Chemistry and Materials Research
ISSN 2224- 3224 (Print) ISSN 2225- 0956 (Online)
Vol.7 No.8, 2015

A New Antifeedant Alkaloid Eburnamonin from the Seed of *Kopsia prunoformis* Rchb.f

I Dewe. K. Anom[1]* Jefry Jack Mamangkey[2]
1, Department of Chemistry, Faculty of Mathematics and Natural Sciences, Manado State University
2, Department of Biology, Faculty of Mathematics and Natural Sciences, Manado State University

Abstract
A new antifeedant eburnamonin alkaloid were isolated from the seed of Kopsia pruniformis Rchb.f. The isolat was obtained a colourless crystal showing an antifeedant activity of 68% to Epilachna sparsa at a concentration of 0.001% (w/v). The structur were elucidated by spectroscopic datas IR, ^{1}H-NMR, ^{13}C-NMR ATP, MS and isolat obtained was eburnamonin which was alkaloid compound ($C_{19}H_{22}N_2O$) with a molecular weight of 294.
Keywords: *Kopsia pruniformis* Rchd.f, antifeedant, alkaloid, eburnamonin.

INTRODUCTION

Kopsia prunoformis Rchb.f which can be classified into crop usually grow wild in Batuan Bali. Based on the information given from the local native, *Kopsia prunoformis Rchb.f* is kind of plant which is seldom attacked by insects. Moreover, the ripe fruit of *Kopsia prunoformis Rchb.f* is very useful since it can serve as traditional medicine for curing diabetes mellitus. Endang (1994) had conducted a research focusing on the fruit of *Kopsia prunoformis Rchb.f* and the result showed that its extract lowered blood sugar level in rabbit *(Orytologus ciniculus).* In China, *K. pitardi* functions as the cure for rheumatoid arthritis, edema, and tonsillitis (Zhou, et al., 2006). Besides, *K. larutensis also has similar function and use as K.pitardi (Awang, et al., 1991). In Malaysia, the root of K.larutensis is often used as traditional medicine to cure scabies, boils, ulcers on skin and syphilis (Kam, et al., 1992). K. officinalis is found to have similar function as K. larutensis (Kam, et al., 1996). Crude extract of K. frofunda and K. teoi proves the activities of anti-hipertension on rats (Mok, et al., 1998). Ahmad,d et al (2008) initiated a study on alkaloid compound obtained from the leaves of K. singapurensis Ridl and found that two indol alkaloid compounds have cytotoxic activity on murine leukemia P388 cell. The study on the leaves and bark of K. singapurensis yielded a total of 5 pentacyclic triterpenoid: lupeol 1, lipeol acetae 2, β-amyrin 3, β-amyrin acetate 4, β-amyrone 5 and a steroid stigmasterol 6. All the isolated compounds exhibited cytotoxic effects against MCF-5 cell line, compound 6 was the most active compared to the rest of compounds in the cytotoxic activity with IC50 = 14.5 µg/mL, while all tested compounds showed no significant on antibacterial and antioxidant activity using the DPPH method (Shan, et al., 2014).*

