INSECTICIDAL ACTIVITY OF BRUCEIN-C FROM BUAH MAKASAR (Brucea javanica) AGAINST Helopeltis antonii AND Dacinus piperis

by Subeki, Sri Hidayati, Elna Karmawati , And Chandra Indrawanto

Submission date: 23-Nov-2020 12:02AM (UTC+0700)
Submission ID: 1453941408
File name: 11._Subeki,_insectisidal_activity.pdf (104.97K)
Word count: 3610
Character count: 18901

INSECTICIDAL ACTIVITY OF BRUCEIN-C FROM BUAH MAKASAR (*Brucea javanica*) AGAINST *Helopeltis antonii* AND *Dacinus piperis*

Subeki[1], Sri Hidayati[1], Elna Karmawati[2], and Chandra Indrawanto[2]

[1]Department of Agricultural Product Technology, Faculty of Agriculture, Lampung University, Jl. S. Brojonegoro No. I, Gedong Meneng, Bandar Lampung, 35145

[2]Research and Development Center of Plantation, Departmen of Agriculture, Jl. Tentara Pelajar No. 1, Cimanggu Bogor

e-mail : bekisubeki@yahoo.com

ABSTRACT

Cashew and pepper are kind of important commodity in Indonesia. In recent times, productivity of these plants decreased due to insect pest *Helopeltis antonii* and *Dacinus piperis*. Generally, farmers use synthetic insecticide to control these pests. The use of synthetic insecticide gives risk to human and environmental. Therefore, there is an urgent need to find natural insecticide to control cashew and pepper insect pest. Many researches showed that buah makasar (*Brucea javanica*) contains quassinoid compounds having insecticidal activities against several pests (Subeki *et al*., 2006; Latif *et al*, 2000; Daido *et al*., 1995; and Klocke *et al*., 1985). In this research was carried out extraction and isolation of brucein-C from *B. javanica* and assayed its activity against *H. antonii* and *D. piperis*. Result of this research showed that bruceine-C formulated with liposomes at concentration 200 ppm gave mortality of *H. antonii* and *D. piperis* with value of 98.3% and 91.7%, respectively. Residual contents of bruceine-C in the soil on the fifteenth and thirtieth day after application at concentration 200 ppm decreased to 80 ppm and 0 ppm, respectively. Application of bruceine-C has no lethal effect against non target insects. Hypothetical study on the technoeconomy showed that insecticide with active substance brucein-C have price 40,3% cheaper than synthetic insecticides. This research can be recommended to Indonesian government to produce natural insecticide from the original Indonesian plant buah makasar.

Keywords: *Brucea javanica*, Brucein-C, Buah makasar, *Dacinus piperis*, *Helopeltis antonii*,

INTRODUCTION

In Indonesia the losses caused by insect pests is about 10 to 60 % of the total cashew and pepper production evidencing the relevancy of the damages. One of the main pests associated to cashew and pepper are *Helopeltis antonii* and *Dacinus piperis* due to their high biotic potential and to their broad host range since they can also attack chocolate. Insects of *H. antonii* and *D. pipperis* have

a large destructive potential in cashew and pepper plants because they are able to damage the young leaf, flower, and fruit within a week. The pest feeds outside cashew and pepper and as a result the fruit become black spot.

Cashew and pepper pest control has been realized in large scale by chemical products. Current researches and the increasing knowledge about the harm derived from the indiscriminate use of these products as environmental and human contamination, existence of residues in foods and the consumer concern with food quality have encouraged studies related to novel tactics of pest control like the use of natural insecticides. These natural insecticides, present several advantages in relation to synthetic compounds as their rapid biodegradation reducing the risks of environment and food contamination besides the easy way of obtaining and preparation (Vendramim and Castiglioni, 2000).

Several plants may have insecticidal activities against insects and among them, *Brucea javanica*) is a medicinal plant widely distributed in Indonesia. *B. javanica* locally known as buah makasar is used in the folk medicine to treat malaria, dysentery, and cancer. Several quassinoids with a broad range of bioactivity as antitumor, antiamoebic, and antimalarial, have been isolated previously from this plant (Lee, *et al*., 1979; Anderson, *et al*., 1991; Yang, *et al,* 1996; Wright, *et al.,* 1988; O'Neill, *et al*., 1987). These quassinoids also showed insecticidal activity against *Plutella xylostella, Tetranychus urticae, Myzus persicae, Meloidogyne incognita, Heliothis virescens,* and *Spodoptera frugiperda* (Okano *et al*., 1994; Latif *et al*, 2000; Daido *et al*., 1993, 1995; Park *et al*., 1987; Klocke *et al*., 1985). In spite of the many phytochemical and pharmacologic investigations, there are no reports on the insecticidal activity of this plant against *H. antonii* and *D. pipperis*. We therefore investigated insecticidal compounds of this plant and herein present data on brucein-C that possess insecticidal activity.

