

Research Article

Research Review on Secondary Metabolite Compounds of *Mangifera Casturi* Bark and Their Functions

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ABSTRACT

Mangifera casturi is one of 31 species of mangoes found in Kalimantan, Indonesia. In 2000, species were collected in the island of Borneo (Sarawak and Sabah). The 'Casturi' originated in a rural area around Banjarmasin in southern Borneo, called Kalimantan or Kasturi. *Mangifera casturi* is a specific plant with superior characteristic. This species can reach a height of 15 m and tolerate extreme weather conditions. *Mangifera casturi* contains bioactive compounds such as alkaloid, flavonoid, tannin, terpenoid and phenolic groups proven can be applied as antioxydant, anti-inflammation, antibacterial, antifungal, antidiabetic, antileukemic and immunostimulatory. *Mangifera casturi* is potential as a traditional treatment.

Keywords: *Mangifera casturi*, borneo, Compounds, Treatment

INTRODUCTION

Diversity of plants can be found in Indonesia. Some of them only found in certain region of Indonesia. *Mangifera casturi* is one of 31 species of mangoes found in borneo, Indonesia. The species were collected in 2000 on the island of Borneo (Sarawak and Sabah). The 'Casturi' may have originated in a very small area around Banjarmasin in southern Borneo. The species was endemic to the region. The tree is about 10–30 m tall. It is due to the study that the 'Casturi' mango tree can reach a height of 15 m (measured from ground level to the top of the tree) and a trunk diameter 40–115 cm measured at 50 cm above ground level. Bark is grayish white to light brown; sometimes there are small cracks or fissures with 1 cm of dead bark. The crown diameter is approximately 12.0 m and the crown shape is semi-circular. The 'Casturi' mango tree growth habit is spreading with dense foliage.^{1,2}

Mangifera casturi is a specific plant with superior characteristic. This species can tolerate extreme weather conditions. Based on the study, they optimumly grow at temperature as low as 29^oF for 5 hours or more with only minimal damage.

They grow with good vigor and have no enviromental limitations.³

Other characteristics of *Mangifera casturi* are dark-brown stems with roughly surface and sticky, green leaves, lancet-shapes, fruit skin has a purplish brown colour, flesh of fruit has a bright yellow till orange colour, distinctive smell, slightly sour sweet taste, and contains lots of fiber. This endemic plant also contains bioactive compound used as medicine. *Mangifera casturi* bark known contains alkaloids, flavonoids, terpenoids, phenols, and saponins. It has been proven by chemical identification test and analysis of thin layer chromatography (TLC) in some studies.⁴

One of the study revealed that either the roots and bark of binjai and kasturi contain common chemical compounds, saponin and tannin. Saponin is a chemical compound having active property for diabetic therapy. This property comes as a result of its ability to inhibit the absorptions of glucose which eventually prevent to increase glucose level in blood. Additionally, it can also reduce the rate of glucose in blood. This condition known well as wound healing process.⁵

Another study, thin layer chromatography (TLC) analysis demonstrates that methanolic extract of *Mangifera casturi* fruit known contains terpenoid and phenolic compounds which apply as antioxidant agents. They play crucial role in inflammatory related diseases. It indicates that *Mangifera casturi* can be applied as anti-inflammation agent. This extract significantly inhibiting the migration of leukocytes induced by thioglycollate.⁶ As we known that an increase of leukocytes level is a marker of infection.^{7,8,9,10} (5,6,22,aku)

Mangifera casturi fruit known can inhibit the growth of *Streptococcus mutans* that causes dental caries. Dental caries is the main problem^{11,12(7,14)} often found in the oral cavity, where in Indonesia alone dental caries have a prevalence of 90.05%. Based on the study, the methanol extract of Kasturi mango fruit contains alkaloids, flavonoids, phenolics, terpenoids, and saponins that has antibacterial activity.¹³⁽¹⁾ These

bioactive compounds can against the growth of *Streptococcus mutans*. The other study revealed that saponin fractions from bark of *Mangifera casturi* can inhibit *Escherichia coli* and *Staphylococcus aureus* activities that cause pneumonia, mastitis and urinary tract infections.^{14,15,16}

Mangifera casturi leaves also known applied as immunostimulatory agent. Leaf extract casturi (*Mangifera casturi*) proven to increase the activity and capacity of macrophage phagocytosis. *Mangifera casturi* stem has been proven as antifungal agent. Extract methanol bark of casturi contains phenolic groups, terpenoids and saponins that are antifungal. Another part, the fruit of *Mangifera casturi* is known to have anticancer activity from bioactive compound, triterpenoid, named Lupeol. This compound can be applied as anti-inflammatory agent as well.^{17,18,19}

SOME RESEARCH OF KASTURI

Below are some researches about the treatment of *Mangifera casturi* and its compounds.