Awang et al (1993) succeeded in isolating 7 types of indole alkaloids obtained from bark and leaves of K.lapidilecta which grows in Malaysia and they serve as venalstonin, lapidilectin, lapidilectam, lapidilektinol dan epilapidilectinol alkaloids. Feng et al (1984) was successful to isolate two types of indole alkaloids from the root of K. offisinalis which grows in China. Those indole alkaloids are 1-norpleiomutin and (+)- kopsofin. Fan et al (1998) has been successful in isolating three indole alkaloids extracted from the root of K. deverrei L., those are compounds of N-carbonmethoxy 17-ß-hydroxicopsinin, N-carbomethoxy 17-ß-hydroxy-14, 15-kopsinine and kopsanone. Kam et al (1996) has isolated six new monoterpen alkaloids gained from the leaves of K. fauciflora, those are kinabularin A, B, C, D, E, and F. Matthias et al (1998) had isolated 2 alkaloid compounds extracted from K.Malaysian, those are kopsingin and kopsingarin. Uzir et al (1997) had successfully isolated four alkaloids from K. terengganensis, namely, terenggenensin A, terenggenensin B, eburnaminol dan larutensin. Kam et al(1998) also isolated four alkaloid compounds obtained from K. griffithii, namely, Harman, harmisin, 16-(R)-19,20-E- isositsirikin and buchtienin. Chatterjee and Deb (1962) had isolated kopsinine compound from K. pruniformis Rchbf which is classified into indole alkaloid compound, however, chemical substance contained in the seed of K. pruniformis Rchbf has not been discovered yet. Reanmongkol et al (2005) have conducted research whose result shows that alkaloid extracted from K. macrophylla leaves has antinociceptive activity towards rat. Wu et al (2008) have successfully isolated two novel alkaloids, those are, kopsiyunnanines A of bisindole alkaloid and oxindole alkaloid type B extracted from K. yunan. Low et al (2009) explained that pentacyclic mersiphilines alkaloid A and B have been isolated from K. singapurensis. Kam et al (2001) also explained that new quinolin alkaloid, mersinines A and B that is isolated from Kopsia Malayan species. Ahmad et al (2008) isolated cytotoxic indole alkaloids, those are, singaporentine A, kopsifoline A and kopsininic acid from K. singapurensis Ridl. Tan et al (2011) isolated three novel indole alkaloids from the bark of Kopsia hainensis, namely, kopsihainin A (1), kopsihainin B (2), and kopsihaini C (3), two kopsinine compounds (4) and methyl demothoxycarbinylchanofruticosinate (5). Two compounds (4 and 5) show antitussive activity in citric acid research.

From literature research that has been conducted, no reliable information has been obtained regarding the isolation of antifeedant compound extracted from Kopsia. Therefore, the writer is greatly interested in

conducting research on antifeedant compound from K. pruniformis Rchbf. The isolation of ethyl acetate fraction from the seeds of K. pruniformis Rchbf results in pure isolate showing antifeedant activity towards Epilachna sparsa. Based on data analysis on pure isolate spectroscopy, it results in eburnamonin alkaloid ($C_{19}H_{22}N_2O$) with molecule weight of 294 and has chemical structure shown in Figure 1

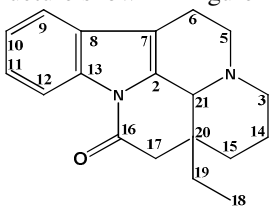

Figure 1. Structure of eburnamonin alkaloid

RESEARCH METHODOLOGY

Material

Research sample in this research is ripe seeds of *K. pruniformis* obtained from Batuan Village, Dusun Puaya, Kecamatan Sukewati, Bali. Chemical substances used are methanol, n-hexan, chloroform, ethyl acetate, ethanol, silica gel 60 (70-230 mesh), and silica gel plate 60 $F_{254.}$ Wagner reactant, Dragendorff reactant, Mayer reactant, and sulfate acid 50%. Bio-indicator for antifeedant activity test uses third or fourth instar *E. sparsa* larvae and uses the leaves of *Solanum nigrum* as test media.

Devices

This research uses some devices, namely; glass tools, blender, scale, oven, petri dish, funnel, glass column, vacuum suction top Rotapavor Buchi R-114 vacuum system B 169, gas chromatography-mass spectrometer (GC5890 Series plus- MS 5989 B), infra red spectrometer FTIR Shimadzu 8501, *Proton Nuclear Magnetic Resonance Spectroscopy*(^{1}H-NMR, JEOL, JNM PMX-400 MHz), *Carbon Nuclear Magnetic Spectroscopy* (^{13} *C-NMR APT,* JEOL, JNM PMX-400 MHz)

Preparation of Antifeedant Extract Test Solution

Fresh seeds of *K. pruniformis Rchb.f (10 g)* are cruched in the blender until it is smooth before it is macerated with the mixture of methanol-water (4:1) for 2 x 24 hours, and every 1 x 24 hour, this extract must be filtered. When thick liquid extracted from *K. pruniformis Rchbf.* has been obtained, test solution for antifeedant activity with concentration 5% (b/v) is conducted by using methanol.