MATERIALS AND METHODS

General

Melting points were measured on a Yazawa micro melting point apparatus. IR spectra were recorded on a Perkin-Elmer 2000 Series FT-IR spectrometer. FAB-MS and HR-FAB-MS were obtained on a Jeol JMS-AX500 mass spectrometer. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker AM-500 FT-NMR (500 MHz) and a Jeol JNM-EX 270 FT-NMR (270 MHz) spectrometer, respectively. Optical rotations were determined on a JASCO DIP-370 digital polarimeter. Column chromatography was performed on silica gel 60 (Spherical, 70-140 mesh ASTM, Kanto Chemical).

Silica gel 60 F_{254} pre-coated plates (Merck) were used for analytical TLC and pTLC.

Plant Material

Plant material was purchased from Bandar Jaya traditional market, Central Lampung, in February 2009. The material was identified by Herbalist Aris Winarso at the Herbal Medicine Research and Education Centre "Karya Tama", Lampung, Indonesia. Voucher specimen is deposited at the Laboratory of Bioactive Compound, Department of Agricultural Product Technology, Lampung University.

Extraction and Isolation

Air dried fruits of *B. javanica* (47 kg) were soaked in EtOH 70% for two weeks. The filtrate was filtered and concentrated to give 1 L. The concentrate was extracted with ethyl acetate to give ethyl acetate and aqueous fractions. The active fraction of ethyl acetate was evaporated to give residue and chromatographed on a silica gel column, eluted with $CHCl_3$ (3 L), MeOH/$CHCl_3$ (3:97, 3 L), MeOH/$CHCl_3$ (1:4, 3 L), and MeOH (3 L), successively. The active fraction of MeOH/$CHCl_3$ (1:4) was evaporated and subjected to column chromatography on silica gel, eluted with Hexane/EtOAc (3:7) to give six fractions. The sixth fraction was recrystallized from hexane to give brucein-C. Extraction and isolation of brucein-C was shown at Figure 1.

Preparation of Liposomes

Liposomes were prepared according to method of Chono (2006). Briefly phosphatidylcholine, cholesterol, and diacetylphosphate in a lipid molar ratio of 7:2:1 were dissolved along with [3H] cholesterylhexadecylether as a noexchangeable lipid phase maker in chloroform:methanol (9:1), followed by evaporation to obtain thin lipid film. The lipid film was completely hydrated by phosphate buffer saline (PBS, pH 7.4) to obtain liposomes. Liposomes were then extruded through polycarbonate filter with pore size of 200 nm.

