PAPER NAME

SUTOPO HADI-ANGGOTA HARDOKO.pdf

WORD COUNT

4370 Words

CHARACTER COUNT

22960 Characters

PAGE COUNT

7 Pages

FILE SIZE

233.2KB

SUBMISSION DATE

Oct 11, 2022 9:49 AM GMT+7

REPORT DATE

Oct 11, 2022 9:50 AM GMT+7

20% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 17% Internet database
- 11% Publications database
- Crossref database
- Crossref Posted Content database
- 6% Submitted Works database

Excluded from Similarity Report

- Bibliographic material
- Quoted material
- Cited material
- Small Matches (Less then 10 words)
- Manually excluded sources
- Manually excluded text blocks

VOL. 16, NO. 15, AUGUST 2021 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

IN VITRO ANTIBACTERIAL ACTIVITY OF SOME OF DIBUTYLTIN (IV) CHLOROBENZOATE DERIVATIVES AGAINST *STAPHYLOCOCCUS AUREUS* AND *ESCHERICHIA COLI*

Sutopo Hadi[1], Samsuar Samsuar[2,3], Hardoko I. Qudus[1], and Wasinton Simanjuntak[1]
[1]Department of Chemistry, Universitas Lampung, Bandar Lampung, Indonesia
[2]Doctoral Program in Mathematics and Natural Sciences, Universitas Lampung, Bandar Lampung, Indonesia
[3]Faculty of Pharmacy, University of Tulang Bawang, Bandar Lampung Indonesia
E-Mail: sutopo.hadi@fmipa.unila.ac.id

ABSTRACT

The antibacterial activity test of some organotin (IV) benzoate derivative compounds, namely dibutyltin (IV) di *o*-, *m*-, *p*-chlorobenzoate (2-4) against *Staphylococcus aureus* and *Escherichia coli* has been performed. These compounds were synthesized from dibutyltin (IV) oxide (1) with *o*-, *m*-, *p*-chlorobenzoic acid. The antibacterial activity tests were conducted by diffusion and dilution method and compared their activity with chloramphenicol as positive control and methanol as negative control. The results of the diffusion test showed that the inhibition zone observed for dibutyltin(IV) oxide was 0 mm indicating that this compound did not have antibacterial activity. The dibutyltin (IV) *m*-dichlobenzoate with a concentration of 100 ppm was observed to have the biggest inhibition zone against the two bacteria, indicating that compound 3 was the most effective as antibacterial compared to the other series. The results of dilution test showed that the minimum inhibitory concentration (MIC) of dibutyltin (IV) *o*-dichlorobenzoate against *S. aureus* and *E. coli* was 100 ppm while the MIC for dibutyltin (IV) di-*m*-chlorobenzoate was 40 ppm. The dibutyltin (IV) di-*p*-chlorobenzoate was only observed against *S. aureus* with MIC value of 60 ppm. Based on the MIC values obtained in the antibacterial activity of these dibutyltin (IV) di- *o*-, *m*-, *p*-chlorobenzoate indicated that these compounds are potential to be developed as antibacterial drug.

Keywords: antibacterial, in vitro, dibutyltin (IV) dichlorobenzoate, E. coli, MIC, S. aureus.

1. INTRODUCTION

The emergence of bacterial resistance to commercial antibiotics is a global issue in the health sector. Over the past two decades, the number of antibacterial agents found and introduced to the market has declined and failed to answer the challenges posed by increasing pathogenic resistance to common antibacterial drugs [1]. Drug resistance has also become a global medical and clinical problem. Therefore, it is very important to develop drugs that are specific and selective, targeting the process of resistance mechanism [2].