Antifeedant Activity Test

Biological test is initiated in petri dish where the researcher put filters and gauze pads soaked in pure water. The researcher uses the leaves of *S.nigrum* as test media. On the back side of the leaves, the researcher puts the solution of *K. pruniform Rchbf's* seed extract. 5% (b/v) is equally smeared at the left side of bone leaf and methanol is smeared at the right side of bone leaf as control, which is dried by using blower. The leaves of *S. nigrum* ready for biological test, is placed on gauze pads, covered by smaller petri dish which has small hole with diameter of 3,5 cm. On the top of this smaller dish, the researcher placed two *E. sparsa larvas* which was fasting for four hours. Petri dish is tightly closed and the observation is conducted for 24 hours. The measurement of antifeedant activity is done by using following equation.

$$\frac{\text{Percent of consumption area (control - treatment)}}{\text{Percent of consumption area (control + treatment)}} \times 100$$

The measurement of leaf area consumed by *E. sparsa larva* is conducted by dividing circular hole on the top of petri dish into 32 parts. The division into 32 parts follows the instruction of Schwinger et al (1983) and it will be shown in Figure 2. The result of previous research shows that the extract of *K. pruniformis Rchbf's seed* has antifeedant activity for 100% within the concentration of 5%

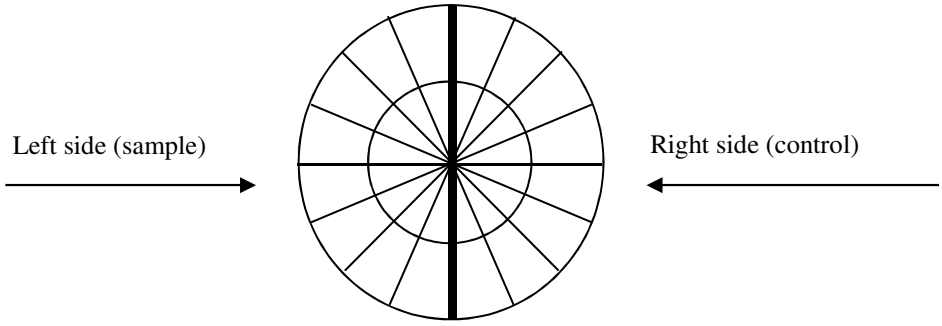

Figure 2. Distribution of *S. nigrum* leaves to be 32 Sectors (Schwinger et al., 1983)

Alkaloid Phytochemical Test

Four grams of *K. pruniformis Rchbf's fresh seed* are crushed in mortar added by small amount of sand and chloroform. The extract obtained is mixed with 10 mL ammoniacal chloroform 0,5 N, then it is stirred and filtered. Filtrate is then placed in reaction tube, added by 0,5 mL sulfate acid 2 N. The next step involves shaking the filtrate then it gets no treatment for several minutes until the division of two phases is obtained. Acid phase dwelling in the top side of this solution will be placed in 4 reaction tubes with equal volume by using pipette. The alkaloid-detecting reactant is dropped in each reaction tube. The extract of *K. pruniformis Rchbf's seed* will give reddish color precipitated with Dragendorff's reagent, brownish color precipitated with Wagner reagent, and white color precipitated with Mayer reagent. It means that the extract of *K. pruniformis Rchbf's seed* positively contains alkaloid.

The Extraction of *K. pruniformis Rchbf fresh seed*

One kilogram of *K. pruniformis is* crushed with blender until its soft form is obtained. Sample is then macerated with 900 mL mixed solution of methanol-water (4:1). Maceration is conducted under room temperature for 1 x 24 hour and is filtered every 1 x 24 hour. The filtrate is scooped up and its waste experiences another maceration with new 900 mL mixed solution of methanol-water (4:1). Maceration is conducted for 5 x 24 hours. The solvent from the filtrate is evaporated by using vacuum suction top rotavapor under the temperature of 40^0C until 112 grams of thick methanol extract are obtained.