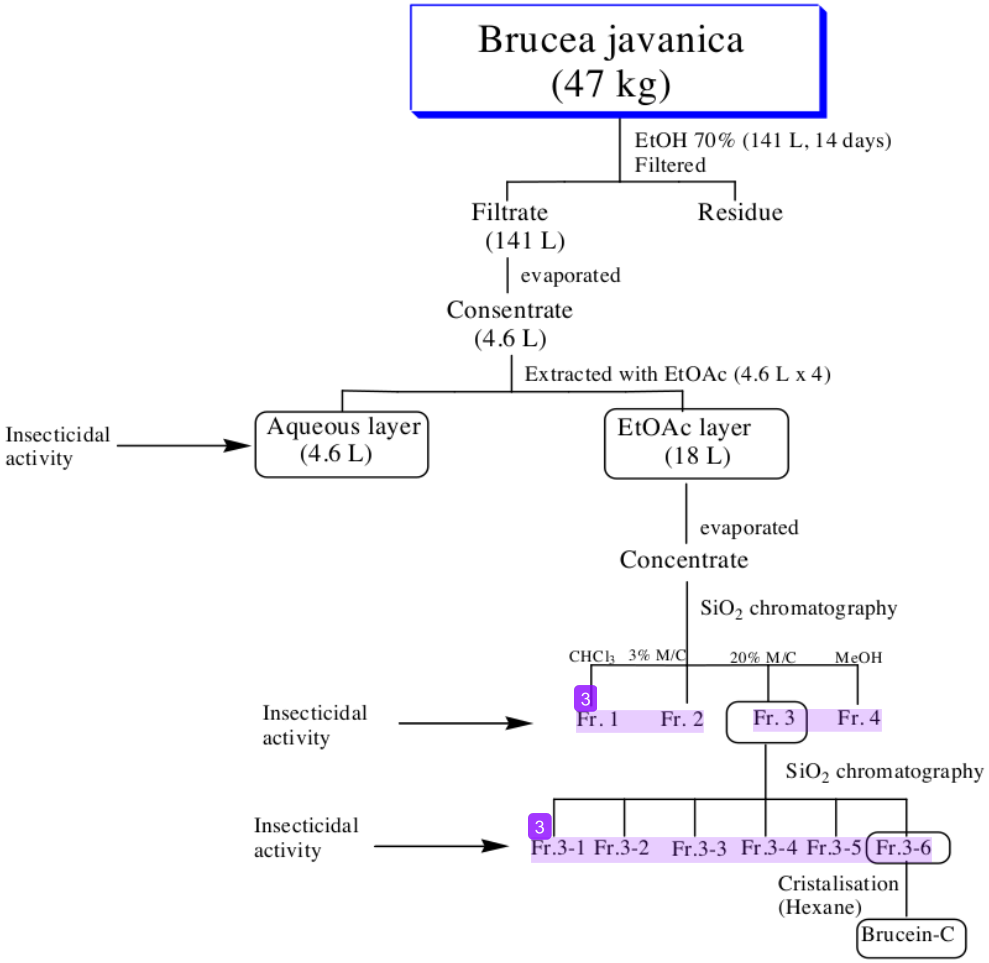

Figure 1. Extraction and isolation of brucein-C from *Brucea javanica*

Insecticidal activity

Insects of *H. antonii* and *D. pipperis* were obtained from field of cashew and pepper plantation. Each kind of insect was put on the cashew and pepper plants covered by net. Each plant contained 50 insects of *H. antonii* or *D. pippperis*. Adaptation of insects in the net were done for one day. Formulation of brucein-C was dissolved in water at concentration of 0, 100, 200, 300, 400, and 500 ppm and sprayed into net containg *H. antonii* and *D. pippperis*. Mortality of insect was evaluated each three hours for three days. Three replications were used per treatment.

Residue of Brucein-C

The experiments were done in the green house. Soil 1 kg were put in polybag and then sprayed with brucein-C at concentration 200 ppm. Content of brucein-C in the soil was evaluated at 0, 15, 30, 45, and 60 after application using HPLC (*High Performance Liquid Chromatography*). Three replications were used per treatment.

RESULTS AND DISCUSSION

Structure Elucidation

Brucein C was isolated from *B. javanica* fruits as a colorless amorphous solid, m.p. 255-256 ^{o}C, and $[\alpha]^{20}_{D}$ -53.0^{o} (*c* 0.8, pyridine). The IR spectrum displayed characteristic absorptions for hydroxyl (3425 cm^{-1}), α-lactone and ester (1740 cm^{-1}), and α,β-unsaturated carbonyl (1688 and 1644 cm^{-1}) groups. FAB-MS: *m/z* 563 $[M-H]^{+}$; HR-EI-MS *m/z* 563.2143 $[M-H]^{+}$ (calcd. for $C_{28}H_{35}O_{12}$, 563.2129). Data of ^{1}H-NMR and ^{13}C-NMR were shown at Table 1.

Table 1. ^{13}C and ^{1}H-NMR of brucein-C from *Brucea javanica*

Position	δC*	δH*
1	50.2	2.85 (d, 16.0)
2	194.5	
3	145.8	
4	130.5	
5	43.2	2.98 (br, d, 13)
6	30.1	2.31 (ddd, 43.8, 3.0, 3.0)
		1.89 (ddd, 14.8, 14.8, 3.0)
7	84.8	4.92 (br, s)
8	46.6	
9	42.2	2.28 (br, s)
10	42.2	
11	72.9	4.17 (d, 4.7)
12	76.5	4.19 (br, s)
13	82.9	
14	50.5	3.79 (br, s)
15	68.5	6.53 (br, s)
16	167.2	
18	13.4	1.84 (d, 1.8)

19	15.6	1.36 (s)
20	74.5	4.70 (d, 7.4)
		3.71 (d, 7.4)
21	172.1	
OMe	53.2	3.73 (s)
1'	168.5	
2'	113.1	6.07 (s)
3'	169.9	
4'	73.6	
5'	28.5	1.34 (s)
6'	28.5	1.32 (s)
7'	15.7	2.16 (d, 1.3)

*) Chemical shifts d (ppm) and coupling constants *J* in Hz in parentheses (500 MHz, CD_3OD).

