidoside

ANTHOCYANINS

Six acylated anthocyanins were isolated from blue C. ternatea flowers that were all derivatives of delphinidin 3,3',5'-triglucoside, The chemical properties of the acylated C. ternateadelphinidins, which were named ternatins, were further elucidated in subsequent studies. The structure of the largest isolated blue anthocyanin, ternatin A1, was determined 18]. The study also showed that not only was ternatin A1 the largest, it was one of the most stable in neutral solution The structure of ternatins A2B1 B2[19] were elucidated shortly after. Subsequent studies isolated and determined the structures of several other novel ternatins isolated from C. ternatea: ternatins A3, B3-B4,C1-C5,D3, and preternatins A3 andC4 [19].

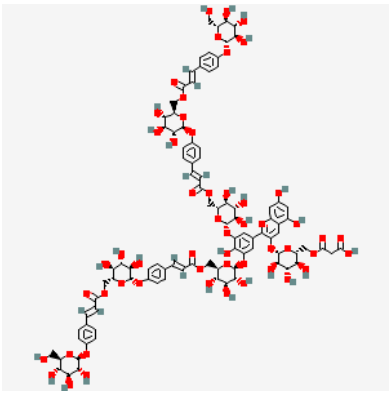

Fig. No. 13: Structure of Ternatin A1

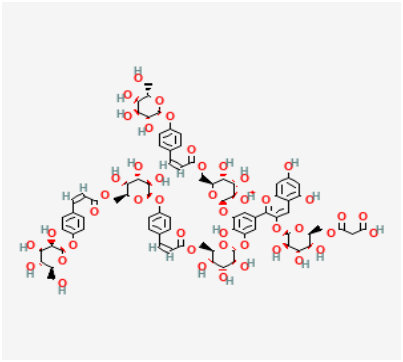

Fig. No. 14: Structure of Ternatin A2

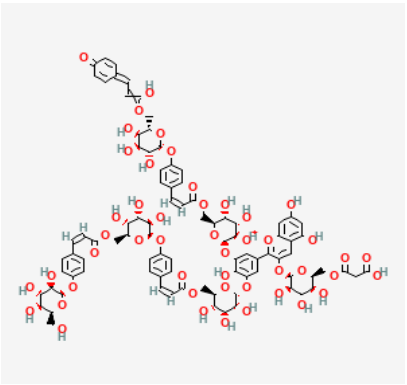

Fig. No. 15: Structure of Ternatin B1

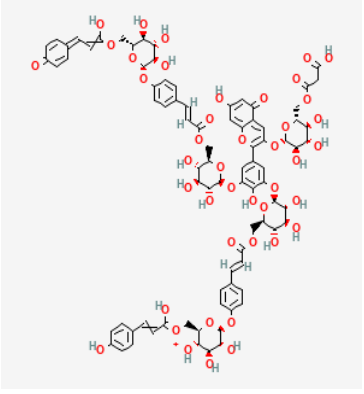

Fig. No. 16: Structure of Ternatin D1

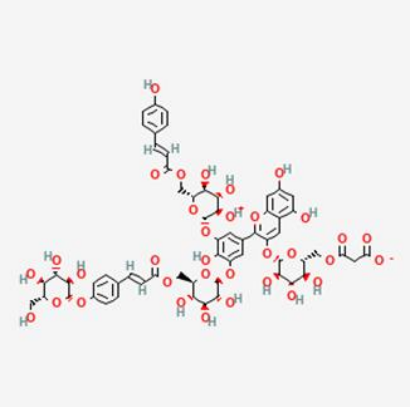

Fig. No. 17: Structure of Ternatin B4

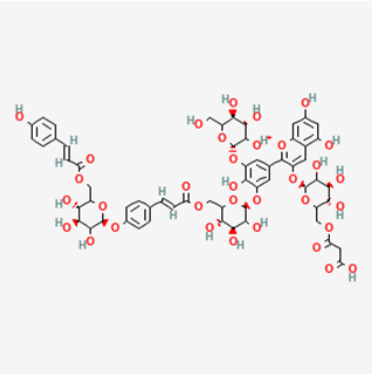

Fig. No. 18: Structure of Ternatin C1

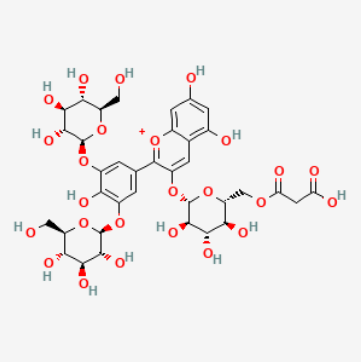

Fig. No. 19: Structure of Ternatin C5

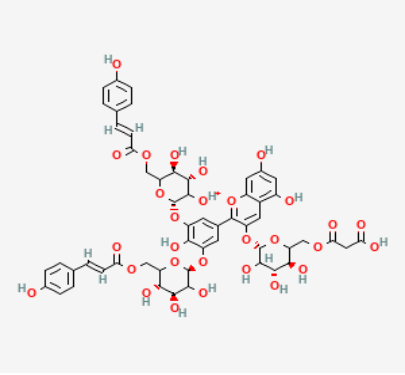

Fig. No. 20: Structure of Ternatin D3

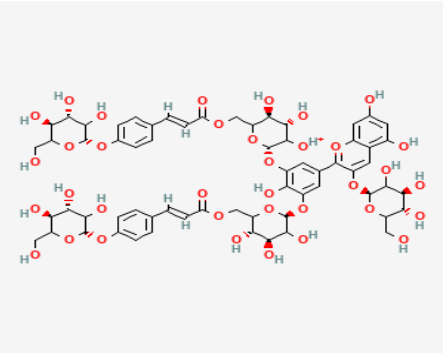

Fig. No. 21: Structure of Preternatin A3

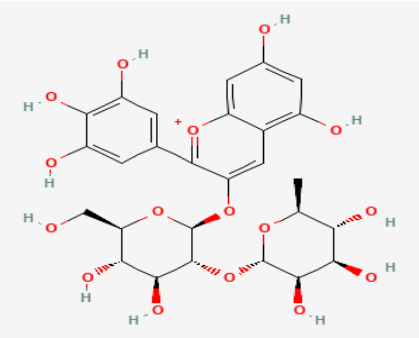

Fig. No. 22: Structure of Delphinidine 3-neohesperidoside

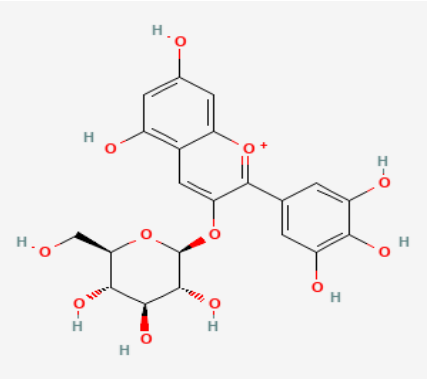

Fig. No. 23: Structure of Delphinidine 3-glucoside

Other Non-proteinaceous Components

The pentacyclic triterpenoids, taraxerol and taraxerone, were isolated from roots of C. ternatea .C. ternatea as a source of taraxerol Its roots also contains taraxerol, novel norneolignans, clitorienolactones A-C,. C. ternateafloral extracts also contain other types of flavonoids, including rutin (flavone), epicatechin (flavanol) and other polyphenolic acids (gallic acid, protocatechuic acid, and chlorogenic acid) [19, 20]

Table No. I: Table showing different parts of *C. ternatea* plant with its phytochemicals and function

Plant Parts	Phytochemicals	Functions	References
Leaf	Alkoloids, Reducing suger, Flavonoids, Steroids, Glycosides	1. Prevention of neurodegenerative diseases and diabetes mellitus 2. Effectively controls the excessive sweating	[21]
Flower	Saphonin, Tanin, Alkoloids, Glycosides, Phytosterols, Carbohydrates	1.Anti-inflammatory, Analgesic 2.Ethanol extract is used as antidiabetic	[22,23]
Root	1,1-Diphenyl-2-picrylhydrazyl(DPPH)	1.Antioxidant 2.diuretic and laxative	[24]
Seed	The seeds contain nucleoprotein with its amino-acid sequence similar to insuline , delphinidin-3,3,5-triglucoside, essential amino acids, anthosxanthin glucosides, 3,5,7,4-tetrahydroxy-flavone-3-rhamoglycoside,p-hydroxy cinnamic acid polypeptide,	1.cathartic purgative and aperients	[25]