112 grams of thick methanol extract are partitioned with 75 mL n-hexane and 75 mL distilled water. By using funnel, this mixture is shaken and gets no treatment for four hours. N-hexane layer is separated from water. The solvent from n-hexane extract is vaporized by using vacuum suction top rotavapor under the temperature of 30^0C until free-solvent extract weighing 19 g is obtained and labeled H. Water experiences another extraction by adding 75 mL ethyl acetate and shaking it, then it gets no treatment for 4 hours. Water and ethyl acetate are then separated. The solvent of ethyl acetate extract is vaporized by using vacuum suction top rotavapor under the temperature of 30^0C until free-solvent extract weighing 6 g is obtained and labeled E. The solvent of water is vaporized by using vacuum suction top rotavapor under the temperature of 30^0C until free-solvent extract, namely water fraction, weighing 75 g is obtained and labeled A. After antifeedant activity test is conducted on each fraction, the result shows that each fraction has different level of antifeedant activity, those are, Fraction H = 48%, Fraction E = 90% and Fraction A = 0%, on the solution concentration 0,1% towards *E. sparsa.* Fraction E having the highest antifeedant activity level then is isolated and purified while fraction H and A get no further treatment.

Distillation and Purification of E

Distillation and purification of 2,00 g Fraction E is conducted by applying open column chromatography of silica gel 60 (70-230 mesh), the length of column is 50 cm, the diameter of the column is 1 cm, with movement phase of methanol-chloroform-ether (1:2:3) on flow rate is 0,4 mL/minute. The result of column chromatography is classified based on the pattern of stain on KLT. Stain pattern on KLT signifies 5 groups, and eluates having the same stain pattern will be placed in one bottle. The solvent of each eluate is vaporized by using vacuum suction top rotavapor Buchi R-114, vacuum system B 169, until the free-solvent eluates, those are, E1 (16mg), E2 (24mg), E3(30 mg), E4 (104 mg) and E5(18mg) are obtained. After activity test on *E sparsa* with solution concentration 0,005% (b/v) is conducted, the result shows that those five eluates have antifeedant activity described as follows; E1= -2%, E2 = -2% , E3= 27%, E4=76%, and E5=14%. It shows that eluate E4 has the highest antifeedant activity, thus, deeper research on this eluat will be conducted by purifying this eluate. Meanwhile, other eluates, those are E1, E2, E3 and E5, will not be further examined due to their low antifeedant activity level.

Eluate E4 is white crystal and it does not solve in cold methanol. E4 is re-crystalized by adding methanol (15 mL) and boils it slowly until all crystals are perfectly solved. This hot solution is filtered and its filtrate is placed in a bottle which is tightly enclosed. This filtrate is stored in the refrigerator for two hours. The crystal formed is separated from its filtrate by using decantation. Then, these crystals are dried inside exicator. After the drying is undertaking, the remain will be 87 mg white crystal, which is called white crystal isolate. Then, it is labeled IK (1)

Purification Level Test of Isolate IK [1]

Isolate IK[1] is analyzed by using KLT applying various movement phase, and the result reveals that all chromatograms refer to sole spot, meaning that isolate IK [1] comprises of one pure compound. The values of Rf on each sole spot from isolate IK[1] on various movement phase are described as follows; methanol-ethyl acetate (1:10=0,6), ethyl acetate-diethylether-methanol (1:1:1=0,9), methanol-ethyl acetate-n-hexane (1:2:6= 0,4), n-hexane-methanol-diethyleter (1:1:4=0,8), and ethanol-methanol-diethyleter (2:2:3=0,9).