Analysis ^{1}H-NMR showed spectrum resonance three metyl tertier (□1.34, 1.32, and 1.36), two olefinic metyl (□ 2.16 and 1.84), and a olefinic proton (□6.07). Analysis ^{13}C-NMR showed spectrum resonance at C-3 (δ 145.8), C-11 (δ 72.9), and C-12 (δ 76.5) indicated hidroxy corelated to carbon. Analysis ^{13}C NMR (□168.5, 113.1, 169.9, 73.6, 28.5, 28.5, and 15.7), COSY, and HMBC showed 4-hydroxy-3,4-dimethyl-2-pentenoyloxy corelated to C-15. Chemical structure and correlation of HMBC and ^{1}H-^{1}H COSY were shown at figure 2 and 3.

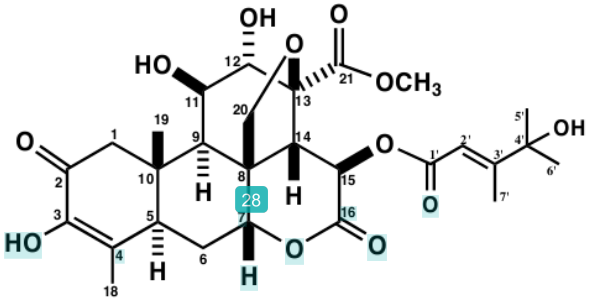

Figure 2. Chemical structure of brucein-C from *Brucea javanica*

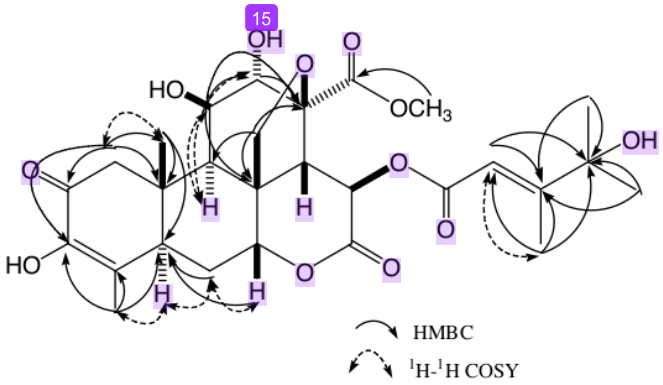

Figure 3. HMBC and ^{1}H-^{1}H COSY correlation of brusein-C from *Brucea javanica*

Insecticidal activity

Insecticidal activities of brucein-C formulated in liposomes against *D. piperis* and *H. antonii* were shown at Figure 4. The results showed that brucein-C at concentration 200 ppm effectively reduced *D. piperis* and *H. antonii* with mortality value of 91.7% and 98.3%, respectively. Insecticidal activity of brucein-C at concentration higher than 200 ppm showed mortality value more than 90%. In contras, brucein-C at concentration 100 ppm showed mortality of *D. piperis* and *H. antonii* 25.0%.

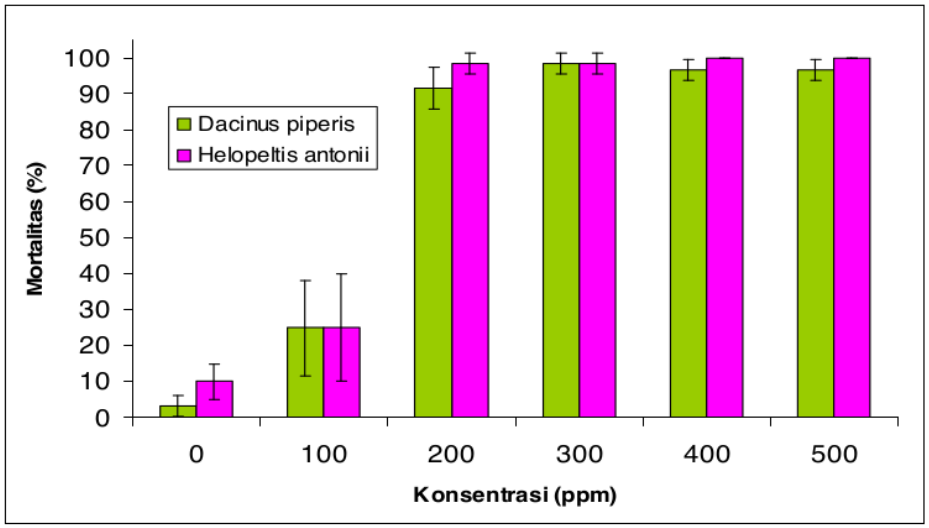

Figure 4. Insecticidal activity of brusein-C against *Dacinus piperis* and *Helopeltis antonii*