Management of antibiotic resistance is the most pressing public health problem that challenges modern medicine [3]. Increased antibiotic resistance is a consequence of microbial evolution and adaptation, which is caused by excessive consumption of anthropogenic antibiotics [4]. Increased cases of bacterial resistance are not matched by the discovery of new antibiotics [5]. One case of increased infection is caused by the opportunistic pathogen *S. aureus*. *S. aureus* is a Gram-positive bacteria that can cause serious infectious diseases such as: septicaemia, pneumonia, endocarditis, osteomyelitis, gastroenteritis and abscesses [6]. In 2002, vancomycin-resistant *S. aureus* (VRSA) was first isolated in Michigan and Pennsylvania [7]. *S. aureus* infection rate continued to rise in recent decades and the growing problem of antibiotic resistance in the treatment of *S. aureus* infections [8]. Amoxicillin is a penicillin derivative that belongs to the β-lactam antibiotic group and is very effective in cases of *S. aureus* infection because of good oral absorption and has been used since the 1940s [9]. Having found the resistance of *S. aureus* cases in hospital and its prevalence is increasing with the discovery of *S. aureus* produce penicillinase [10]. Cases of *S. aureus* resistance to penicillin group occur in more than 86% of cases. The case of resistance caused the failure of therapy using amoxicillin in *S. aureus* infections [11].

E. coli is a Gram-negative rod bacteria facultative anaerobic species most common in the gastrointestinal tract of humans and animals. This microbe is usually harmless and is also an important bacterium, but in large amounts, it can cause a number of diseases [12]. *E. coli* can be a pathogen if there is an increase in the amount or is outside the digestive tract. *E. coli* will produce enterotoxins which can cause diarrhoea or urinary tract infections [13]. Antimicrobial resistance to *E. coli* has been reported worldwide. Treatment for *E. coli* infection has been complicated by the emergence of resistance to most first-line antimicrobial drugs [14]. Many cases of *E. coli* resistance to ampicillin have been found, so its use to overcome this bacterial infection needs to be reconsidered [13]. Complex compounds resulting from metal-based synthesis are designed by combining ligands to produce important biological activities. The resulting complex compound can increase efficiency and reduce the effects of poisons or side effects while lowering therapeutic doses and overcoming the mechanism of drug resistance. Additionally, the metal can act as a carrier and / or stabilizer of the drug until it is able to reach the target. At the same time, organic ligands with well-known biological activities can transport and protect metals, then avoid side reactions on the route to potential targets. The combined

effect of metal-ligands can produce a significant increase in the activity of the resulting coordination compounds [15, 16].

A research on the type of ligand and asymmetric complexes of tin(II) complex has been reported that the compound has a significant effect on the inhibition of *S. aureus* and *E. coli* [17]. Organotin (IV) 2-amino-5-nitrobenzoate compounds has also been known to have good activity as antibacterial compounds [18]. The diphenyltin (IV) di-3-chlorobenzoate and triphenyltin (IV) 3-chlorobenzoate have been reported to have strong activity against *Pseudomonas aeruginosa* and *Bacillus subtilis* [19]. The antibacterial activity of diphenyltin(IV) dibenzoate and triphenyltin(IV) benzoate compounds by the diffusion method against *B. substilis* and *P. aeruginosa* provides produced growth inhibition at a concentration of 200 ppm [20]. Based on the interesting results of antibacterial activity of some organotin(IV) compounds which have been reported by some researchers, the purpose of this study is to do *in vitro* bacterial activity for compounds of dibutyltin(IV) *o*-dichlorobenzoate, dibutyltin(IV) *m*-dichlorobenzoate and dibutyltin(IV) *p*-dichlorobenzoate against *S. aureus* and *E. coli*.

2. METHODS AND MATERIALS

2.1 Materials

All reagents used were AR grade. dibutyltin(IV) oxide [$(C_4H_9)_2SnO$], *o*-,*m*-, *m*-chlorobenzoic acid, sodium chloride (NaCl), Nutrient Agar (NA) were obtained from Sigma, methanol (CH_3OH) is product of JT Baker, and chloramphenicol were used as received without further purification. Gram positive bacteria *S. Aureus* was obtained from laboratory of PGI Cikini hospital, Jakarta, Gram negative bacteria E. coli was obtained from Integrated laboratory and inovation technology center, Universitas Lampung.

2.2 Instrumentations

IR spectra were recorded on a Bruker VERTEX 70 FT-IR spectrophotometer with KBr discs in the range of 4000-400 cm^{-1}. ^1H and ^{13}C NMR spectra were recorded on a Bruker AV 600 MHz NMR (600 MHz for ^1H and 150 MHz for ^{13}C). All experiments were run in DMSO-D_6 at 298K. The number of runs used for ^1H experiments were 32 with reference at DMSO signal at 2.5 ppm, while the ^{13}C were 1000-4000 scans with the reference DMSO signal at 39.5 ppm. The UV spectra were recorded in the UV region using a Shimadzu UV-245 Spectrophotometer. Measurements were performed in 1 mL quartz-cells. Solutions with concentration of $1.0x10^{-4}$M were prepared using methanol as a solvent. Elemental analyses (CHNS) were conducted on Fision EA 1108 series elemental analyser.

2.3 Preparation of Dibutyltin(IV) 2-, 3-, 4-Chlorobenzoate

The dibutyltin(IV) 2-, 3-, 4-chlorobenzoate compounds used in this work were prepared based on the procedures previously reported [19-27]. These procedures are adaptation from the work available in the literature [3]. The procedures as follows:

A mass of 3.44 g (0.01 mol) of dibutyltin(IV) oxide [$(C_4H_9)_2SnO$] (1) was disolved in 30 mL methanol, and 0.8 g (0.02 mol) 2-,3-, 4-chlorobenzoic acid in 20 mL methanol was added into solution. This reaction mixture was stirred for about 4 h. The product, dibutyltin(IV) dichlorobenzoate (2=ortho, 3=meta, 4=para) was precipitated out as white solid, filtered off and dried *in vacuo* for several days until completely dry. The yield was 2.33 g (94 %). The products were then characterized by microelemental analyzer and spectroscopies of UV, IR and ^1H and ^{13}C NMR.

Dibutyltin(IV) di-*o*-chlorobenzoate (2): yellow solid; UV-Vis $\lambda_{max.}$ (MeOH) nm (log ε): 238 and 278; IR $\nu_{max.}$ (KBr) cm^{-1}: 2925.97 (bu), 1595.96 (C=O), 1436.51 (CO_2 asym), 1053.30 (Sn-O-C), 748.04 (Sn-O), 420.10 (Sn-Bu);^1H-NMR (in DMSO-D_6, 600 MHz) δ (ppm): H_α. H_β = 1.56-1.67. H_γ = 1.30-1.35, H_δ = 0.84-0.97, H in benzoate = 7.31-7.75; ^{13}C-NMR (in DMSO-D_6, 150 MHz): δ (ppm): C in butyl, C_α = 21.32; C_β = 26.86; C_γ = 25.69; C_δ = 13.57; C in benzoate C_5 = 165.90; C_6 =133.09,C_7 = 131.35; $C_{8.9}$ = 130.76, C_{10} = 130.39; C_{11} = 127.03; microelemental analysis, found (calculated): C 48.52 (48.56), H 4.78 (4.83).

Dibutyltin(IV) di-*m*-chlorobenzoate (3): white yellowish solid; UV-Vis $\lambda_{max.}$ (MeOH) nm (log ε): 238 and 279; IR $\nu_{max.}$ (KBr) cm^{-1}: 2925.63 (bu), 1628.80 (C=O), 1421.59 (CO_2 asym), 1070.96 (Sn-O-C), 747.88 (Sn-O), 431.19 (Sn-Bu);^1H-NMR (in DMSO-D_6, 600 MHz) δ (ppm): H_α. H_β = 1.54-1.60, H_γ = 1.24-1.33, H_δ = 0.83-0.86, H in benzoate = 7.53-7.90; ^{13}C-NMR (in DMSO-D_6, 150 MHz): δ (ppm): C in butyl, C_α = 21.29; C_β = 26.78, C_γ = 25.56; C_δ = 13.57; C in benzoate C_5 = 164.62; C_6 = 133.00, $C_{7.8}$ = 130.76; $C_{9.11}$ = 128.94, C_{10} = 127.985; microelemental analysis, found (calculated): C 48.48 (48.56), H 4.68 (4.83).

Dibutyltin(IV) di-*p*-chlorobenzoate (4): white solid; UV-Vis $\lambda_{max.}$ (MeOH) nm (log ε): 240 and 278; IR $\nu_{max.}$ (KBr) cm^{-1}: 2925.37 (bu), 1609.25 (C=O), 1401.90 (CO_2 asym), 1084.84 (Sn-O-C), 771.96 (Sn-O), 477.29 (Sn-Bu); ^1H-NMR (in DMSO-D_6, 600 MHz) δ (ppm): H_α. H_β = 1.52-1.55, H_γ = 1.26-1.30, H_δ = 0.78-0.81, H in benzoate = 7.55-7.97; ^{13}C-NMR (in DMSO-D_6, 150 MHz): δ (ppm): C in butyl, C_α = 21.28; C_β = 26.79, C_γ = 25.54; C_δ = 13.52; C in benzoate C_5 = 163.89; C_6 = 131.35, $C_{7.11}$ = 131.27; $C_{8.10}$ = 128.51, C_9 = 127.92; microelemental analysis, found (calculated): C 48.54 (48.56), H 4.80 (4.83).

2.4 Antibacterial Activity Test by Diffusion Test

Nutrient agar (NA) has been used as the media for the antibacterial activity test. In 100 mL aquadest was dissolved 2.8 g of NA, heated and sterilized by autoclave at 121 °C, pressure of 1 atm for 15 minutes. 15 mL of steril media was placed on sterilized petri disc. The preparation of the media was conducted at laminar air flow, and left the media to solidify.

The diffusion test method was performed based on the procedure available in the literature [19, 20, 28-30] and as follows: one ose of *S. aureus* and *E. coli* was diluted with 2 mL of salin solution (NaCl 0.85%) and was used as bacteria suspension. 1 mL of the suspension was then innoculated on NA, flattened with spreader. 4 paper discs were prepared. The first paper disc was for the positive control (chloramphenicol), the second was for negative control containing the methanol, solvent used for the test, the third and fourth paper discs containing the organotin(IV) compounds tested. All paper discs were then placed on the surface of media.They were then incubated for 1 day at 37°C and were monitored to see the inhibition zone. The compounds giving the most effective inhibition was then chosen for the dilution method.

2.5 Antibacterial Activity Test with Dilution Test

The most effective concentration inhibition zones obtained for all dibutyltin(IV) dichlorobenzoate (**2-4**) compounds tested with diffusion test, then were tested with dilution test. They were dissolved with methanol and the volumes were varied for dilution test based on the procedure described by other [19, 20, 28-30]. The compounds tested with certain volume were then placed to liquid NA media, homogenized with vortex and then pour to petri disc, left them until solidified. The bacteria suspensionsof *S. aureus* and *E. coli* were then innoculated on the media at temperature of 37°C for 2-3 days. The growth of bacteria was then monitored every day. The volume of the compound tested was varied into 0.5; 1.0; 1.5; 2.0 and 2.5 mL where each of them was mixed with 15 mL of liquid NA media, homoginezed with shaker. The most effective compounds tested were a compound which was the compound with the smallest concentration but the inhibition zone was the biggest [28-30].

3. RESULTS AND DISCUSSIONS

3.1 Synthesis Anda Characterization of the Compounds

The results of microelemental analysis of all compounds synthesized are all in good agreement with the calculated values where the value differences are less than 1%, indicated that the synthesized compound 2 to 4 have been formed as expected. The analysis with IR spectroscopy has also been taken to all compounds. Based on the spectra recorded, compound 1 is characterized by the presence of stretch of Sn-O at 666.76 cm^{-1}. Upon reaction of 1 with the ligands (*o*-benzoicd acid, *m*-benzoicd acid and *p*-benzoicd acid), the strecthes of Sn-O from compounds 2 - 4 were still observed, but has been shifted to higher wave numbers, i.e. at 748.04; 747.88; and 771.96 cm^{-1}, moreover in compounds 2 - 4 are now present the Sn-O-C vibration at 1053.30; 1070.96; and 1084.84 cm^{-1}, respectively. The presence of C=O strectch at 1595.96; 1628.80; and 1609.25 cm^{-1} for these three compounds indicating that the carbonyl group is now present in the compounds 2 - 4. The data observed were in agrrement with the data obtained in the literatures [20-27]. The data of λ_{max} in the UV analysis for the reported compound 2-4 were also obtanied and it is clear that there was important shifting in the λ_{max} for each synthesized compound. For example in compounds 1, the λ_{max} observed was 204 nm. An example in 2 , there were large shift in both $\pi \rightarrow \pi^*$ and n-л* transitions, due to the replacement of oxygen by 2-chlorobenzoate making the λ_{max} were observed at 238 and 263 nm. In general, the chlorobenzoates ligand are strong chromophore group due to the presence of –C=O- and –C=C- bonds. The large shifts observed in 2, 3 and 4 were due to the increase of conjugate bond in these compounds, leading to decreased energy difference between HOMO and LUMO, and increased λ_{max} [18-24, 31].

The characteristic chemical shifts of the spectra for the compounds were characterized carefully and compared to some previous results [20-27, 32]. Based on the data of ^{1}H NMR spectra for compound 2-4, the chemical shifts of butyl protons attached to tin metal appeared in the range of 1.26 - 1.60 ppm, and the protons in benzoate ring appeared at 7.31-7.90 ppm. The ^{13}C NMR spectra of these compounds are very similar to the results obtained previously [22, 23, 32]. The carbon in the carboxyl group for all compounds appeared in the chemical shiftt region of 163.9-165.9 ppm. The δ of carbons in the butyl ligand of 2-4 are tin the range of 13.5-26.79 ppm, and the carbons in the benzoate are in δ range of 127 – 133 ppm [22, 23, 32].

3.2 Antibacterial Test of Compounds 2-4

The results of antibacterial test of dibutyltin(IV) di-*o*-, *m*-, *p*-chlorobenzoate (2-4) compounds by diffusion methods against *S. aureus* and *E. coli* bacteria are shown in Table-1.

Table-1. Average inhibition Zone (mm).

No	Materials	Inhibition Zone (mm)									
		S. aureus					*E. coli*				
		concentration (ppm)					concentration (ppm)				
		100	200	300	400	800	100	200	300	400	800
1	**1**	0	0	0	0	0	0	0	0	0	0
2	**2**	0	5.8	5.8	7.17	11.53	0	0	9.67	9.4	12.4
3	**3**	7.1	8.16	11.7	15.45	18.23	9.5	9.5	10.5	13.5	16.7
4	**4**	8	8.8	10.7	13.07	14.3	0	0	0	0	0
C+	K(+)	31	32.7	34.3	36.2	36.8	21.8	26.3	32.1	34.4	36.2
C-	K(-)	0	0	0	0	0	0	0	0	0	0

The dibutyltin(IV) oxide (1) compound did not show any inhibition against both bacteria *S. aureus* and *E coli*, indicating that compound 1 did not have antibacterial activity. Of dibutyltin(IV) dichlorobenzoate (2, 3 and 4) derivative compounds, dibutyltin(IV) di-*m*-chlorobenzoate (3) has shown to have the largest inhibition zone. Compound 3 was not only giving the largest inhibition zone againts *S. aureus*, but this compound also gave inhibition to *E. coli*, although the inhibition observed was still smaller compared to the inhibition zone of the positive control used, chloramphenicol. When the higher concentration of compounds applied in the bacterial activity test (the concentration was up to 800 ppm) the bigger inhibition zone observed (i.e. the diameter of inhibition zone was > 16 mm).

Table-2. The effectiveness of the compounds against *S.aureus*.

Concentration (ppm)	2	3	4
100	0	0.0071	0.0080
200	0.0029	0.0041	0.0044
300	0.0019	0.0039	0.0036
400	0.0018	0.0039	0.0033
800	0.0014	0.0023	0.0019

Table-3. The effectiveness of the compounds against *E. coli.*

Concentration (ppm)	2	3
100	0	0.0095
200	0	0.0046
300	0.0032	0.0035
400	0.0024	0.0034
800	0.0016	0.0021

The dilution method has been used to determine the minimum inhibitory concentration (MIC). Based on Table-4, dibutyltin(IV) di-*o*-chlorobenzoate (2) compound has a minimum inhibitory concentration (MIC) of 100 ppm against *S. aures* and *E. coli*, dibutyltin(IV) di-*m*-chlorobenzoate (3) 45 ppm against *S. aures* and *E. coli*, dibutyltin(IV) di-*p*-chlorobenzoate (4) 60 ppm against *S. aureus*.

Table-4. Minimum inhibitory concentration of compounds tested.

No	Materials	Concentration (ppm)								Bacteria
1	2	60	70	80	90	100	110	120	130	*S.aures*
		+++++	++++	+++	++	+	-	-	-	
2	2	70	80	90	100	150	200	250	300	*E.coli*
		+++++	++++	+++	+++	++	+	-	-	
3	3	30	35	40	45	55	60	70	80	*S.aures*
		+++	++	-	-	-	-	-	-	
4	3	30	35	40	45	55	60	70	80	*E.coli*
		+++	++	-	-	-	-			
5	4	60	70	80	90	100	110	120	130	*S.aureus*
		+++++	++++	+++	++	-	-	-	-	

Note of bacterial growth:
+++++ = Very high
++++ = high
+++ = medium
++ = little
\+ = very little
\- = no growth

The differences in antibacterial activity for the same compound against *S. aures* and *E. coli* were because of the structure and composition of the cells of the two different bacteria [30, 33]. The different in the structure of the compound can also produce a different result in the antibacterial activities [19, 20]

4. CONCLUSIONS

The organotin(IV) compounds which have been prepared i.e. dibutyltin(IV) di-*o*-chlorobenzoate (2), dibutyltin(IV) di-*m*-chlorobenzoate (3), dibutyltin(IV) di-*p*-chlorobenzoate (4) have shown to have antibacterial activity against *S. aureus* and *E. coli* where compound 3 has been the strongest compared to the other series. Based on the finding of this work, we believe that these compounds will be available for future applications as antibacterial drug. However we still aim to have better and stronger antibacterial drug.

ACKNOWLEDGMENT

The authors are grateful to Institute of Research and Community Services, Universitas Lampung and Directorate of Research and Community Services, The Ministry of Research, Technology and Higher Education, Indonesia that provided fund for this project to be undertaken through Penelitian Disertasi Doktor (Doctoral Research Grant Scheme) 2020.

REFERENCES

[1] Patra M., Gasser G., Metzler-Nolte N. 2012. Small Organometallic Compounds as Antibacterial Agents. Dalton Transactions. 41: 6350-6358.

[2] Chohan Z. H. 2009. Synthesis of organometallic-based biologically active compounds: In vitro antibacterial, antifungal and cytotoxic properties of some sulfonamide incorporated ferrocences. J Enzyme Inhib Med Chem. 24(1): 169-175.

[3] Laxminarayan R., A. Duse, C. Wattal, A. K. Zaidi and H. F. Wertheim. 2013. Antibiotic resistance-the need for global solutions. Lancet Infect Dis. 13: 1057-1098.

[4] Rodríguez-Rojas, A., J. Rodríguez-Beltrán, Couce A., Blázquez J. 2013. Antibiotics and antibiotic resistance: a bitter fight against evolution. Int. J Med Microbiol. 303: 293-297.

[5] Fischbach M. A., Walsh T. 2009. Antibiotics for Emerging Pathogens. Science. 325(5944): 1089-1093.

[6] Bernardo W. L. C., Boriollo M. F., Goncalves R. B., Holing J. F. 2005. *Staphylococcus aureus* Ampicillin-Resistant from the Odontological Clinic Environment. Rev Inst Med Trop S. Paulo. 47(1): 19-24.

[7] Moran G. J., Talan D. A. 2003. Update on Emerging Infections: News From the Centers for Disease Control and Prevention. Syndromic surveillance for bioterrorism following the attacks on the World Trade Center-New York City, 2001. Ann Emerg Med. 41(3): 414-418.

[8] Huttner A., Harbarth S., Carlet J., Cosgrove S., Goossens H., Holmes A. 2013. Antimicrobial resistance: a Global View from the 2013 World Healthcare Associated Infections Forum. Antimicrob Resist Infect Control. 2: 31.

[9] Appelbaum P. C. 2007. Microbiology resistance in Staphylococcus aureus. CID Supplement. 3, 45, S166 - S170.

[10] DeLeo F. R., Chambers H. F. 2009. Reemergence of antibiotic-resistant Staphylococcus aureus in the genomics area. J Clin Invest. 119(9): 2464- 2474.

[11] Shituu A. O., Okon K., Adesida S., Oyedara O., Witte W., Strommrnenger B., Layer F., Nubel U. 2011. Antibiotic Resistance and Molecular Epidemiology of Staphylococcus aureus in Nigeria. BMC Microbiol. 11: 92.

[12] Friedman N. D., Kaye K. S., Stout J. E., McGarry S. A., Trivette S. L., Briggs J. P. 2002. Health care-associated bloodstream infections in adults: a reason to change the accepted definition of community-acquired infections. Ann Intern Med. 137(10):791-797.

[13] Niranjan V., Malini A. 2014. Antimicrobial resistance pattern in Escherichia coli causing urinary tract infection among inpatients. Indian J Med Research. 139(6): 945-948.

[14] Sabate M., Prats G., Moreno E., Ballesté E., Blanch A. R., Andreu A. 2008. Virulence and antimicrobial resistance profiles among Escherichia coli strains isolated from human and animal wastewater. Res Microbiol. 159: 288-93.

[15] Pellerito L., Nagy L. 2002. Organotin $(IV)^{n+}$ Complexes Formed with Biologically Active Ligands: Equilibrium and Structural Studies and Some Biological Aspect. Coord Chem Rev. 224(1-2): 111-150.

[16] Roy S., Hagen K. D., Maheswari P. U. 2008. Phenanthroline derivatives with improved selectivity as DNA-targeting anticancer or antimicrobial drugs. Chem Med Chem. 3(9): 1427-1434.

[17] Sharma K., Agarwal S., Gupta S. 2013. Antifungal, Antibacterial and Antifertility Activities of Biologically Active Macrocyclic Complexes of Tin(II). Int J ChemTech Res. 5(1): 456-463.

[18] Win Y-F, Teoh S. G., Vikneswaran M. R., Ha S. T., Ibrahim P. 2010. Synthesis and characterization of organotin(IV) complexe derived of 4(dethylamino) benzoic acid: in vitro antibacterial screening activity. Int J Phys Sci. 5(8): 1263-1269.

[19] Annissa, Suhartati T., Yandri, Hadi S. 2017. Antibacterial Activity of Diphenyltin (IV) and Triphenyltin (IV) 3-Chlorobenzoate againts *Pseudomonas aeruginosa and Bacillus subtilis.* Orient. J. Chem. 33(3): 1133-1139.

[20] Hadi S., Hermawati E., Noviany, Suhartati T., Yandri. 2018. Antibacterial Activity Test Of Diphenyltin IV) Dibenzoate and Triphenyltin (IV) Benzoate Compounds against Bacillus Substilis and Pseudomonas Aeruginosa. Asian J Microbiol Biotech Env Sci. 20(1): 113-119.

[21] Hadi S., Rilyanti M. 2010. Synthesis and in vitro anticancer activity of some organotin(IV) benzoate compounds. Orient J Chem. 26(3): 775-779.

[22] Hadi S., Rilyanti M., Suharso. 2012. In Vitro Activity and Comparative Studies of Some Organotin (IV) Benzoate Derivatives Against Leukemia Cancer Cell: L-1210. Indo J Chem, 12(2): 172-177. https://doi.org/10.22146/ijc.21359

[23] Hadi S., Afriyani H., Anggraini W. D., Qudus H. I., Suhartati T. 2015. The Synthesis and Potency Study of Some Dibutyltin (IV) Dinitrobenzoate Compounds as Corrosion Inhibitor for Mild Steel HRP in DMSO-HCl Solution. Asian J Chem. 27(4): 1509-1512.

[24] Kurniasiah H., Nurissalam M., Iswantoro B., Afriyani H., Qudus H. I., Hadi S. 2015. The Synthesis, Characterization and Comparative Anticorrosion Study of Some Organotin (IV) 4-Chlorobenzoates. Orient J Chem. 31(4): 2377-2383.

[25] Hadi S., Noviany, Rilyanti M. 2018. In Vitro Antimalarial Activity of Some Organotin (IV) 2-Nitrobenzoate Compounds Against Plasmodium falciparum. Macedon J Chem Chem Eng. 37(2): 185-191.

[26] Hadi S., Noviany, Qudus H. I., Wattana-Amorn P. 2019 The Potency Study of Organotin (IV) 3-Nitrobenzoate Compounds as Antimalarial Agents. J Phys: Conf Ser. 1338: 012012.

[27] Hadi S., Fenska M. D., Wijaya R. A., Noviany, Suhartati S. 2020. Antimalarial Activity of Some

Organotin (IV) Chlorobenzoate Compounds against *Plasmodium falciparum*. Mediterr J Chem. 10(3): 213-219.

[28] Samsuar S., Simanjuntak W., Qudus HI., Yandri Y., Herasari H., Hadi S. 2021. In Vitro Antimicrobial Activity Study of Some Organotin(IV) Chlorobenzoates against *Staphylococcus aureus* and *Escherichia coli*. J Adv Pharm Edu Res. 11(2): 17-22.

[29] Hadi S., Lestari S., Suhartati S., Qudus HI., Rilyanti M., Herasari D., Yandri Y. 2021. Synthesis and comparative study on the antibacterial activity organotin (IV) 3-hydroxybenzoate compounds. Pure Appl Chem. 93: 623-628.

[30] Lorian V. 1980. Antibiotics in Laboratory Medical. Wiliam and Wilkins Co., Baltimore. London. pp. 1-22, 170-178, 511-512.

[31] Sudjadi. 1985. The Structure Determination of Organic Compounds. Ghalia Publishers, Jakarta,. pp. 45-51. (In Indonesian).

[32] Hadi S, Appleton TG, Ayoko GA. 2003. Reactions of *fac*-$[PtMe_2(OMe)(H_2O)_3]^+$ with halide ions: effect of halide trans effect on methoxide hydrolysis. Inorg. Chim. Acta, 352, 201-207.

[33] Prescott L. M., Harley J. P., Klein D. A. 2002. Microbiology. 5th Ed. Boston: McGraw-Hill.

20% Overall Similarity

Top sources found in the following databases:

- 17% Internet database
- Crossref database
- 6% Submitted Works database
- 11% Publications database
- Crossref Posted Content database

TOP SOURCES

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	orientjchem.org Internet	7%
2	mafiadoc.com Internet	2%
3	japer.in Internet	2%
4	Samsuar, Wasinton Simanjuntak, Hardoko Insan Qudus, Sutopo Hadi. "... Crossref	2%
5	Sutopo Hadi, Tati Suhartati, Noviany Noviany, Kamisah D. Pandiangan, ... Crossref	1%
6	ncbi.nlm.nih.gov Internet	1%
7	medjchem.com Internet	1%
8	pasca.unila.ac.id Internet	<1%

9	hindawi.com Internet	<1%
10	e-journals.in Internet	<1%
11	123dok.com Internet	<1%
12	mjcce.org.mk Internet	<1%
13	Safia Arbab, Hanif Ullah, Weiwei Wang, Jiyu Zhang. " Antimicrobial dru... Crossref	<1%
14	Sutopo Hadi, Noviany, Hardoko Insan Qudus, Pakorn Wattana-Amorn. ... Crossref	<1%
15	zora.uzh.ch Internet	<1%

Excluded from Similarity Report

- Bibliographic material
- Cited material
- Manually excluded sources
- Quoted material
- Small Matches (Less then 10 words)
- Manually excluded text blocks

EXCLUDED SOURCES

arpnjournals.org Internet	69%
arpnjournals.org Internet	67%
repository.lppm.unila.ac.id Internet	29%
degruyter.com Internet	18%
Sutopo Hadi, Sri Lestari, Tati Suhartati, Hardoko Insan Qudus, Mita Rilyanti, Di... Crossref	17%
University of Ioannina on 2021-05-29 Submitted works	13%
S Hadi, B Irawan, Yandri, T Suhartati. "Synthesis, characterization and the anti... Crossref	8%
repository.stikeskepanjen-pemkabmalang.ac.id:8080 Internet	8%
ijsei.com Internet	7%

arpnjournals.com

Internet

7%

EXCLUDED TEXT BLOCKS

VOL. 16, NO

School of Business and Management ITB on 2022-04-29

IN VITRO ANTIBACTERIAL ACTIVITY OF SOME OF DIBUTYLTIN (IV)CHLOROBENZ...

www.degruyter.com

NMR (in DMSO-D6, 150MHz): ? (ppm): C in butyl, Cα

S Hadi, B Irawan, Yandri, T Suhartati. "Synthesis, characterization and the antifungal activity test of some or...