Melting point of isolate IK [1] is measured by Fiser-John melting point apparatus and isolate is melted under the temperature of 181-182^{0}C. This data show that isolate IK[1] is considered pure because its melting point only ranges about 1 degree. GC chromatogram from isolate IK[1] displays one peak, revealing the fact that isolate IK [1] is already pure substance.

RESULT AND DISCUSSION

Data obtained from infrared spectrum of isolate IK[1] show the existence of aromatic H-bond (H-Ar) as sharp absorption with low intensity and it is considered as stretchvibration with wave length of (v) 3049 cm^{-1}. The estimate on the forming of this CH-aromatic bound is strengthened by the existence of sharp absorption with high intensity as flexural vibrations C=C aromatic on wave length of 1628 and 1456 cm^{-1}. CH_3 and CH_2 alkanes serve as sharp absorption with low intensity as the result of stretchvibration with wave length of 2934 and 2856 cm^{-1}. C=O carbonyl group serves as sharp absorption with very high intensity as the result of stretchvibrationwith wave length of 1701 cm^{-1}. C-N amide groupserves as sharp absorption with very high intensity as the result of flexural vibrations with wave length of 1375 and 1333 cm^{-1}. Subtituted CH aromatic bond exists as sharp absorption with high intensity as the result of flexural vibrations with wave length of 750 cm^{-1}.

Data of ^{1}H-NMR, chemical shift (ppm), multiplicity and relative number of proton from isolate IK[1] are presented in Table 1. Data identification of isolate IK [1] compared to data ^{1}H-NMR eburnamonin and larutenin that have been isolated from *K.laretensis* by Kam et al [1992]

Table 1. Data of 1H-NMR spectrum from IK [1] isolate, compare with eburnamonin and larutenin compounds by Kam, at al. (1992).

Position	δH (∑H, multiplicity) IK [1]	δH (∑H, multiplicity) Eburnamonin	δH (∑H, multiplicity) Larutenin
3a 3b	2,3 m -	2,32-250 m 2,53-2,54 m	2,20-2,30 m 2,90-3,10 m
5a 5b	3,2 m 3,3 m	3,20 ddd (14,11.6) 3,20 dd (14, 6)	2,70 td (11,7) 3,24 dd (11, 7)
6a 6b	- 2,8 m	2,32-2,50 m 2,80-2,96 m	2,84 br ddd (15,7, 1,5) 2,90-3,10 m
9	-	7,42 dd (7,2)	7,46 d (7)
10	7,3 m	7,27 td (7,2)	7,11 t (7)
11	7,4 m	7,31 td (7,2)	7,18 t (7)
12	8,4 dd	8,37 dd (7,2)	7,41 d (7)
14a 14b	1,4 d 1,7 m	1,37 br d (13, 1) 1,74 br qt (13, 3)	1,60-1,80 m 1,60-180 m
15a 15b	- 1,4 d	1,01 td (13, 3) 1,48- br d (13)	1,35-1,48 m 1,60-180 m
16	-	-	5,83 t (2)
17a 17b	2,6 m -	2,56 d (17) 2,65 d (17)	1,60-1,80 m 1,60-1,80 m
18a 18b	- -	- -	3,80 dd (13, 6) 3,95 td (13,3)
Me-18	0,9 m	0,92 t (7)	-
19a	1,6 d	1,63 dq (14, 7)	1,54 br d (13)

19b	2 m	2,03 dq (14,7)	1,82 td (13,6)
21	3,8 s	3,92 s	3,17 s

The data gained from *Proton Nuclear Magnetic Resonance Spectroscopy show that the chemical shift of isolate IK [1] resembles to eburnamonin and consists of 15 groups of proton. Based on the calculation of relative number of proton analyzed from ^{1}H-NMR, isolate IK[1] consists of 22 protons*

To discover the number of primary, secondary, tertiary, and quaternary carbon atoms, isolate IK [1] is analyzed by using carbon-13 nuclear magnetic resonance attached proton test (^{13}C-NMR APT) shown in Table 2. Data identification of Isolate IK[1] compared to data from ^{1}C-NMR eburnamonin that has been isolated from *K.laretensis* by Kam et al [1992]