Insecticidal activities of brucein-C in order to kill pests of *D. piperis* and *H. antonii* were caused by its ability to inhibit protein synthesis of insect. Side chain of 4-hydroxy-3,4-dimethyl-2-pentenoyloxy in the brucein-C has ability to inhibit protein syntesis. Many researches previously showed that brucein-C have activity as insecticidal against *Plutella xylostella, Tetranychus urticae, Myzus persicae, Meloidogyne incognita, Heliothis virescens,* and *Spodoptera frugiperda*. (Okano *et al*., 1994; Latif *et al*, 2000; Daido *et al*., 1993, 1995; Park *et al*., 1987; Klocke *et al*., 1985).

Activity of Brucein-C against Non Target Insects

Experiments were done in order to know spectrum inhibition of brucein-C as insecticide. Experiments were done at field with put some insect in the net and sprayed with brucein-C at concentration 200 ppm. The results showed that brucein-C at concentration 200 ppm have no lethal effect against ant, grasshopper, butterfly, bee, and dragonfly. Therefore, brucein-C has narrow insecticidal spectrum. It is just kill pest of *D. piperis* and *H. antonii* and not kill other insect at concentration 200 ppm. Spectrum inhibitions of brucein-C against non target insects were shown at Table 2.

Table 2. Spectrum inhibitions of brucein-C against non target insects

	Amount of insect dead*				
Treatment	Ant	grasshopper	butterfly	bee	dragonfly
Control	0	0	1	0	0
Brucein-C (200 ppm)	0	0	0	0	0

*) Each insect is five

Residue Brucein-C in the soil

Residual analysis of brucein-C were done with sprayed brucein-C in the soil at concentration 200 ppm. Content of brucein-C in the soil were evaluated with HPLC at 0, 15, 30, 45, and 60 days after aplication. The result showed that content of brucein-C in the soil at fifteenth after aplication decreased to 80 ppm and at thirtieth to 0 ppm. Some microorganisme in the soil degradated brucein-C to other derivation. The fact indicated that brucein-C safe for environmental and biodegradable.

Hypothetical Technoeconomy

Hypothetical study of technoeconomy on the natural insecticide produced from *B. javanica* were done in laboratorium scale with 10 L containing active substance of brucein-C 5 g. Direct production costs consist of raw material, extraction/isolation, liposomes formulation, direct labor, and other. These costs not included laboratorium equipments. Direct costs of production brucein-C as insecticide were shown at table 3.

Table 3. Direct production costs of insecticide 10 L containing brucein-C 5 g

No	Production cost	Total (Rp)
1	Raw material (Production 5 g of brucein-C)	
	Brucea javanica (50 kg x Rp 500)	25.000
2	Extraction and isolation (Solvent 10 times used)	
	- EtOH 70% (4 L x Rp 25.000/10 times)	10.000
	- EtOAc (4 L x Rp 100.000/10 times)	40.000
	- MeOH (4 L x Rp 87.500/10 times)	35.000
	- $CHCl_3$ (4 L x Rp 112.500/10 times)	45.000
	- Hexane (4 L x Rp 120.000/10 times)	48.000
	- Silica Column chromatography (250g x Rp2.000/10 times)	50.000
3	Formulation	
	- Phosphatidylcholine (10 g x Rp 30.000)	300.000
	- Cholesterol (1,4 g x Rp 20.000)	28.000
	- Diacetylphosphat (1 g x Rp 20.000)	20.000
4	Other	
	-Water (10 L)	12.000
	- Electricity	38.000
5	Labor costs (2 people x Rp 40.000)	80.000
TOTAL PRODUCTION COSTS		**731.000**

Direct costs to produce insecticide 10 L containing brucein-C 5 g are Rp. 731.000. Sale price of the insecticide brucein-C are Rp. 73.100 per liter. Wereas syntetic insecticide such as lamda sihalotrin is Rp. 181.250 per liter. Therefore, the use of insecticide brucein-C cheaper 40.3% than commercial insecticide. Present several advantages in relation to natural insecticide as their rapid biodegradation reducing the risks of environment and food contamination besides the easy way of obtaining and preparation.

CONCLUSION

Brucein-C isolated from buah makasar (*B. javanica*) at concentration 200 ppm inhibited *H. antonii* and *D. piperis* with mortality value of 98.3% and 91.7%, respectively, biodegradable, and no lethal effect against non target insects.