No	Title of research	Method of Research	Conclusion / Resarch Result
1	The study potency of binjai (<i>Mangifera caesia</i>) and casturi (<i>Mangifera casturi</i>) as antidiabetic by phytochemistry fitokimia.	Phytochemistry screening	Casturi contains saponin that can reduce the rate of glucose in blood. ⁵
2	Anti-inflammatory activity of methanolic extract kasturi in thioglycollate - induced leukocyte migration on mice	Thin Layer Chromatography (TLC) analysis and counting leukocytes. Anti-inflammatory effect was tested by Leukocyte migration method.	Methanolic extract of <i>Mangifera casturi</i> fruit contains terpenoid and phenolic compounds that have inflammatory activity that is lower than the positive control. ⁶
3	Antibacterial activity and mechanism of action of methanol extract from casturi mango fruit on caries-causing bacterium <i>Streptococcus mutans</i>	Antibacterial activity was tested by agar diffusion method and GCMS analysis	The methanol extract of Casturi mango fruit has an inhibitory activity against the growth of <i>Streptococcus mutans</i> . ¹⁴
4	Antibacterial activity saponin fractions from stem bark of <i>Mangifera casturi</i> .	Thin Layer Chromatography analysis and diffusion method	Stem bark of <i>Mangifera casturi</i> can inhibit the growth of <i>E.coli</i> and <i>S.aureus</i> . ¹⁵
5	The comparison of antibactery activity between casturi's bark extract and ampicillin in <i>Staphylococcus aureus</i> in vitro.	Bacterial test with diffusion method	The results showed that there were significant differences between the treatment casturi's bark compared to ampicillin. ¹⁶
6	Immunostimulatory effect of leaf extract casturi (<i>Mangifera castur</i>) in mice	Observation from activity and phagocytic capacity macrophages in mice	Casturi leaves (<i>Mangifera casturi</i>) can be applied as immunostimulatory. ¹⁷