Table 2 ^{13}C-NMR APT data of chemical shift (ppm) isolate IK[1] compared to data from ^{1}C-NMR eburnamonin that has been isolated from *K.laretensis* by Kam et al [1992]

Table 2. Data of ^{13}C-NMR *APT*chemical shift (ppm) IK [1] isolate compare with data of ^{13}C-NMR from eburnamonin compound acording to Kam, et al.(1992)

Posisi No	δC (ppm) Isolat IK [1] (400 MHz, $CDCl_3$)	δC (ppm) Eburnamonin (270 MHz, $CDCl_3$)	No	δC (ppm) Isolat IK [1] (400 MHz, $CDCl_3$)	δC (ppm) Eburnamonin (270 MHz, $CDCl_3$)
2	131,2 (C)	132,0	12	116,1 (CH)	116,1
3	44,2 (CH_2)	44,2	13	134,2 (C)	134,0
5	50,4 CH_2)	50,5	14	20,5 (CH_2)	20,5
6	16,4 (CH_2)	16,4	15	26,8 (CH_2)	26,8
7	112,3 (C)	112,4	16	167,5 (CO)	167,5
8	129,9 ((C)	130,0	17	44,1 (CH_2)	44,1
9	117,9 (CH)	117,9	18	7,6 (CH_3)	7,6
10	123,6 (CH)	123,7	19	28,2 (CH_2)	28,2
11	124,1 (CH)	124,2	20	38,2 (C)	38,2
-	-	-	21	57,4 (CH)	57,4

From data of ^{13}C-NMR APT spectrum, it is highlighted that isolate IK [1] has 10 carbon atoms consisting of one primary carbon atom (CH_3), seven secondary carbon atoms (CH_2), 5 tertiary carbon atoms (CH) and six quaternary carbon atoms (C). Data obtained from isolate IK [1] chemical shift are similar to those of eburnamonin, which means that two compounds are identical.

To strengthen the idea of compound structure shown in Figure 1, confirmation and identification of comparison data between eburnamonin and larutenin has been done (Kam et al 1992). Data from mass spectroscopy (MS) of isolate IK [1] show that molecular ion $(M)^+$ in m/z 294 is 100% identical with mass spectroscopy (MS) from eburnamonin and larutenin having the same molecule ion in m/z 294, and it is presented in Table 3

Table 3. Datas of MS isolate IK [1] compare with MS datas of eburnamonin and larutenin compounds (Kam, et al., 1992)

Isolate of IK [1]			Eburnamonin			Larutenin		
m/z	Abundance (%)	Fragmentation	m/z	Abundance (%)	Fragmentation	m/z	Abundance (%)	Fragmentation
294	100	(M)+	294	100	(M)+	294	98	(M)+
279	0,6	M-CH3	-	-	-	293	100	M-H
265	39	M-C2H5	265	38	M-C2H5	265	7	M-C2H5
237	41	M-C3H5O	237	40	M-C3H5O	237	11	M-C3H5O
224	29	M-C4H8N	224	28	M-C4H8N	194	12	-

From table 3, it is clearly explained that isolate IK [1] and eburnamonin has similar base peak and molecular ion within the condition of m/z 294. Fragmentation and relative abundance of molecular ion in larutenin is also different. Based on those data, it can be concluded that isolate IK [1] is identical with eburnamonin.Based on the pattern of molecular ion fragmentation MS, groups possible disconnected from isolate IK [1] is shown in figure 3