Acknowledgments. The authors are grateful to Mr. Ahmad (The Indonesian Science of Institute) for measuring the NMR and mass spectra. This work was supported in part by KKP3T Department of Agriculture.

REFERENCES

Anderson, M.M., O'Neill, M.J., Phillipson, J.D., Warhurst, D.C., 1991. *In Vitro* Cytotoxicity of a Series of Quassinoids from *Brucea javanica* Fruits against KB cells. Planta Med. 57: 62-64.

Bedikian, A.Y., Valdivieso, M., Bodey, G.P., Murphy, W.K., Freireich, E.J., 1979. Initial Clinical Studies with Bruceantin. Cancer Treat. Rep. 63: 1843-1847.

Chono, S., Tauchi, Y., and Morimoto, K. 2006. Pharmacokinetic Analysis of Uptake of Liposomes by Macrophages and Foam Cells *In Vitro* and their Distribution to Atherosclerotic Lessions in Mice. Drug Metab. Pharmacokinet. 21 (1): 37-44.

Daido, M., Fukamiya, N., Okano, M., Tagahara, K., Hatakoshi, M., Yamazaki, H. 1993. Antifeedant and Insectidal Activity of Quassinoid against the Diamondback Moth (*Plutella xylostella*). Japan Biosci. Biotec. Biochem. 57 (2): 244-246.

Daido, M., Ohno, N., Imamora, K., Fukamiya, N., Hatakhosi, M., Yamazaki, H., Pagahara, K., Lee, K., Okano, M. 1995. Antifeedant and Insectidal Activity of Quassinoid against the Diamondback Moth (*Plutella xylostella*) and Structure Activity Relationship. Japan Biosci. Biotec. Biochem. 59 (6): 974-979.

Finney, D.J. 1971. Probit Analysis. Edition Third. Cambridge. The University Press. 357 pp.

Fukamiya, N., Okano, M., Miyamoto, M., Tagahara, K., Lee, K.H. 1992. Antitumor Agents. 127. Bruceoside C, a New Cytotoxic Quassinoid Glucoside, and Related Compounds from *Brucea javanica*. J. Nat. Prod. 55: 468-475.

Guru, P.Y., Warhurst, D.C., Harris, A., Phillipson, J.D. 1983. Antimalarial Activity of Bruceantin *in vitro*. Ann. Trop. Med. Parasitol. 77: 433-435.

Klocke, J.A., Arisawa, M., Handa, S. S., Kinghorn, A. D., Kordel, G. A., Farnsworth. 1985. Grow

Inhibitory, Insecticidal and Antifeedant Effects of some Antileukemic and Cytotoxic Quassinoids on Two Species of Agricultural Pests. USA Experientia 41 (3): 379-382.

Latif, Z., Careven, L., Hartlye, T.G., Kemp, B.R., Potter, J., Rice M. J.,Whaigh, R. D., Waterman, P. G. 2000. An Insectidal Quassinoid from the New Australian Species *Quasssia sp.* Aff bidwilli. Phytochemistry Research Laboratories, UK. Biochemical Systematic and Ecology. 28(2): 183-184.

Lee, K.H., Imakura, Y., Sumida, Y., Wu, R.Y., Hall, I.H., Huang, H.C. 1979. Antitumor Agents. Isolation and Structural Elucidation of Bruceoside–A and –B, Novel Antileukemic Quassinoid Glycosides, and Bruceine–D and –E from *Brucea javanica.* J. Org. Chem. 44 (13): 2180-2185.

Lee, K.H., Hayashi, N., Okano, M., Nozaki, H., Ju-Ichi, M., 1984. Antitumor Agents. 65. Brusatol and Cleomiscosin-A, Antileukemic Principles from *Brucea javanica*. J. Nat. Prod. 47: 550-551.

Liesmann, J., Belt, R.J., Haas, C.D., Hoogstraten, B. 1981. Phase I Study on Bruceantin Administered on a Weekly Schedule. Cancer Treat. Rep. 65: 883-885.

Makkar, H.P.S., Becker, K., Sporer, F., Wink, M. 1997. Studies on nutritive potential and toxic constituents of different provenances of *Jatropha curcas.* J. Agricul. Food Chem. 45: 3152-3157

Okano, M., Fukayama, K; Hatagoshi, M., Yamazaki, H. 1994. Quassinoids for Control of *Plutella xylostella*. Jpn. Kokai Tokkyo Koho. 6 pp.

O'Neill, M.J., D.H. Bray, P. Boardman, K.L. Chan, J.D. Phillipson, D.C. Warhurst, and W. Peters. 1987. Plants as Sources of Antimalarial Drugs. Part 4: Activity of *Brucea Javanica* Fruits against Chloroquine-resistant *Plasmodium falcifarum In Vitro* and against *Plasmodium berghei in vivo*. J. Nat. Prod. 50: 41-48.

Park, M. H., Maeda, M., Komura, H., nakanishi, K., Nomoto, K. 1987. Acute Insecticidal Activity of Quassinoid and its Congeners againts the American Cockroach. Jpn. Chem. Pharm. Bul. (7): 3082-3085.

Rahman, S., Fukamiya, N., Tokuda, H., Nishino, H., Tagahara, K., Lee, K.H., Okano, M. 1999. Three New Quassinoid Derivatives and Related Compounds as Antitumor Promoters from *Brucea javanica*. Bul. Chem. Soc. Jpn. 72: 751-756.

Subeki, Yamasaki, M., Maede, Y., Matsuura, H., Takahashi, K., Nabeta, K., 2006. Isolation and Identification of Antibabesial Compound from *Brucea javanica* Fruit. Jpn. Kokai Tokkyo Koho. 18 pp.

Subeki, Matsuura, H., Yamasaki, M., Maede, Y., Katakura, K. 2007. Screening of some Indonesian Medicinal Plants for Antibabesial Activity and Isolation of New Quassinoids from *Brucea javanica.* J. Nat. Prod. 70: 1654-1657.

Wibowo. A. 2005. Potensi Buah Makasar (*Brucea javanica*) sebagai Obat Herbal Keluarga. Bulletin Sehat. CV. Karya Tama Lampung. 19 Hlm.

Wright, C.W., M.J. O'Neill, J.D. Phillipson, and D.C. Warhurst. 1988. Use of Microdilution to Assess *In Vitro* Antiamoebic Activities of *Brucea javanica* Fruits, *Simarouba amara* stem, and a Number of Quassinoids. Antimicrob. Agents Chemother. 32: 1725-1729.

Yang, Z., Xie, H., Wang, J., Shun, T., Li, X., 1996. Chemical Studies of the Active Antitumor Components from the Fruits of *Brucea javanica* (L.). Tianran Chanwu Yanjiu Yu Kaifa. 8 (2): 35-39.

Vendramim, J.D., Castiglioni, E., 2000. Aleloquímicos, resistência de plantas e plantas inseticidas. Allelochemicals, plant resistance and insecticide plants. In: Guedes, J.C., Costa, I.D., Castiglioni, E. (Ed) Bases e técnicas do manejo de insetos. Bases and techniques of insect management. UFSM/CCR/DFS, Santa Maria, pp. 113-128.

INSECTICIDAL ACTIVITY OF BRUCEIN-C FROM BUAH MAKASAR (Brucea javanica) AGAINST Helopeltis antonii AND Dacinus piperis

ORIGINALITY REPORT

16%	10%	15%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Sumio Chono. "Uptake of dexamethasone incorporated into liposomes by macrophages and foam cells and its inhibitory effect on cellular cholesterol ester accumulation", Journal of Pharmacy and Pharmacology, 09/2006 Publication	1%
2	Hiroaki Toshima, Hiroji Sato, Akitami Ichihara. "Total synthesis of (2S,3R,5S)-(−)-2,3-dihydroxytetradecan-5-olide, a new biologically active δ-lactone produced by Seiridium unicorne", Tetrahedron, 1999 Publication	1%
3	oacis.repo.nii.ac.jp Internet Source	1%
4	d-nb.info Internet Source	1%
5	Mabrouka Ghabbari, Salvatore Guarino, Virgilio Caleca, Filippo Saiano et al. "Behavior-	1%

modifying and insecticidal effects of plant extracts on adults of Ceratitis capitata (Wiedemann) (Diptera Tephritidae)", Journal of Pest Science, 2018
Publication

---

6 doras.dcu.ie
Internet Source
1%

---

7 Yoshihiro Sano, Takao Kishimoto. " Delignification Mechanism During High-Boiling Solvent Pulping. V. Reaction of Nonphenolic β- -4 Model Compounds in the Presence and Absence of Glucose ", Journal of Wood Chemistry and Technology, 2003
Publication
1%

---

8 Fyaz M.D. Ismail, Lutfun Nahar, Kalin Y. Zhang, Satyajit D. Sarker. "Antiparasitic natural products", Elsevier BV, 2020
Publication
1%

---

9 Punita Sharma, Prashant S. Chauhan, Prabhu Dutt, Musarat Amina et al. "A unique immuno-stimulant steroidal sapogenin acid from the roots of Asparagus racemosus", Steroids, 2011
Publication
1%

---

10 Ahmed Elkhateeb, Yusuke Tosa, Hideyuki Matsuura, Kensuke Nabeta, Ken Katakura. "Antitrypanosomal activities of acetylated bruceines A and C; a structure–activity
1%

relationship study", Journal of Natural Medicines, 2011
Publication

11	Qing-Mei Ye, Liang-Liang Bai, Shu-Zhi Hu, Hai-Yan Tian et al. "Isolation, chemotaxonomic significance and cytotoxic effects of quassinoids from Brucea javanica", Fitoterapia, 2015 Publication	1%
12	Ines Tomoco Matsuse. "A human immunodeficiency virus protease inhibitory substance fromSwietenia mahagoni", Phytotherapy Research, 09/1997 Publication	1%
13	Sumio Chono. "Efficient drug delivery to atherosclerotic lesions and the antiatherosclerotic effect by dexamethasone incorporated into liposomes in atherogenic mice", Journal of Drug Targeting, 5/1/2005 Publication	<1%
14	journals.iucr.org Internet Source	<1%
15	www.paradise.caltech.edu Internet Source	<1%
16	V. U. Ahmad. "A new acylated flavone glycoside from the fruits of Stocksia brauhica", Journal of Asian Natural Products Research, 4/2007 Publication	<1%

17	Ayyub Wibowo, Farida Fathul. "IDENTIFIKASI KANDUNGAN ZAT MAKANAN PADA BIJI BUAH DI PASAR BANDAR LAMPUNG", JURNAL ILMIAH PETERNAKAN TERPADU, 2017 Publication	<1%
18	Shin Yoosoo. "Two new components from the roots of Angelicae koreana Kitagawa", Chemistry of Natural Compounds, 11/2007 Publication	<1%
19	NoorShahida, A.. "Hypoglycemic effect of quassinoids from Brucea javanica (L.) Merr (Simaroubaceae) seeds", Journal of Ethnopharmacology, 20090730 Publication	<1%
20	Luyengi, L.. "A lignan and four terpenoids from Brucea javanica that induce differentiation with cultured HL-60 promyelocytic leukemia cells", Phytochemistry, 199609 Publication	<1%
21	www.mdpi.org Internet Source	<1%
22	www.thieme-connect.de Internet Source	<1%
23	Bedir, Erdal, Hassan Abou-Gazar, Julius Ngunde Ngwendson, and Ikhlas Ahmad Khan.	<1%

"Eurycomaoside: A New Quassinoid-Type Glycoside from the Roots of Eurycoma longifolia", CHEMICAL & PHARMACEUTICAL BULLETIN, 2003.
Publication

24	Xiao-Hui Yan, Jia Chen, Ying-Tong Di, Xin Fang et al. " Anti-Tobacco Mosaic Virus (TMV) Quassinoids from (L.) Merr. ", Journal of Agricultural and Food Chemistry, 2010 Publication	<1%
25	docobook.com Internet Source	<1%
26	lhsdesasumberjofixmanehyeah.wordpress.com Internet Source	<1%
27	Ik Hwi Kim, Yukio Hitotsuyanagi, Koichi Takeya. "Quassinoid glucosides from seeds of Brucea amarissima", Phytochemistry, 2004 Publication	<1%
28	Lijuan Zhao, Chao Li, Yao Zhang, Qing Wen, Dongmei Ren. "Phytochemical and Biological Activities of an Anticancer Plant Medicine: Brucea javanica", Anti-Cancer Agents in Medicinal Chemistry, 2014 Publication	<1%
29	Ying-Gang Luo. "Four new glycosides from Pleurospermum franchetianum", Journal of Asian Natural Products Research, 1/1/2002	<1%

Publication

30	Anna Rita Bilia. "Non-nitrogenous Plant-derived Constituents with Antiplasmodial Activity", Natural Product Communications, 2019 Publication	<1%
31	J Dou. "A New Quassinoid from Crude Quassin-extract of Quassia amara", Pharmaceutical Biology (Formerly International Journal of Pharmacognosy), 12/1/1996 Publication	<1%
32	R. Caniato, L. Puricelli. "Review: Natural Antimalarial Agents (1995-2001)", Critical Reviews in Plant Sciences, 2003 Publication	<1%
33	Iasmine A.B.S. Alves, Henrique M. Miranda, Luiz A.L. Soares, Karina P. Randau. "Simaroubaceae family: botany, chemical composition and biological activities", Revista Brasileira de Farmacognosia, 2014 Publication	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		