7	Semi-polar fraction from casturi leaves	Phytochemical test	The fraction showed the existence of flavonoids, tannins and triterpenoids ²⁰
8	Antioxydant activity assay of extracts and active fractions of casturi fruit (<i>Mangifera casturi</i> Kosterm)	1,1-diphenyl-2-picrylhydrazyl (DPPH) method	Methanolic extracts of <i>Mangifera casturi</i> had antioxydant activity ²¹
9	Fractionation of Methanol extract from <i>Mangifera casturi</i> leaves with n-butanol solvent	Gradient fractionation method using n-hexane	The fractionation showed the present of flavonoids ²²
10	Determining flavonoid total content and anti-oxidant activity from ethanol extract of <i>Mangifera casturi</i> leaves with DPPH method.	1,1-diphenyl-2-picrylhydrazyl (DPPH) method	Ethanol extract of <i>Mangifera casturi</i> leaves has high anti-oxidant activity ²³
11	Identification of alkaloids from methanol extract <i>Mangifera indica</i> L. bark	Thin Layer Chromatography (TLC) analysis	The existence of alkaloids in methanol extract casturi's bark. ²⁴
12	Determining total phenolic and flavonoid of ethanol extract from casturi (<i>Mangifera casturi</i>) leaves, cortex, and peel	Thin Layer Chromatography (TLC) analysis	The highest content of phenolics and flavonoids present in the leaves while the total phenolic content was lowest for the cortex and total flavonoid content was lowest for the peel. ²⁵
13	Fractionation of Methanol extract from <i>Mangifera casturi</i> leaves	Gradient fractionation method using n-hexane	The fractionation showed the existence of flavonoids. ³⁸
14	The comparison of antifungal activity between methanol extract of the bark casturi with ketoconazole 2% against <i>Candida albicans</i> in vitro	Bacterial test with diffusion method	There is a significant difference between the treatment with ketoconazole 2%. ¹⁸
15	Chemical structure optimization of lupeol as er- α and HER2 inhibitor.	Hartree-Fock method	These results predict that lupeol has great potential as anticancer that can be developed as a HER2 inhibitor. ¹⁹
16	The potentiation of <i>Mangifera casturi</i> bark extract on interleukin1 β and bone morphogenic protein-2 expressions during bone remodeling after tooth extraction	Immunohistochemistry method	<i>Mangifera casturi</i> 's bark extract was able to suppress the IL-1 β expression and increase the BMP-2 expression during bone remodeling after tooth extraction. ²⁶
17	Flavonoid level analysis of binjai leaf extract in Ethanol, methanol, and n-hexane solvents (Research report)	UV-Vis spectrophotometer analysis	There were differences of total flavonoid in binjai leaf extract using ethanol and methanol solvent ²⁷
18	Flavonoid level test on ethanol extract of binjai leaf	UV-Vis spectrophotometer analysis	The optimal solvent concentration to dissolve flavonoid in Binjai leaf is 95% of ethanol solvent. ²⁹
19	Isolation an antioxydant compound from the bark of Binjai	Gradient fractionation method using n-hexane	The antioxydant activity of the isolated compounds smaller than vitamin C. ³⁰
20	The effect of ethyl acetate fraction of casturi fruit (<i>Mangifera casturi</i> kosterm.) on macroscopic and microscopic heart male rats	Observing the number of mouse deaths, macroscopic picture and microscopic picture of cardiac organ	Fraction of ethyl acetate of M. casturi did not give the significant effect of inflammation in mouse heart organ. ^{31,32}
21	Isolation and identification of active compound of ethylacetate fraction of Casturi (<i>Mangifera casturi</i> konsterm. fruit from south	Spectroscopic analyses of UV-Vis, FT-IR, HNMR, CNMR, DEPT and LCMS	The identification found a polyphenol compound, namely (methyl gallate). ³³

	kalimantan Indonesia		
22	Antioxydant and antileukemic activity of chemical components from bark of <i>Mangifera casturi</i>	Spectroscopic analysis and ultra-performance liquid chromatography - mass spectrometry	The isolated compound, gallic acid, showed potent antioxidative and antileukemic activity. ³⁴
23	Antioxydant activity of bioactive compound produced by endophytic fungi isolated from endemic plant of South Kalimantan <i>Mangifera casturi</i> Kosterm.	DPPH radical scavenging method, TLC-bioautography assay and GC-MS analysis	The potential of endophytic fungi as a source of antioxydants and can be an alternative to the antioxydants produced by plants to support <i>M. casturi</i> conservation. ³⁵
24	Identification antibacterial activity casturi bark (<i>Mangifera costuri</i> Kosterm.) extract to <i>Estherichia coli</i> In Vitro	Disk diffusion method	The casturi bark extract significantly influenced to the growth of <i>E.coli</i> . ⁴¹
25	Total flavonoid and antioxydant activity of some selected medicinal plants in South Kalimantan of Indonesian	Spectrophotometer analysis	Kasturi has the greatest total flavonoid content among others ⁴⁵

The comparison of the anti-inflammatory activity from *Mangifera casturi* and other extracts.

No.	Title of research	Method of Research	Conclusion / Resarch Result
1	Anti-inflammatory activity of methanolic extract casturi in thioglycollate - induced leukocyte migration on mice	Leukocyte migration method.	The anti-inflammatory activity of methanolic extract is lower than the positive control (indomethacin).
2	Anti-inflammatory effect of <i>Morninga oleifera</i> lam extract in rats	leukocyte migration method	The anti-inflammatory activity of methanolic extract is lower than the positive control (indomethacin and hydrocortisone)
3	Anti-inflammatory activity of methanolic extract of <i>Bambusa vulgaris</i> leaves	The cotton pellet granuloma method	The anti-inflammatory activity of methanolic extract is greater than the positive control (indomethacin)

Some researches about gel preparations *Mangifera casturi* and other extracts.

No.	Title of research	Method of Research	Conclusion / Research Result
1	Optimization of gel fraction etil asetat fruit kasturi (<i>Mangifera casturi</i> kosterm.) with combination of bases CMC-Na and carbopol using lattice design method	Lattice design method	The optimum effect of the extract can be reached in concentration of 4 % CMC-Na and 1% carbopol. ⁴⁹
2	The comparison of stability and activity from gel <i>Aloe vera L.</i> on bases CMC-Na and carbopol	Animal design method	The optimum effect of the stability and activity extract can be reached in bases 5% CMC-Na
3	The influence CMC-Na base to the physical quality of gel <i>Aloe vera L.</i>	Gel physical test	The optimum of the gel extract can be reached in bases 5% CMC-Na

DISCUSSION

Mangifera casturi is one of extinct fruit, in situ and wildly,^{37,39} but has been proven as a treatment due to the presence of bioactive compounds.⁴⁰ Based on the table above, *Mangifera casturi* contains alkaloid, flavonoid, tannin, terpenoid and phenolic compounds that can be applied as antioxydant, anti-inflammation, antibacterial agent, antifungal, antidiabetic, antileukimic and immunostimulatory.^{4,42}

Antioxydant is a substance required to neutralize the free radicals,^{43,44} and prevent the resultant damages to normal cell, protein and fat. Antioxydant comes from alkaloid, flavonoid, terpenoid and phenolic compounds that found in fruit, leaf, cortex and peel of *Mangifera casturi*. The highest content of phenolics and flavonoids present in the leaves while the total phenolic content was the lowest for cortex and total flavonoid content was the lowest for the peel. Antioxydant also relate to anti-inflammation. Antioxydant plays crucial role in inflammatory related diseases. The anti-inflammatory effect of *Mangifera casturi*. extract have been proven in research. We understand that the methanolic extract of *Mangifera casturi* has anti-inflammatory activity compared to the positive control (indomethacin).^{6,21,24,30}

Antibacterial agent known as a substance that inhibit the growth of some bacteria, such as the Gram-positive bacterium *Staphylococcus aureus* and the Gram-negative bacterium *Escherichia coli*. *Mangifera casturi* can be applied as antibacterial agent because the existence saponin and flavonoid. The total flavonoid in *Mangifera casturi* is greatest among plants in South Borneo. This compound is well extracted with ethanolic solvent. Flavonoid in *Mangifera casturi* fruit known can inhibit *Streptococcus mutans* which interfere the membrane integrity of the *Streptococcus mutans* bacteria. Saponin in *Mangifera casturi* bark also known inhibit the growth of *Estherechia coli* and *Staphylococcus aureus*.^{14,15,16,36}

Antifungal activity in *Mangifera casturi* come from phenolic groups, terpenoids and saponins. They extracted from *Mangifera casturi* bark. The others, root and bark, also contain of saponin which are antidiabetic agent. It can reduce the level of blood glucose.^{5,18}

Antileukimic or anticancer activity is known come from fruit *Mangifera casturi* consist of triterpenoid, named Lupeol. Anticancer activity is predicted to be associated with antiproliferation and induced apoptotic effects of cancer cells. Lupeol is also potentially used as an anti-inflammation.¹⁹

Furthermore, immunostimulatory activity is known come from *Mangifera casturi* barks and leaves.⁴⁶ *Mangifera casturi*'s bark extract was able to suppress the IL-1 β expression and increase the BMP-2 that play crucial roles in in stimulating immune system. *Mangifera casturi* leaves extract can increase the activity and capacity of macrophage phagocytosis.^{26,28,47}

Mangifera casturi is also applied to gel preparation. Based on some researches, the optimum effect of the extract can be reached on 4 % CMC-Na and 1% carbopol.^{48,49}

CONCLUSION

Mangifera casturi is endemic plant in South borneo, proven as a medicine due to the presence of bioactive compounds such as alkaloid, flavonoid, tannin, terpenoid and phenolic groups.

Mangifera casturi has been proven as antioxydant, anti-inflammation, antibacterial, antifungal, antidiabetic, antileukimic and immunostimulatory.

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REFERENCES

1. Silva TA, Gubbuk H, Urbina C. Physico-chemical Evaluation of Casturi Mango. Proceeding of the Florida State Horticultural Society. 2013;126:17-20.
2. Campbell R. Kasturi (*Mangifera casturi*) as a Graft Interstock for Wild Mangos. Proceeding of the Florida State Horticultural Society. 2007;120:15-16.
3. Campbell R. The Potential of New *Mangifera* Species in Florida. Proceeding of the Florida State Horticultural Society. 2007;120:11-12.
4. Sutomo, Agustina N, Arnida, Fadilaturahmah. Study Pharmacognostic and Non-Specific Parameter Test of Stem Bark Methanol Extract Casturi. Pharmascience Journal. 2017;1(4): 94-101.
5. Mustikasari K, Ariyani D. The Study Potency of Binjai (*Mangifera caesia*) and Casturi (*Mangifera casturi*) as Antidiabetic by Phytochemistry Fitokimia. Science and applied chemistry. 2008;2(2): 64-73.
6. Fakhruddin N, Putri PS, Sutomo, Wahyuono S. Antiinflammatory Activity of Methanolic Extract of *Mangifera Casturi* in Thioglycollate-Induced Leukocyte Migration on Mice. Traditional Medical Journal. 2013;18(3): 151-156.
7. Huldani, Pattelongi I, Massi MN, Idris I, Bukhari A, Widodo ADW, Achmad H. Research Reviews on Effect of Exercise on DAMP's, HMGB1, Proinflammatory Cytokines and

- Leukocytes. Systematic Reviews in Pharmacy. 2020; 11(4), 306-312. doi:10.31838/srp.2020.4.44
8. Huldani, Achmad H, Arsyad A, Putra AP, Sukmana BI, Adiputro DL, Kasab J. Differences in VO₂ Max Based on Age, Gender, Hemoglobin Levels, and Leukocyte Counts in Hajj Prospective Pilgrims in Hulu Sungai Tengah Regency, South Kalimantan. Systematic Reviews in Pharmacy. 2020; 11 (4), 09-14. doi:10.31838/srp.2020.4.03
 9. Huldani, Pattelongi I, Massi MN, Idris I, Bukhari A, Widodo ADW, Uinarni H, Carmelita AB, Trisia A, Gunma S, Prayudhistya BKA, Achmad H. Cortisol, IL-6, TNF Alfa, Leukocytes and DAMP on Exercise. Systematic Reviews in Pharmacy. 2020; 11(6), 474-485. doi:10.31838/srp.2020.6.74
 10. Huldani, Sukmana BI, Rahmiati, Pujiningtyas A & Savitri E, Fauziah, Nihayah U. Cellular Immunity of River Water Consumers and Bandarmasih Municipal Waterworks Consumers. Indian Journal of Public Health Research & Development. 2019; 10(7): 823
 11. Sukmana BI, Huldani, Achmad A, Hidayah N, Putra AP, Ramadhany S, Gadisha SB. A Review of Breastfeeding in Infants: Relation to the Occurrence of Early Childhood Caries (ECC). Systematic Reviews in Pharmacy. 2020; 11(5): 116-122. doi:10.31838/srp.2020.5.19
 12. Achmad H, Ramadany S, Fajriani, Sukmana BI, Hanan N, Hartami E, Huldani, Mutmainnah N, Ramadhany YF, Pagala MI. A Review of Stunting Growth in Children: Relationship to the Incidence of Dental Caries and its Handling in Children. Systematic Reviews in Pharmacy. 2020; 11 (6), 230-235. doi:10.31838/srp.2020.6.36
 13. Achmad H, Huldani, Ramadhany YF. Antimicrobial Activity and Sulfated Polysaccharides Antibiofilms in Marine Algae Against Dental Plaque Bacteria: A Literature Review. Systematic Reviews in Pharmacy. 2020;11(6): 459-465. doi:10.31838/srp.2020.6.72
 14. Suhendar U, Fathurrahman M, Sogandi. Antibacterial Activity and Mechanism of Action of Methanol Extract from Casturi Mango Fruit (*Mangifera casturi*) on Caries-Causing Bacterium *Streptococcus mutans*. Journal of Scientific and Applied Chemistry. 2019;22(6): 235-241.
 15. Rosyidah K, Nurmuhammad SA, Komari N, Astuti MD. Antibacterial Activity Saponin Fractions from Stem Bark of *Mangifera casturi*. ALCHEMY. 2010;2(1): 53-103.
 16. Akbar MRV, Budiarti LY, Edyson. The Comparison of Antibacterial Activity between Casturi's Bark Extract and Ampicillin in *aureus* In Vitro. Medical Periodicals Journal. 2016;1(12): 1-9.
 17. Rahim MA, Suartha IN, Sudimartini LM. Immunostimulatory Effect of Leaf Extract Casturi (*Mangifera casturi*) in Mice. Indonesia Medicus Veterinus. 2017;6(1): 10-19.
 18. Siddiq, MA, Yulia L, Edyson. The Comparison of Antifungal Activity between Methanol Extract of The Bark Casturi with Ketoconazole 2% Against *Candida Albicans* In Vitro. Medical Periodicals Journal. 2016;2(12): 271-278.
 19. Pratama MRZ, Sutomo S. Chemical Structure Optimization of Lupeol as ER-A And HER2 Inhibitor. Asian Journal of Pharmaceutical and Clinical Research. 2018;6(11): 298-303.
 20. Tamaya V, Retnowati R, Suratmo. Semi-Polar Fraction from Casturi Leaves. Chemistry Student Journal. 2015;9(1): 778-784.
 21. Sutomo, Wahyuono S, Setyowati EP, Rianto S, Yuswanto A. Antioxydant Activity Assay of Extracts and Active Fractions of Casturi Fruit (*Mangifera casturi* Kosterm). using 1,1-diphenyl-2-picrylhydrazyl (DPPH) method Journal of Natural Product. 2014;7: 124-130.
 22. Firdausi I, Retnowati R, Sutrisno. Fractionation of Methanol Extract from *Mangifera casturi* Leaves with N-Butanol Solvent). Chemistry Student Journal. 2015;1(1): 785-790.
 23. Bakti AA, Triyasmono L, Rizki MI. Determining Flavonoid Total Content And Anti-Oxidant Activity From Ethanol Extract Of *Mangifera casturi* Leaves with DPPH method). Pharmascience Journal. 2017;1(4): 102-108.
 24. Aksara R, Weny JA, Alio L. Identification of Alkaloids from Methanol Extract *Mangifera indica* L. Bark. Entropy Journal. 2013;1(3): 514-519.
 25. Marlioni L, Naimah A, Roni A. Determining Total Phenolic and Flavonoid of Ethanol Extract from Casturi (*Mangifera casturi*) Leaves, Cortex, and Peel. Proceedings of the 50th Indonesia plant seminar. 2016. p. 275-281.
 26. Sukmana BI, Budhy TI, Ardani IW. The Potentiation of *Mangifera casturi* Bark Extract on Interleukin-1 β and Bone Morphogenic Protein-2 Expressions during Bone Remodeling after Tooth Extraction. Dental Journal. 2017;50(1): 36-42.
 27. Adham D, Taufiqurrahman I, Helmi ZN. Flavonoid Level Analysis of Binjai Leaf Extract in Ethanol, Methanol, and N-Hexane Solvents (Research Report). Dentist Journal. 2019;1(4): 46-49.
 28. Chabib L, Muhtadi WK, Rizki MI, Suhendri MR, Hidayat A. Potential Medicinal Plants for Improve The Immune System from Borneo Island and The Prospect to Be Developed as Nanomedicine. MATEC Web Conferences. 2017;154:1-6.
 29. Ansari AA, Taufiqurrahman I, Dewi N. Flavonoid Level Test on Ethanol Extract of

- Binjai Leaf (Research Report). Dentino. 2019;1(4): 50-54.
30. Rosyidah K, Siska, Astuti MD. Isolation An Antioxydant Compound from The Bark of Binjai. 2011;1(5): 8-14.
31. Sutomo, Meliawati G, Arnida. Pengaruh. The Effect of Ethyl Acetate Fraction of Casturi Fruit (*Mangifera Casturi* Kosterm.) on Macroscopic and Microscopic Heart Male Rats).Ibn Sina's Scientific Journal. 2019;4(2): 370-379.
32. Sutomo, Rafi M, Arnida. The Effect of Ethyl Acetate Fraction of Casturi Fruit (*Mangifera Casturi* Kosterm.) on Acute Toxicity, Macroscopic and Microscopic Liver Male Rats). Pharmascience Journal. 2019;1(6): 106-113.
33. Sutomo, Arnida, Yunus R, Wahyuono, Setywati EP, Riyanto. Isolation and Identification of Active Compound of Ethylacetate Fraction of Casturi (*Mangifera casturi* Konsterm.) Fruit from South Kalimantan Indonesia. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2017;8: 249-254.
34. Pardede A, Koketsu M. Antioxydant and Antileukemic Activity of Chemical Components From Bark of *Mangifera casturi*. Comparative ClinicalPhatology. 2017;26(3): 499-504.
35. Nuraini FR, Setyaningsih R, Susilowati. Antioxydant Activity of Bioactive Compound Produced by Endophytic Fungi Isolated From Endemic Plant of South Borneo *Mangifera Casturi* Kosterm. AIP Conference Proceedings. 2019. p.1-9.
36. Ichsan MC. Casturi Mango Crosstechnique as A Result of Designing Several High Variety. Agritrop Journal. 2010;2:20-26.
37. Fakhrosi I, Hikmat A, Widyatmoko D. Ex situ Conservation of *Mangifera casturi* Kosterm Based on Community: A case study in Indragiri Hilir Regency of Riau Province. Journal Biology Indonesia. 2013;9(1): 141-151.
38. Putri HL, Retnowati R, Suratmo. N-Hexane Fraction from Methanol Extract of *Mangifera casturi* Leaves and Phytochemical Test). Chemistry Student Journal. 2015;1(1): 772-777.
39. Darmawan ARD. Efforts to Improve The Quality of Casturi Mango (*Mangifera Casturi*) with Modification of Cultivation. Chemistry Student Journal. 2015;1(4): 894-899.
40. Sari, SG. Abundance and Dispersion as Convesation Effort and Utilization The Rare and Special Plant in South borneo. Enviro Scientistae. 2014;10:41-48.
41. Santi N, Prahatamaputra A, Ajizah A. Identification Test of Antibacterial Activity Casturi Bark (*Mangifera costuri* Kosterm.) Extract to *Estherichia coli* In Vitro. Bio Vesicle Journal.16(2). 2016. p.36-42.
42. Syah MI, Suwendar, Mulqie L. Antidiabetic Activity Test from Ethanol Extract *Mangifera* Leaves on Male Swiss Webster Mice with Tolerance Oral Glucosa Test. Proceedings of the UNISBA Academic Reserch Program (Health and Pharmacy). 2015. p.297-303.
43. Achmad H, Aflanie I, Putra AP, Noor F, Carmelita AB, Fauziah, Sukmana BI, Huldani. An Overview of the Potential of Sea Cucumbers with Antioxidant and Antiviral Contents as Nutritional Supplements. Systematic Reviews in Pharmacy. 2020; 11(6): 761-770. doi:10.31838/srp.2020.6.112
44. Amiruddin Eso, Herlina Uinarni, Thomas Tommy, Ryanto Karobuana Sitepu, Iwan Kurnia Effendi, Yustinus Charles Ariestiyanto, Hutasoit Charles Martamba, Evi Mustikawati Arifin, Ferra Olivia Mawu, Bayu Indra Sukmana, Huldani (2020) A Reviews on Use of Sea Cucumber as a Treatment for Oral Cancer. Systematic Reviews in Pharmacy, 11 (5), 299-307. doi:10.31838/srp.2020.5.44
45. Suhartono E, Viani E, Ramadhan MA, Syahuri I, Gultom, Rakhman MF, Indawardhana D. Total Flavonoid and Antioxydant Activity of Some Selected Medicinal Plants in South Borneo of Indonesian. ELSEVIER. 2012;4:235-239.
46. Rosyidah K. Isolation and Cytotoxic Test Limonene from Casturi's Bark. Biosciantiae. 2011;2(8): 1-5.
47. Sutomo, Rianto S, Setyowati EP. Isolation and Identification active compound from Casturi (*Mangifera casturi* Kosterm.) against antioxidant and immunodulatory activity. Biology Science Journal. 2013;13(7): 596-604
48. Sutomo, Arnida, Widianti SA, Fadilaturrehmah, Yunus R. Inhibitory Activity of Heme Polymerization from N-Hexane and Ethyl Acetate Fraction of *Mangifera Casturi* Fruit Originated South Kalimantan. National Coference. 2016;1(1): 22-31.
49. Sari DE, Fitriana M. Optimization of Gel Fraction Etil Asetat Fruit Casturi (*Mangifera casturi* Kosterm.) with Combination of Bases CMC-Na and Carbopol Using Lattice Design Method. Current Pharmaceutical Science Journal. 2017;1(1): 19-24.