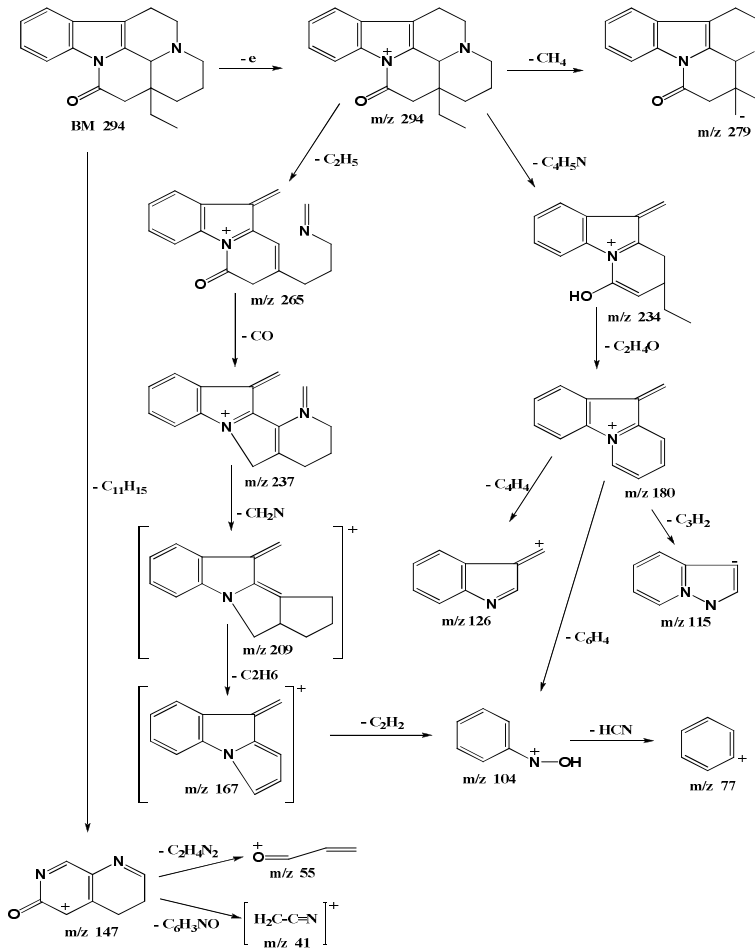

Figure 3. Possible disconnected group from Isolate IK[1] based on the fragmentation of molecular ion in mass spectrum(JEOL JMS.5989 B).

CONCLUSION

Isolation of etyhlacatate fraction from *K. pruniformis Rchbf* results in non-colored cystal isolate with melting point is 181-182^{0}C. This isolate has antifeedant activity of 68% in solution concentration 0,001% towards *E. sparsa.* Based on analysis data from IR spectrometry, ^{1}H-NMR, ^{13}C-NMR APT and MS, it can be concluded that active isolate obtained is alkaloid eburnamonin having molecular formula $C_{19}H_{22}N_20$

References

Amad, K., N. F. Thomas, K. Awanga. (2008). Cytotoxic Indole Alkaloids from *K. singapurensis* Ridl. *Proc. of International Seminar on Chemistry 2008*, pp. 203, Jatinangor, 30-31 October 2008.

Awang, K., M. Pais, T. Sevenet, H. Schaller, A. M. Nasir, A. Hamid, A. Hadi. (1991). Eburnaminol dan Larutensine, Alkaloid from *Kopsia larutensis*. *Phytochemistry*, 30, 3164-3167. Laruten

Awang, K., Sevenet, M. Pais, A. Hamid, A. Hadi. (1993). Alkaloid of *Kopsia lapidilecta*. *J. of Natural Products,* 56, 1134-1139.

Chatterjee, A., A. Deb. (1962). New Observations on Kopsine, an Indole Alkaloid of Kopsia pruniformis. *Chem. Abstracts*, 58, 4607.

Endang, L. C. (1994). Pengaruh Buah Palajiwa (Kopsia pruniformis Rchbf.) Terhadap Gula Darah Kelinci. *Laporan Penelitian*. Fakultas Kedokteran Universitas Udayana Bali, 27.

Fan, C. K., S. K. Kan, J. R. Deverre, J. C. Quirion, H. P. Husson. (1998). Nouveaux Alcaloides De Type Aspidofractinine Fonctionnalises En C-17, Extraits Des Ecorces De Tronc D'un *Kopsiade Malaisie*. *J. of Natural Products*, 51, 703-707.

