International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 03 | March - 2024 SJIF Rating: 8.176 ISSN: 2582-3930

Phytochemical Screening and Antioxidant Activity in Dragon Fruit Plant Extracts as Immunomodulators in Pregnant Women

Author Name : Miss. Gayatri Mahale 1st, Mr. Nikhil Chaudhari 2nd , Mr. Utkarsh Mandage 3rd , Miss. Jagruti Patil 4th, Miss Swati Patil 5th , Pratiksha Patil 6th

Abstract :

Introduction: Numerous organic acids, proteins, and minerals like potassium, magnesium, calcium, iron, and vitamin C are found in dragon fruit. A number of naturally occurring substances, including flavonoids, curcumin, limonoids, vitamin C, vitamin E, and catechins, have the ability to stimulate the immune system. **Objective:** to evaluate the concentrations of active components and phytochemicals in the fruit, skin, stem, and roots of dragon fruit plants. **Methods:** This study was conducted in the Pucuk Sirih Jamu Factory using experimental methods. This study prepared an extract, screened for phytochemicals, and measured the levels of phytochemicals in red dragon fruit trees using fresh and ripe plants that were picked directly from the Tanah Laut District garden in South Kalimantan. The highest antioxidant activity in red dragon fruit stems. **Conclusions:** The fruit, peel, stems, and roots of dragon fruit plants from Kalimantan Selatan, Indonesia, include families of secondary metabolites and antioxidants.

Key words: Phytochemical Screening, Antioxidant, Dragon fruit plant, Immunomodulator, Pregnant Women.

Introduction

The plant known as dragon fruit has compounds that can speed up metabolism and improve endurance.1 Dragon fruit is a rich source of phytochemicals linked to its antioxidant activity, including polyphenols, flavonoids, and vitamin C. The red and white varieties in particular have gained popularity recently due to their economic worth as well as their health advantages.2. A popular tropical fruit, dragon fruit (Hylocereus spp.) is thought to be beneficial in part because of its high phenolic component concentration.3. Pulp's phenolic components have a number of possible health advantages and exhibit antioxidant activity.4 In 2016, the value of dragon fruit as a global commodity reached 4.9 billion US dollars.Five naturally occurring ingredients must be included in the dose form when used as supplements. In general, natural materials lose stability when exposed to the elements. This makes it possible to formulate natural

components in appropriate preparations. The stability of the active components will be increased by using natural compounds that are produced in dosage forms. This study set out to quantify the phytochemical and secondary metabolite contents of the fruit, stem, and root of the Hylocereus polyrhizus, or dragon fruit plant. While the skin of the dragon fruit has more tannins and flavonoids than the flesh, the flesh of the fruit has a higher overall phenolic content and antioxidant potential. The findings demonstrated that while the skin of the dragon fruit has a higher flame and tannin content than the meat, the dragon flesh grown in Australia has a stronger overall phenolic content and antioxidant capacity.Six Fito-albumin and betalain, which are widely prized for their antioxidant properties, are among the many nutrients and minerals that Hylocereus polyrhizus possesses in abundance. Moreover, betalains are helpful to the food sector because they can be used as a natural food colouring.7. Numerous studies have demonstrated the high antioxidant content of fresh fruits and vegetables, which can offer defence against oxidative stress-related chronic diseases like heart disease and various cancers. Additionally, phenolic compounds and flavonoids have been shown to exhibit antioxidant qualities.8,9 According to the investigation, the H. Polyrhizus rod extract exhibited good ABTS and Radical Radical antidote properties. Additionally, stem extract, skin, and flower in watery ethanol 95% demonstrate the remarkable DNA damage prevention activity. Cell migration is enhanced by 1000 g/ml of stem and flower extract in 95% aqueous ethanol. These findings suggest that H. Polyrhizus stem, leather, and flower are sources of antioxidant polyphenols with potential uses in the food, cosmetics, and pharmaceutical industries.10 Dragon fruit contains high concentrations of betalains, flavonoids, polyphenols, terpenoids, steroids, saponins, alkaloids, and tannins, which are bioactive phytochemicals. Numerous studies have examined the antioxidant capacity of dragon fruit and found that it is very capable of absorbing antioxidants.11 Foods get their antioxidant action from the presence of phenols and tannins.12 Depending on the part of the fruit you examine, the phytochemical makeup and antioxidant activity of dragon fruit vary. For example, the peel of the red dragon fruit contains more antioxidants than the pulp of the white dragon fruit.Thirteen Red dragon fruit, also called Hylocereus polyrhizus, contains a number of phytochemicals with antioxidative and anti-inflammatory properties, such as flavonoids, polyphenols, and betalains. 13–15 Some noteworthy outcomes from the search include the following:

The anthocyanin compounds delphinidin, cyanidin, and malvidin are found in the peel of red dragon fruit. The total flavonoid concentrations (TFC) of red dragon fruit extracts were measured using a modified colorimetric assay. This demonstrated the high TFC of red dragon fruit.13 Red dragon fruit peel extract has been found to contain phenol and flavonoid chemical components.14 A phytochemical examination of the peel of the red dragon fruit has identified several bioactive ingredients, including as betalains, flavonoids,

and polyphenols.15 Red dragon fruit is high in flavonoids, a family of antioxidants that can protect cells from damage caused by free radicals. Some noteworthy outcomes from the search include the following: The total flavonoid content of red dragon fruit extract has been examined in a number of research. Flavonoids of several kinds, including as myricetin, kaempferol, and quercetin, are found in red dragon fruit.Six High concentrations of antioxidants, fibre, vitamin C, and minerals can be found in dragon fruit pulp, rind, seeds, flower buds, and dried flowers. Due to its anti-inflammatory, antioxidant, anti-diabetic, anti-cancer, and cardioprotective properties, dragon fruit offers numerous health advantages. The nutritional and medicinal qualities of dragon fruit account for a large portion of its substantial commercial worth.It has been discovered that 19 dragon fruit stems include steroids, flavonoids, and saponins.20 Alkaloids, which are found in the fruit's peel and seeds, are among the phytochemicals found in dragon fruit. Quercetin, myricetin, rutin, epicatechin, and catechin are all found in dragon fruit seeds. The red dragon fruit (Hylocereus polyrhizus) peel is rich in anthocyanins, including delphinidin, cyanidin, and malvidin. Other bioactive substances found in dragon fruit include polyphenol, carotene, pyridoxine, niacin, tianine, terpenoids, flavonoids, and betalains. Numerous biological activity of alkaloids are recognised, such as their antibacterial, anti-inflammatory, and antioxidant qualities. However, further research is needed to fully understand the individual alkaloids found in dragon fruit and how they affect human health.21 To fully comprehend the health benefits, nutritional value, commercial value, and potential uses of dragon fruit which is readily available and reasonably priced in the area research on the fruit's phytochemical and antioxidant content is imperative. This fruit is a potential immunomodulator for pregnant women.

Materials and Methods

Create This study employed an experimental design, with the Pucuk Sirih Herbal Plant serving as the research site. The study used dragon fruit plants (fruit, bark, stems, and roots) as a sample, and the plants had to meet certain local requirements, such as being native to Tanah Laut Regency. (Kalimatan, South). Indonesia: Fresh dragon fruit plants and ripe dragon fruit are harvested straight from the garden. Glassware, Maseri Vessel, Rotary Evaporator, Waterbath, Grinder, UV-Vis Spectrophotometer, and Atomic Absorption Spectrocopic (AAS) are the instruments and materials utilised. Dragon Fruit Plant from Pelaihari, Whatman Filter Paper No. 10, Technical Ethanol, Pro Analysis of Ethanol, Pro Analysis of Citric Acid, Pro Analysis of Vitamin C, Sterile water, DPPH, Tris Buffer Saline (TBS) solution, pro analysis of bovine serum albumin, and pure diclofenac standard.

Dragon fruit extract-making procedure

Every plant's components are separated, carefully cleaned under running water, and then emptied. After being divided into smaller pieces, the samples were dried for three days at 60°C in an oven. After that, the dry samples were ground into a powder using a grinder. After weighing the dry sample powder to a maximum of 1 kilogramme, each was submerged for three days in 10 litres of ethanol. Every 24 hours, the solvent was swapped out. To extract the active components from the pulp, filter paper and a hydraulic press were used to filter the extract solution. After that, the extract solution was reduced to 1/10 part by evaporating it using a rotary evaporator. After that, it was once more evaporated in a water bath to produce a thick extract.

Process for phytochemical screening

For three days, the drying process was conducted at 60°C, the highest temperature that can be used to dry Simplicia. This was done to lower the water content and prevent the fungus from growing. After that, dirt, foreign organic debris, and Simplicia that were harmed by the prior procedure are separated by dry sorting. Pollinating dry Simplicia to produce powder for extraction is the final step.22 After extraction, an extract solution is produced, and organic solvents are eliminated by evaporating it. An oven and a rotary evaporator

are used in the solvent evaporation procedure. After that, the extract was collected to create a dry extract that contained the active ingredients.

Phytochemical assay procedure

Total Flavonoid Content is determined by weighing the samples, placing them in a beaker, and repeatedly extracting them at room temperature using 100 cc of methanol. Whattman filter paper No. 41 was then used to filter the entire solution. The filtrate was then weighed to ensure a consistent weight and dried by evaporating over a water bath. Next, the flavonoid percentage was computed.23 Calculating the Concentration of All Alkaloids Total 200 ml of a 10% acetic acid solution was added to a beaker containing 5.0 g of sample. After covering the mixture, the mixture was left to stand for four hours. after which the leaf powder and solution were separated by filtering, and the remaining volume was evaporated using a water bath. Concentrated ammonium hydroxide (NaOH) is poured into the solution to create a precipitate, which is then let to stand until more precipitate forms. Following filtering and a NaOH wash, the precipitate was dried and weighed using the previously weighed filter paper. The percentage of weight per volume was used to compute the percentage of alkaloids. The gravimetric technique was the assay employed in this investigation.22, 24 Total Saponin Content was determined by refluxing a 1.25 g sample with 50 mL petroleum ether for 30 minutes at a temperature between 60 and 80˚C. The petroleum ether solution was removed once it had cooled, and the remaining residue was then dissolved in 50 millilitres of ethyl acetate. The ethyl acetate solution was separated by moving the mixture to a separatory funnel. Three times, n-butanol was used to dissolve the remaining residue. Next, a rotary evaporator is used to combine and evaporate the butanolic solution. Methanol was used to dissolve the residual evaporation, and the mixture was then added to diethyl ether while being stirred. The mixture's precipitate is placed onto filter paper, the weight of which is known. A set weight was used to weigh the precipitate. The weight of the saponins was calculated as the difference between the weight of the filter paper before and after filtration. The gravimetric technique was the assay employed in this investigation.25 Calculating the Overall Terpenoid Content along with In a beaker, about 2g of powder was weighed, 50 ml of 95% ethanol was added, and the mixture was let to stand for 24 hours. The filtrate was then dried at a temperature between 60 and 80 C after being filtered and combined with petroleum ether. The sample's dry extract is entirely terpenoid.23 spectroscopic technique was used in this investigation to determine the total steroid levels.26, 27

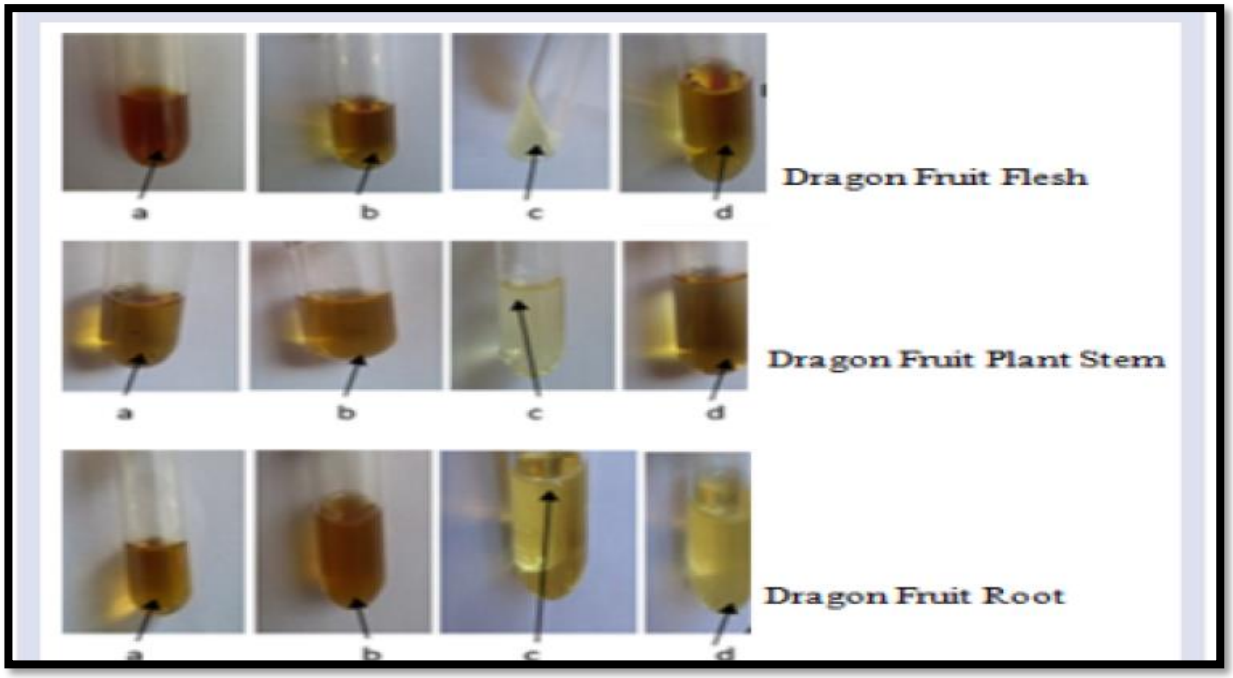
Results And Discussion

Phytochemical Test results dragon fruit plant extract

Outcomes of Phytochemical Screening on the Fruit Extract, Skin, and Stem of the Native Tanah Laut Regency Dragon Fruit (Hylocereus polyrhizus). A preliminary step called phytochemical screening is done to give a basic description of the class of compounds present in the plant being studied (Table 1). Using specific reagents, a colour change reaction or precipitate generation is used to carry out the phytochemical screening approach.28 Table 1 shows that the phytochemical test results on the fruit, skin, stems, and roots of the native Hylocereus polyrhizus dragon fruit plants from Tanah Laut Regency demonstrated the presence of flavonoids, alkaloids, saponins, and steroids, as indicated by variations in the colour of the fruit plant extracts. dragon. Numerous health issues can be resolved by secondary metabolites. The active components in secondary metabolites are what give drugs their pharmacological effects. The secondary metabolite levels in red dragon fruit plants are displayed in Table 2 for the highest flavonoid content (0.74%), highest alkaloids content (4.21%), highest saponin content (0.55%) and highest levels of steroids (0.81%) in the fruit flesh. The average phytochemical content was higher in the stems of red dragon fruit, with alkaloids predominating at the highest levels and generally having various pharmacological properties as antioxidants. Table 3 demonstrates that UV-Vis spectrophotometry was used to assess the antioxidant activity using the DPPH technique (2,2-diphenyl-1-picrylhydrazyl). Alkaloids, flavonoids, and steroids were found in the red dragon fruit stem extract, according to the results of the phytochemical study. The stems of red dragon fruit, or Hylocereus polyrhizus, are rich in secondary metabolites that function as potent antioxidants.30 Bioactive chemicals such as alkaloids, tannins, carotenoids, terpenoids, steroids, betalains, and flavonoids can be extracted from every section of the fruit plant. roots are part of the dragon.31 The findings demonstrated that while the peel of dragon fruit contained more flavonoids and tannins than the pulp, the pulp had a greater total phenolic content and a stronger antioxidant potential. The acquired data suggested that Australian pulp waste and by-products from dragon fruit peels are possible sources of phenolic compounds, which have antioxidant potential for use in the food, cosmetic, pharmaceutical, and nutraceutical sectors.Six The FTIR method was utilised to identify the contents of the red dragon fruit peel extract, and the results showed the presence of flavonoids, tannins, alkaloids, and steroids.32 FTIR is used to identify a compound's bonding group based on the plant's wavelength and wave number. The approach taken in this study was marginally different from previous studies, but the findings with regard to the class of compounds found in the red dragon fruit's skin were the same. To determine the amount of secondary metabolites in the red dragon fruit peel extract, phytochemical screening was done as a preliminary test.

TLC was then used to confirm the positive reaction results. Red dragon fruit peels with the potential to be utilised in traditional medicine were found to include alkaloids, tannins, flavonoids, steroids, and favourable screening and TLC results.33 Tannins, flavonoids, alkaloids, and saponins were found in the ethanolic extract of red dragon fruit peel, according to the study's qualitative identification results of phytochemical screening. Based on the detection of flavonoid components with a UV-Vis spectrophotometer and shear reagent, it was suggested that the ethanol extract of red dragon fruit peel contained isoflavone compounds. OH, C-O alcohol, C=C aromatic, C-H aromatic, C-H aliphatic, C=O, and C-O ether are examples of the specific functional groups of flavonoid compounds that were found in the ethanol extract of red dragon fruit peel, according to the results of the FTIR identification process. The phytochemical analysis of the red dragon fruit peel methanol extract comprises a review of the following compounds: flavonoids, alkaloids, steroids/triterpenoids, saponins, tannins, and essential oils.34 The flesh of red dragon fruit was discovered to include steroids, alkaloids, tannins, and flavonoids in another study.32 According to the phytochemical test results, phenolic compounds, alkaloids, steroids, flavonoids, and terpenoids were found in red dragon fruit (Hylocereus polyrhizu). In thin-layer chromatography, the plate showed no spots. A number of structures in GC-MS are comparable to those of n-henecosane, 1-nonadecene, 5-eicosene, and 1,2-benzene dicarboxylic acid. Chemicals having the aforementioned structure are beneficial to health in a number of ways, including as antibacterial, antioxidant, antifungal, and anti-inflammatory properties.35 Vitamin B1, B2, B3, and C, as well as protein, fat, carbs, crude fibre, flavonoids, thiamin, niacin, pyridoxine, cobalamin, glucose, phenolic, betacyanin, polyphenols, carotene, phosphorus, iron, and phytoalbumin are all abundant in red dragon fruit. Additionally, it contains a lot of phytoalbumin, which is prized for its potent antioxidant qualities. Fibre, vitamin C, minerals, and phytoalbumin which is prized for its antioxidant qualities are abundant in Hylocereus polyrhizus. Peel from red dragon fruit has several benefits, including being high in antioxidant-rich polyphenols and anthocyanins. The peel of the red dragon fruit has more antioxidant content than the fruit itself.36

Figure 1: The phytochemical test findings for the red dragon fruit extract show that it contains flavonoids, alkaloids, saponins, and steroids.



Conclusion

Tanah Laut Regency's native dragon fruit plants have the highest concentrations of phytochemicals in the stems of the fruit, as well as secondary metabolic components (flavonoids, alkaloids, saponins, and terpenoids). It is recommended to formulate dragon fruit extract formulations in an effective and efficient manner using experimental animals.

Reference

1. Oktaviani EP, Purwijantiningsih LE, Pranat FS. Kualitas Dan Aktivitas Antioksidan Minuman Probiotik Dengan Variasi Ekstrak Buah Naga Merah (Hyloreceus Polyrhizus) Quality And Activity Of Antioxidant From Probiotic Drinks With Variations Of Red Dragon Fruit (Hyloreceus Polyrhizus) Extract. Jurnal Teknobiologi. 2015;1- 15.

2. Padmavathy K, Sivakumari K, Karthika S, Rajesh S, Ashok K. Phytochemical profiling and anticancer activity of dragon fruit Hylocereus undatus extracts against human hepatocellular carcinoma cancer (hepg-2) cells. Int J Pharma Sci Res. 2021;12(5):2770-78.

3. Zain N, Nazeri M, Azman N. Assessment on bioactive compounds and the effect of microwave on pitaya peel. Jurnal Teknologi. 2019;81.

4. Som AM, Ahmat N, Hamid HAA, Azizuddin N. A comparative study on foliage and peels of Hylocereus undatus (white dragon fruit) regarding their antioxidant activity and phenolic content. Heliyon. 2019;5:e01244.

5. Chen J. Phytochemical Cocktail–Waste Utilization of Inedible Dragon Fruit Peel. 2018.

6. Chen Z, Zhong B, Barrow CJ, Dunshea FR, Suleria HAR. Identification of phenolic compounds in Australian grown dragon fruits by LC-ESIQTOF-MS/MS and determination of their antioxidant potential. Arab J Chem. 2021;14(6):103151.

7. Gengatharan A, Dykes GA, Choo WS. The effect of pH treatment and refrigerated storage on natural colourant preparations (betacyanins) from red pitahaya and their potential application in yoghurt. LWT-Food Sci Tech. 2017;80(1):437-45.

8. Soccio M, Laus MN, Alfarano M, Dalfino G, Panunzio MF, Pastore D. Antioxidant/Oxidant Balance as a novel approach to evaluate the effect on serum of long-term intake of plant antioxidant-rich foods. J Funct Food. 2018;40(1):778-84.

9. Reboredo-Rodríguez P, González-Barreiro C, Cancho-Grande B, Forbes-Hernández TY, Gasparrini M, Afrin S, et al. Characterization of phenolic extracts from Brava extra virgin olive oils and their cytotoxic effects on MCF-7 breast cancer cells. Food Chem Toxicol. 2018;119(1):73-85.

10. Tsai Y, Lin CG, Chen WL, Huang YC, Chen CY, Huang KF, et al. Evaluation of the antioxidant and wound-healing properties of extracts from different parts of hylocereus polyrhizus. Agronomy. 2020;9(1):1-11.

11. Mahdi MA, Mohammed MT, Jassim AMN, Mohammed AI. Phytochemical content and anti-oxidant activity of hylocereus undatusand study of toxicity and the ability of wound treatment. Plant Archives. 2018;18(2):2672-80.

12. Bassiag SKR, Aguinaldo KR, Singson ZA, Guzman R. Phytochemical Analysis of Dragon Fruit (Hylocereus Spp.) and Carica Papaya Stems. 2023.

13. Saenjum C, Pattananandecha T, Nakagawa K. Antioxidative and anti-inflammatory phytochemicals and related stable paramagnetic species in different parts of dragon fruit. Molecules. 2021;26(12):3565.

14. Siregar TW, Julianti E. Effectiveness test of red dragon fruit skin (Hylocereus costaricensis jack) as natural preservation for nila fish (Oreochromis niloticus). In IOP Conference Series: Earth and Environmental Sci. 2020;515(1):012056.

15. Vera Cruz DG, Paragas DS, Gutierrez RL, Antonino JP, Morales KS, Dacuycuy EA, et al. Characterization and assessment of phytochemical properties of dragon fruit (Hylocereus undatus and Hylocereus polyrhizus) peels. Technol. 2022;18(3):1307-18.

16. Hanifa NI, Rumiyati R, Sismindari S, Fakhrudin N. Cytoprotective and antioxidant effects of ethanolic extract of red dragon fruit (Hylocereus polyrhizus) and carrot (Daucus carota L.). In AIP Conference Proceedings. 2016;1755(1).

17. Maigoda TC, Darwis D, Rizal A, Kamsiah K, Meriwati M, Wahyuni E. Research Article Red Dragon Fruit Powder as a Basic Ingredient for Functional Foods Rich in Bioactive Compounds, Nutritional Substances and Antioxidants. Pak J Nutr. 2017;16(9):714-8.

18. Paśko P, Galanty A, Zagrodzki P, Luksirikul P, Barasch D, Nemirovski A, Gorinstein S. Dragon fruits as a reservoir of natural polyphenolics with chemopreventive properties. Molecules. 2021;26(8):2158.

19. Nishikito DF, Borges ACA, Laurindo LF, Otoboni AMMB, Direito R, Goulart RA, et al. Anti-Inflammatory, Antioxidant, and Other Health Effects of Dragon Fruit and Potential Delivery Systems for Its Bioactive Compounds. Pharmaceutics. 2023;15(1):159.

20. Sulistyarini I, Sari DA, Wicaksono TA. Skrining Fitokimia Senyawa Metabolit Sekunder Batang Buah Naga (Hylocereus polyrhizus). Cendekia Eksakta. 2020;5(1).

21. Singh A, Hussain Dar A, Sharma A, Altaf A, Sharma P. Unfolding the potential of dragon fruit (Hylocereus spp.) for value addition : A review. 2023;4(2):1-19.

22. BPOM RI. Guidelines for the Technology of Formulation of ExtractBased Preparations Volume 2. Food and Drug Administration of the Republic of Indonesia. Jakarta. 2019.

23. Ladan Z, Amupitan JO, Oyewale OA, Ayo RG, Temple E, Ladan EO. Phytochemical screening of the leaf extracts of Hyptis spicigera plant. Afr J Pure Appl Chem. 2014;8(5):83-8.

24. Achyadi NS. Effect of extracting agent on the characteristics of functional compound extract from red dragon fruit peel (Hylocereus polyrhizus). Pasundan Food Technol J. 2020;6(1):23-30.

25. Alasa AN, Anam S, Jamaluddin J. Analyze Total Level of Secondary Metabolites from Ethanol Extracts of "Tamoenju" Leaves (Hibiscus Surattensis L.). Kovalen. 2017;3(3):258-68.

26. Kaur-Atwal G, Reynolds JC, Mussell C, Champarnaud E, Knapman TW, Ashcroft AE, et al. Determination of testosterone and epitestosterone glucuronides in urine by ultra performance liquid chromatography-ion mobility-mass spectrometry. Analyst. 2011;136(19):3911-6.

27. Sharma P, Bhardwaj P, Arif T, Khan I, Singh R. Pharmacology, Phytochemistry and Safety of Aphrodisiac Medicinal Plants: A Review. J Pharmacol Toxicol Stud. 2014;2(3):1-18.

28. Khotimah K. Skrining Fitokimia dan Identifikasi Metabolit Sekunder Senyawa Karpain Pada Ekstrak Metanol Daun Carica pubescens Lenne dan K. Koch Dengan LC/MS. Uin Maulana Malik Ibrohim Malang, januari. 2016;1-69.

29. Sulistyarini II, Sari DA, Rahardian MRR. Anti-Bacterial Activity Test Of Ethanol Extract, N-Hexane Fraction, Ethyl Acetate Fraction And Water Fraction From Dragon Fruit Stem (Hylocereus Polyrhizus) Against Methicillin-Resistant Staphylococcus Aureus (Mrsa). Jurnal Ilmu Kesehatan. 2021;9(2):162-71.

30. Hanifa F. Uji Aktivitas Antioksidan Gel Ekstrak Batang Buah Naga Merah (Hylocereus polyrhizus) dengan Metode DPPH. 2018.

31. Luu TTH, Le TL, Huynh N, Quintela-Alonso P. Dragon fruit: A review of health benefits and nutrients and its sustainable development under climate changes in Vietnam. Czech J Food Sci. 2021;39(2):71- 94.

32. Noor MI, Yufita E, Fisika J, Matematika F. Identifikasi kandungan ekstrak kulit buah naga merah menggunakan Fourier Transform Infrared (FTIR) dan fitokimia. Journal of Aceh Physics Society (JAcPS), 2016;5(1):14-6.

33. La EOJ, Sawiji RT, Yuliawati AN. Skrining Fitokimia Dan Analisis Kromatografi Lapis Tipis Ekstrak Etanol Kulit Buah Naga Merah (Hylocereus polyrhizus). Indonesian J Pharm Nat Prod. 2020;3(1):45- 58.

34. Sarasmita MA, Laksmiani NPL. Uji Sitotoksisitas Ekstrak Etanol Limbah Kulit Buah Naga Merah (Hylocereus Polyrhizus) pada Sel Kanker Payudara secara In Vitro dan In Silico. Jurnal Farmasi Udayana. 2015;4(2):643-9.

35. Laurencia E, Tjandra O. Identifikasi Senyawa Kimia Ekstrak Metanol Buah Naga Merah (hylocereus polyrhiz) dengan Kromatografi Gas. Tarumanagara Med J. 2018;1(1):67-73.

36. Fitriyani F, Zahra LA, Istifadah I. Anthocyanin Activity of Red Dragon Fruit (Hylocereus polyrhizus) Peel as Immunostimulan in the Covid-19 Pandemic Era. J Kesehatan Metro Sai Wawai. 2022;15(1):61-9.

37. Shinde SM, Smita SA, dan SRB. Dragon Fruit as a Nutraceuticals. World J Pharm Pharma Sci. 2018;7(4):958-72.

38. Manihuruk FM, Suryati T, Arief II. Effectiveness of the red dragon fruit (Hylocereus polyrhizus) peel extract as the colorant, antioxidant, and antimicrobial on beef sausage. Media Peternakan. 2017;40(1):47-54.