Pharmacological Activities

1. Anxiolytic activities

Oral treatment with alcohol extract of clitoria ternatea at a dose of 460 mg/kg significantly prolonged the time taken to traverse the maze as produced by chlorpromazine in rat demonstrated significant effect on anxiety. The animal treated with clitoria ternatea (100 mg/kg) showed a significant increase in the inflexion ratio and discrimination index which provides evidence for the species nootropic activity [1]

2. Anti-epileptic activity studies

Methanol extract from the aerial parts of clitoria ternatea screend by using pentylenetetrazol (PTZ) and maximum electroshock (MES)- induced seizures in mice at the dose of 100 mg/kg p.o. CT significantly delayed the onset of convulsions and also delayed the duration of tonic hind limb extension in MES- induced convulsions [2]

3. Antimicrobial Activity

Different extracts of Clitoria ternatea showed inhibitory effects against Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumonia, Bacillus subtilis, AeromonasFormicans, Aeromonashydrophila and Streptococcus agalactiae. Ethyl acetate extracts of Clitoriaternatea showed maximum zone of inhibition against A. Formicans , A. hydrophilia B. subtilis and P. aeruginosa next to that ethanol extract of Clitoria ternatea showed maximum zone of inhibition against A. formicans and E. coli followed by the acetone extract which showed maximum zone of inhibition against S. agalactiae and K. pneumonia . [12]

4. Anticancer effect

The in vitro cytotoxic effect of petroleum ether and ethanolic flower extracts (10, 50, 100, 200, 500 µg/ml) of Clitoria ternatea was studied using trypan blue dye exclusion method. Both extracts exhibited significant dose dependent cell cytotoxic activity. For petroleum ether extract the concentration 10 µg/ml showed 8% reduction in cell count, however, 100% reduction was observed at 500 µg/ml. In case of ethanolic extract, 10 µg/ml concentration possessed 1.33% reduction in cell count, while, at 500 µg/ml 80% reduction in cell count was observed. [24]

5. Wound healing effect

The wound healing activity of Clitoria ternatea seed and root extracts was investigated using excision, incision and dead-space models in rats. Clitoria terntea seed and root extracts significantly improved wound healing in excision, incision and dead-space models when administered orally by gavages as well as applied topically as ointment. These effects were comparable to that of cotrimoxazole ointment. The finding of the study also showed that Clitoria ternatea affected all three

phases: inflammatory, proliferative and remodeling phases of wound healing. [23]

6. Gastrointestinal effect

The antiulcer potential of aqueous and ethanolic extracts of Clitoria ternatea was evaluated was evaluated in differed in different experimentally induced ulcer models in rats. Ethanolic extract (200 and 400 mg/kg) and aqueous extract (200 and 400 mg/kg) of whole plant were examined in pylorus ligation and indomethacin induced gastrc ulcer in rats. Various parameters like volume of gastric acid secretion, pH, total acidity, ulcer index and antioxidant parameters were determined and compared between extracts, standard and vehicle control group following ulcer induction. Among different dose of alcoholic extract, high dose showed significant antiulcer activity in pylorus ligation and indomethacin induced ulceration [20].

7. Insecticidal Activity

Proteins and peptides isolated from C. ternatea are reported to exhibit insecticidal properties (Kelemu et al., 2004; Poth et al., 2011a) (Table 5). One study reported 100% larval mortality when 1% w/w of the purified C. ternatea protein (20 kDa), finotin, was applied to the bruchidsAcanthoscelidesobtectus and Zabrotessubfasciatus, respectively (Kelemu et al., 2004). Another study showed that when the lepidopteran species Helicoverpaarmigera, larval growth retardation was observed in a dose dependent at 1µmol CterM peptide g-1 diet. [23]

8. Anthelminthic Activity

The methanolic extract of C. ternatea was also found to inhibit 93% of M. incognita egg from hatching. In another study that utilized the model organism, Caenorhabditis elegans, C. ternatea extracts were found to effectively kill nematode larvae, with the root extracts showing greater lethality than the leaf extracts [26].

9. Anti-diabetic studies

Oral administration of aqueous extract of CT leaves (400mg/kg body weight) and flowers (400mg/kg body weight) for 84 days showed significantly reduced serum glucose, glycosylated hemoglobin, total cholesterol, triglycerides, urea, creatinine and the activity of gluconeogenic enzyme glucose-6-phosphatase, but increased serum insulin, HDL-cholesterol, protein, liver and skeletal muscle glycogen content and the activity of glycolyt7ic enzyme glucokinase. For all the above biochemical parameters investigated, Clitoriaternatea leaves treated rat showed a little better activity than Clitoria ternatea flowers treated diabetic rats.[22]

CONCLUSION

Clitoria ternatea is perennial herbaceous plant from family Fabaceae. It has potential applications in modern medicine as well as agriculture.C. ternatae is garden plant of India, which has been used in traditional as well as mordern medicines nowadays. This review paper includes plant distribution, phtyconstituents like- flavonaols- kaempferol, kaempferol 3-glucoside, kaempferol 3-robinobioside-7-rhamnoside, Quercetin, anthocyanins, etc. It also includes the different pharmacological acivities were shown by Clitoria ternatea like anti-inflamatory, antioxidant, catheratics, insecticides etc. From this study it conclude that C. ternatea is a very effective plant whiuch will be benifical for future drug development form natural origin.

Acknowledgements

We would like to thank Dr. R. S. Adnaik, Anandi Pharmacy College, Kalambe tarf Kale, Kolhapur for providing the necessary laboratory facilities.

REFERENCES

1.Lijon et al., Phytochemistry and pharmacological activities of Clitoria ternatea, International Journal of Natural and Social Sciences, 2017, 43(1):01-10

2.JagbirChahal et al. Clitoria ternatea (L.): Old and new aspects / Journal of Pharmacy Research 2010, 3(11),2610-2614

3.Shradha Lakhera1, Kamal Devlal1,Meenakshi Rana1, Ismail Celik, et al.,Study of nonlinear optical responses of phytochemicals of Clitoriaternatea by quantum mechanical approach and investigation of their anti-Alzheimer activity with in silico approach, Structural Chemistry June 2022

4.Lakshan, S. A. T., Jayanath, N. Y., MendisAbeysekera, W. P. K., & Abeysekera, W. K. S. M. (2019). A Commercial Potential Blue Pea (Clitoriaternatea L.) Flower Extract Incorporated Beverage Having Functional Properties. Evidence-Based Complementary and Alternative Medicine, 2019, 1–13.

5. Fadheela Al-Salman, Ali AliRedha*, ZainabAqeel and Zahra Ali et al., Phytochemical Content, Inorganic Composition, Mineral Profile, andEvaluation of Antioxidant Activity of Some Common Medicinal Plants ,Iraqi Journal of Science, 2022, Vol. 63, No. 7, pp: 2764-2773 Fatmah A. Safhi 1, Salha M. ALshamrani2 et al. Asian Pigeonwing Plants (Clitoriaternatea) Synergized Mesenchymal Stem Cells by Modulating the Inflammatory Response in Rats with Cisplatin-Induced Acute Kidney InjuryInjury. Pharmaceuticals 2022, 15Shu En GOH1

6. , PhekJin KWONG1,2,3, Chong Lee NG1Wen Jie NG1,3, Kah Yaw EE1,2 , Antioxidant-rich Clitoriaternatea L. flower and its benefits in improving murine reproductive performanceFood Science and Technology ISSN 0101-2061 (Print)ISSN 1678-457X

7. Oguis, G. K., Gilding, E. K., Jackson, M. A., & Craik, D. J. (2019). Butterfly Pea (Clitoriaternatea), a Cyclotide-Bearing Plant With Applications in Agriculture and Medicine. Frontiers in Plant Science, 10. doi:10.3389/fpls.2019.00645

8. Chusak, C., Thilavech, T., Henry, C. J., & Adisakwattana, S. (2018). Acute effect of Clitoriaternatea flower beverage on glycemic response and antioxidant capacity in healthy subjects: a randomized crossover trial. BMC Complementary and Alternative Medicine, 18(1). Doi:10.1186/s12906-017-2075-7

9. Lakshan, S. A. T., Jayanath, N. Y., MendisAbeysekera, W. P. K., &Abeysekera, W. K. S. M. (2019). A Commercial Potential Blue Pea (Clitoriaternatea L.) Flower Extract Incorporated Beverage Having Functional Properties. Evidence-Based Complementary and Alternative Medicine, 2019, 1–13.

10. SadayappanRajendra, kesaniprabhakar et al. Phytochemical analysis and antimicrobial activity of clitoriaternitea Linn against extended spectrum beta .Lactamase producing enteric and urinary pathogens,Asian Journal of Pharmaceutical and Clinical ResearchVol.2 Issue 4, October- December 2009 ISSN 0974-2441

11. Pallavi Mahesh More and Kunal Ramesh Hake, Medicinal importance of Clitoriaternatea, International Journal of Applied Research 2019; 5(11): 222-225

12. Angkana, , Tantituvanont, Chulalongkorn University, PornpenWerawatganone, Chulalongkorn University Preparation and stability of butterfly pea color extract loaded in microparticles prepared by spray dryingjanuary 2008

13. Jayanti Patel (DMAPR)B. Z. Dholakiya Sardar Vallabhbhai National Institute of TechnologyN. A. Gajbhiye (DMAPR)Ashok Kumar Bishoyi Assessment of chemical diversity in Clitoriaternatea accessions by an improved and validated HPTLC methodSeptember 2016Indian Journal of Agricultural Sciences 86(9):1133-1139

14. Mukherjee, P. K., Kumar, V., Kumar, N. S., & Heinrich, M. (2008). The Ayurvedic medicine Clitoriaternatea—From traditional use to scientific assessment. Journal of Ethnopharmacology, 120(3), 291–301. Doi:10.1016/j.jep.2008.09.009

15. Barbour, E. K., Al Sharif, M., Sagherian, V. K., Habre, A. N., Talhouk, R. S., &Talhouk, S. N. (2004). Screening of selected indigenous plants of Lebanon for antimicrobial activity. Journal of Ethnopharmacology, 93(1), 1–7. Doi:10.1016/j.jep.2004.02.027

16. Saito, Y. (1985) Life types of spider mites. In Spider Mites. Their Biology, Natural Enemies and Control,Vol. 1A (W. Helle and M.W. Sabelis eds.), pp. 253-264, Elsevier, Amsterdam.

17. Rai, Y. K., Ale, B. B., &Alam, J. (1970). Impact Assessment of Climate Change on Paddy Yield: A Case Study of Nepal Agriculture Research Council (NARC), Tarahara, Nepal. Journal of the Institute of Engineering, 8(3), 147–167. Doi:10.3126/jie.v8i3.5941

18. Kumar, M., Bhatt, G., and Duffy, C.J. (2008) An efficient domain decomposition framework for accurate representation of geodata in distributed hydrologic models International Journal of Geographical Information Science, 23(12):1569-1596.

19. Swann, C., Keegan, R. J., Piggott, D., & Crust, L. (2012). A systematic review of the experience, occurrence, and controllability of flow states in elite sport. Psychology of Sport and Exercise, 13(6), 807–819. Doi:10.1016/j.psychsport.2012.05

20. Scalbert, A., Manach, C., Morand, C., Rémésy, C., & Jiménez, L. (2005). Dietary Polyphenols and the Prevention of Diseases. Critical Reviews in Food Science and Nutrition, 45(4), 287–306. Doi:10.1080/10408690590960

21. S.K. Srivastava Traditional insect bioprospecting-As human food and medicine November 2009Indian Journal of Traditional Knowledge 8(4):485-494

22. Malic, S., Hill, K. E., Hayes, A., Percival, S. L., Thomas, D. W., & Williams, D. W. (2009). Detection and identification of specific bacteria in wound biofilms using peptide nucleic acid fluorescent in situ hybridization (PNA FISH). Microbiology, 155(8), 2603–2611. Doi:10.1099/mic.0.028712-0

23. Braca, A., Sortino, C., Politi, M., Morelli, I., & Mendez, J. (2002). Antioxidant activity of flavonoids from Licanialicaniaeflora. Journal of Ethnopharmacology, 79(3), 379–381. Doi:10.1016/s0378-8741(01)00413-5

24. Basu, B.D. and Kirtikar, K.R. (1980) Indian Medicinal Plants, second edn, Bishen Singh Mahendra Pal Singh, Dehradun, 1, 676-683

25. Salhan, S., Tripathi, V., Singh, R., &Gaikwad, H. S. (2012). Evaluation of Hematological Parameters in Partial Exchange and Packed Cell Transfusion in Treatment of Severe Anemia in Pregnancy. Anemia, 2012, 1–7. Doi:10.1155/2012/608658

26. Peired, A. J., Sisti, A., &Romagnani, P. (2016). Mesenchymal Stem Cell-Based Therapy for Kidney Disease: A Review of Clinical Evidence.