Feng, X. Z., C. Kan, H. P. Husson, P. Potier, S. K. Kan, M. Lounasma. (1984). Kopsoffine, A New Dimeric Indole Alcaloid of Pleiomutine Type from *Kopsia officinalis*, *J. of Natural Products*, 47, 117-122.

Kam, T. S., P. S. Tan, C. H. Chuah. (1992). Alkaloids from Leaves of *Kopsia Larutensis*. *Phytochemistry,* 31, 2936-2938.

Kam, T. S., L. Arasu, K. Yoganathan. (1996). Alkaloids from *Kopsia pauciflora*. *Phytochemistry,* 43, 1385-

1387.

Kam, T. S., and K. Yoganathan. (1996). Three Aspidoftactine-Type Alkaloids from *Kopsia Teoi. Phytochemistry*, 42, 539-541.

Kam, T. S., and K. M. Sim. (1998). Alkaloids from *Kopsia graffithii*. *Phytochemistry*, 47, 145-147.

Kam, T. S., G. Subramaniam, T. M. Lim. (2001). Mersinines A and B and Mersiloscine, Novel Quinolinic Alkaloids from *Kopsia*. *Tetrahedron Letters*, 42, 5977-5980.

Low Yun-Yee, G. Subramaniam, Kuan-Hon Lim, C. S. R. Wong, W. T. Robinson, T. S. Kam. (2009). Mersiphyllines A and B from *Kopsia*. Determination of Relative Configuration at a Quaternary Center via Formation of an Alkaloid-Borane Complex. *Tetrahedron Letters*, 65, 6873-6876.

Matthias, O., Hamburger, A. Geoffrey, Cordell, K. Likhitwitawuid, N. Ruangrungsi. (1998). 10-Demetoxykopsidasinine from *Kopsia jasminiflora*. *Phytochemistry*, 27, 2719-2723.

Mok, S. L., K. Yoganathan, T. M. Lim, T. S. Kam. (1998). Cardiovascular Effects of Aspidofractinine Type Alkaloid from *Kopsia.J. of Natural Products*, 61, 328-332.

Reanmongkol, W., S. Subhadhirasakul, S. Thienmontree, K. Thanyapanit, J. Kalnaowakul, S. Sengsui. (2005). Antinociceptive Activity of Alkaloid Extract from *Kopsia macrophylla* leaves in mice. *J. Sci. Technol*, 27, 509-516.

Schwinger, M., B. Ehhamer, W. Kraus. (1983). Methodology of the *Epilachna varivestis* Biossay of Antifeedants Demonstrated with Some Coumpounds from *Azadirachta indica* and *Melia azedarach*. *Proc. 2nd int. Neem Conf. Stuttgart*, 181-198.

Shan, L. Y., T. C. Thing, T. S. Ping, K. Awang, N. M. Hashim, M. A. Nafiah, K. Ahmad. (2014). Cytotoxic, Antibacterial and Antioxidant Activity of Triterpenoids from *Kopsia singapurensis* Rild.*J. of Chem and Pharmaciutecal Research,* 6, 815-822

Uzir, S., A. M. Mustafa, A. Hamid, A. Hadi, K. Awang, C. Wiart, J. F. Gallard, M. Pais. (1997). Terengganensines A and B, Dihydroeburnane Alkaloid from *Kopsia Terengganensis*. *Tetrahedron Letters*, 38, 1571-1574.

Wu, Y., M. Kitajima, N. Kogure, R. Zhang, H. Takayama. (2008). Two Novel Indole Alkaloids, Kopsiyunnanines A and B, from a Yunan *Kopsia*. *Tetrahedron Letters*, 49, 5935-5938.

Zhou, H., H. P. He, N. C. Kong, Y. H. Wang, X. D. Liu, C. J. Hao. (2006). Three New Indole Alkaloids from the Leaves of *Kopsia officinalis*. *Helvetica Chimica Acta*, 89, 417-421.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar