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# DAFTAR PUSTAKA

Adamson, A.W., 1990, Physical Chemistry of Surface, John Wiley dan Sons, Inc., New York.

Adawiah, S.R., Sutarno, S., dan Suyanta, S., 2020, Studi Adsorpsi-Desorpsi Anion Fosfat Pada Bentonit Termodifikasi CTAB, *Indo. J. Chem. Res.*, 8, 125–136.

Akhtar, M.S., Ali, S., dan Zaman, W., 2024, Innovative Adsorbents for Pollutant Removal: Exploring the Latest Research dan Applications, *Molecules*, 29, 1–37.

Alfanaar, R., Yuniati, Y., dan Rismiarti, Z., 2017, Studi Kinetika dan Isoterm Adsorpsi Besi(III) pada Zeolit Alam dengan Bantuan Gelombang Sonikasi, *EduChemia (Jurnal Kimia dan Pendidikan)*, 2, 63–72.

Ali, Shafqat, Zuhra, Z., Ali, Sajjad, Han, Q., Ahmad, M., dan Wang, Z., 2021, Ultra-deep removal of Pb by functionality tuned UiO-66 framework: A combined experimental, theoretical dan HSAB approach, *Chemosphere*, 284, 1–11.

Al-Qodah, Z., Dweiri, R., Khader, M., Al-Sabbagh, S., Al-Shannag, M., Qasrawi, S., dan Al-Halawani, M., 2023, Processing dan characterization of magnetic composites of activated carbon, fly ash, dan beach sand as adsorbents for Cr(VI) removal, *Case Studies in Chemical dan Environmental Engineering*, 7, 1–11.

Ananda, A. dan Aini, S., 2021, Rapid synthesis of well-ordered mesoporous silica from sodium silicate, *Chemistry Journal of Universitas Negeri Padang*, 10, 37–39.

Anisara, R., Wardhani, G.A.P.K., dan Taufiq, A., 2024, Silica Gel from Bagasse Ash for Methylene Blue Adsorption, *Jurnal Sains Natural*, 14, 142–153.

Astuti, M.D., Nurmasari, R., Rasy Mujiyanti, D., Yani Km, J.A., dan Selatan, K., 2012, Imobilisasi 1,8-Dihidroxyanthraquinon pada Silika Gel melalui Proses Sol-Gel, *Nurmasari, Mujiyanti) IMOBILISASI*, 6, 25–34.

Ayawei, N., Ebelegi, A.N., dan Wankasi, D., 2017, Modelling dan Interpretation of Adsorption Isotherms, *J. Chem.*, 2017, 1–11.

Azis, Y., Ida Zahrina, Mutamima, A., Alfarisi, C.D., dan Nurfatihayati, 2024, Sintesis Natrium Silikat Menggunakan Silika dari Pasir Pantai Bengkalis, *Jurnal Riset Kimia*, 15, 39–47.

Barman, M.K., 2025, Recent Advancements of Silica Supported Hybrid Composite Materials dan Its Application for Heavy dan Toxic Metal Ion Removal: A Review, *Geomicrobiol. J.*, 43, 387–409.

Bozecka, A., Bozecki, P., dan Sanak-Rydlewska, S., 2016, Removal of Pb(ii) dan Cd(ii) ions from aqueous solutions with selected organic wastes, *Physicochemical Problems of Mineral Processing*, 52, 380–396.

UNIVERSITAS GADJAH MADA
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Cahyani, A. dan Purwanto, P., 2025, Sustainable Industrial Approaches: Utilizing Organic Acid for Purity Enhancement in Green Silica Production, *Engineering Proceedings*, 84, 1-10.

Chaerunnisa, R. dan Supardi, 2021, Persentase Penurunan Kadar Logam Berat Timbal pada Kerang Hijau (Perna Viridis) Pasca Proses Depurasi oleh Nelayan Teluk Jakarta, *EduBiologia*, 1, 121–127.

Christensen, J.M., 2026, The theoretical basis for the Freundlich adsorption isotherm, *Surf. Sci.*, 774, 123025.

Ciobanu, R., Bucatariu, F., Mihai, M., dan Teodosiu, C., 2024, Silica-Based Composite Sorbents for Heavy Metal Ions Removal from Aqueous Solutions, *Polymers (Basel).*, 16, 1–13.

Di, J., Ruan, Z., Zhang, S., Dong, Y., Fu, S., Li, H., dan Jiang, G., 2022, Adsorption behaviors dan mechanisms of $Cu^{2+}$, $Zn^{2+}$ dan $Pb^{2+}$ by magnetically modified lignite, *Sci. Rep.*, 12, 1394.

Fitriana, D., Mudasir, M., dan Siswanta, D., 2025, The Modification of Coal Fly Ash Adsorbent Using Dithizone Immobilization for Cd(II) Ions Removal, *Jurnal Kimia Sains dan Aplikasi*, 28, 215–224.

Fitriani, Kurniati, T., dan Hambali, 2017, Penyerapan Ion Logam Pb(II) Dari Larutan Menggunakan Serbuk Daun Puring (Codiaeum Variegatum),8, 34–42.

Furozi, N., Fajriati, I., Artsanti, P., dan Krisdiyanto, D., 2020, Adsorpsi Zat Warna Rhodamin B dan Congo Red dengan Silika Gel dari Limbah Ampas Tebu (Saccharum officinarum), *Indonesian Journal of Materials Chemistry IJMC*, 2, 53–59.

Gracia, A.N., Rihaadatul 'aisy, M.K., Rafifah, S., dan Utami, Z.K., 2021, Pemurnian Besi dari Pasir Besi Hitam dari Pantai Glagah Indah di Kulon Progo, *Eksergi*, 1-45.

Hemra, K., Kobayashi, T., Aungkavattana, P., dan Jiemsirilers, S., 2021, Enhanced mechanical dan thermal properties of fly ash-based geopolymer composites by wollastonite reinforcement, *Journal of Metals, Materials dan Minerals*, 31, 13–25.

Huda, B.N., Wahyuni, E.T., dan Mudasir, M., 2021, Eco-friendly immobilization of dithizone on coal bottom ash for the adsorption of lead(II) ion from water, *Results in Engineering*, 10, 1–12.

Huda, B.N., Wahyuni, E.T., dan Mudasir, M., 2022, Greener Procedure of Dithizone Immobilization on Coal Bottom Ash for Heavy Metal Adsorbent: Synthesis Optimization dan Characterization, *Key Eng. Mater.*, 927, 3–10.

Huda, B.N., Wahyuni, E.T., dan Mudasir, M., 2023, Simultaneous adsorption of Pb(II) dan Cd(II) in the presence of Mg(II) ion using eco-friendly immobilized dithizone on coal bottom ash, *S. Afr. J. Chem. Eng.*, 45, 315–327.

UNIVERSITAS GADJAH MADA
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Kaim, W., dan Schwederski, B., 2013, *Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life: An Introduction dan Guide*, John Wiley & Sons Inc, Chichester.

Idzati, N.R., Susatyo, E.B., dan Kusumastuti, E., 2017, Indonesian Journal of Chemical Science Penurunan Kadar Ion $Cd^{2+}$ dalam Larutan dengan Kitosan Imobilisasi Ditizon, *Indo. J. Chem. Sci*, 6, 156–160.

Ishmah, S.N., Permana, M.D., Firdaus, M.L., dan Eddy, D.R., 2020, Extraction of Silica from Bengkulu Beach Sand using Alkali Fusion Method, *PENDIPA Journal of Science Education*, 4, 1–5.

Jagirani, M.S., Zhang, T., dan Soylak, M., 2025, Current development in extraction methods using next-generation sustainable adsorbent materials: A comprehensive review, *Microchemical Journal*, 219, 115884.

Kaebeka, M., Koly, F.V.L., dan Tellu, N.M., 2020, karbeka 2020 pasir besi dari gunung sumbernya, *Lantanida Journal*, 8, 96–188.

Kajjumba, G.W., Emik, S., Öngen, A., Kurtulus Özcan, H., dan Aydın, S., 2019, *Modelling of Adsorption Kinetic Processes—Errors, Theory dan Application*, London, UK: IntechOpen.

Karbeka, 2024, Kinetika Adsorpsi Pb (II) Oleh Adsorben Pasir Teraktivasi NaOH Dengan Variasi Konsentrasi, *Lantanida Journal*, 12(1), 16-28.

Kazemnejadi, M., 2025, Heavy metal (Pb, Ni, Cd) elimination from water dan wastewater using an antibacterial modified cellulose filter paper as an efficient filtration membrane technology: A portable filtration with high selectivity, *Results Chem.*, 13, 1–14.

Khalifa, M., Touil, M., Hammadi, K., Haddadi, I., Attyaoui, A., Meftah, N., Mannai, F., Aouida, S., dan Ezzaouia, H., 2025, High-Purity Silica Produced from Sand Using a Novel Method Combining Acid Leaching dan Thermal Processing, *Arab. J. Sci. Eng.*, 50, 4129–4135.

Khan, A.S., Khalid, H., Sarfraz, Z., Khan, M., Iqbal, J., Muhammad, N., Fareed, M.A., dan Rehman, I.U., 2017, Vibrational spectroscopy of selective dental restorative materials, *Appl. Spectrosc. Rev.*, 52, 507–540.

Kumar, A., Kumar, A., Cabral-Pinto, M., Chaturvedi, A.K., Shabnam, A.A., Subrahmanyam, G., Mondal, R., Gupta, D.K., Malyan, S.K., Kumar, S.S., Khan, S.A., dan Yadav, K.K., 2020, Lead toxicity: Health hazards, influence on food Chain, dan sustainable remediation approaches, *Int. J. Environ. Res. Public Health*, 17, 1–33.

Kusmiati, A.R. dan Nurhayati, 2020, Pemanfaatan Kitosan Dari Cangkang Udang sebagai Adsorben Logam Berat Pb pada Limbah Praktikum Kimia Farmasi, *Indonesian Journal of Laboratory*, 3, 6–14.

Kusumaningrum, D.I.P., Sudarni, D.H.A., dan Wahyuningsih, S., 2022, Optimasi Pengaruh Waktu Kontak dan Dosis Adsorben Limbah Daun Kayu Putih

UNIVERSITAS
GADJAH MADA
**Imobilisasi Ditizon pada Silika Gel Berbahan Dasar Pasir Pantai Parangkusumo dan Aplikasinya untuk
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(Melaleuca cajuputi) dengan Metode Isoterm Adsorpsi Langmuir, *Jurnal Teknik Kimia USU*, 11, 72–79.

Maslahat, M., Taufiq, A., dan Wahyu Subagja Jurusan Kimia FMIPA Universitas Nusa Bangsa, P., 2015, Pemanfaatan Limbah Cangkang Telur sebagai Biosorben untuk Adsorpsi Logam Pb dan Cd, *Jurnal Sains Natural Universitas Nusa Bangsa*, 5, 92–100.

Meftah, N. dan Mahboub, M.S., 2019, Spectroscopic Characterizations of Sand Dunes Minerals of El-Oued (Northeast Algerian Sahara) by FTIR, XRF dan XRD Analyses, *Silicon*, 12, 147–153.

Meldha, Z., Amri, I., Dandy Tito Angkoso, M., Jumaga, Y., dan Drastinawati, 2023, The utilization of silica sand dan clay with the addition of sawdust as raw material for manufacturing ceramic membranes to reduce TSS dan TDS levels of peat water, *Mater. Today Proc.*, 87, 415–419.

Mudasir, M., Baskara, R.A., Suratman, A., Yunita, K.S., Perdana, R., dan Puspitasari, W., 2020, Simultaneous Adsorption of Zn(II) dan Hg(II) Ions on Selective Adsorbent of Dithizone-Immobilized Bentonite in the Presence of Mg(II) Ion, *J. Environ. Chem. Eng.*, 8, 1–9.

Munasir, Sulton, A., Triwikantoro, Zainuri, M., dan Darminto, 2013, Synthesis of silica nanopowder produced from Indonesian natural sand via alkalifussion route,. In, *AIP Conference Proceedings*., pp. 28–31.

Munasir, Triwikantoro, Zainuri, M., dan Darminto, 2015, Synthesis of $SiO_2$ nanopowders containing quartz dan cristobalite phases from silica sands, *Materials Science- Poland*, 33, 47–55.

Musah, M., Azeh, Y., Mathew, J., Umar, M., Abdulhamid, Z., dan Muhammad, A., 2022, Adsorption Kinetics dan Isotherm Models: A Review, *Caliphate Journal of Science dan Technology*, 4, 20–26.

Nafi'ah, R., 2016, Kinetika Adsorpsi Pb(II) Dengan Adsorben Arang Aktif Dari Sabut Siwalan, *Jurnal Farmasi Sains dan Praktis*, I, 28–37.

Naheed, S., Amir, T., Syed, S., Ahmad, F., Ahmad, Z., dan Nawaz, F., 2023, Sorption of Ni(II) by sol-gel silica functionalized with DMG dan other chelating agents, *J. Dispers. Sci. Technol.*, 45, 48–57.

Nazerdeylami, S. dan Zare-Dorabei, R., 2019, Simultaneous adsorption of $Hg^{2+}$, $Cd^{2+}$ dan $Cu^{2+}$ ions from aqueous solution with mesoporous silica/DZ dan conditions optimise with experimental design: Kinetic dan isothermal studies, *Micro Nano Lett.*, 14, 823–827.

Nitsae, M., Solle, H.R.L., Martinus, S.M., dan Emola, I.J., 2021, Studi Adsorpsi Metilen Biru Menggunakan Arang Aktif Tempurung Lontar (Borassus flabellifer L.) Asal Nusa Tenggara Timur, *Jurnal Kimia Riset*, 6, 46–57.

Nopianingsih, N.N.S., Sudiarta, I.W., dan Wahyu, D.S., 2015, Sintesis Silika Gel Terimobilisasi Difenilkarbazon dari Abu Sekam Padi melalui Teknik Sol Gel, *JURNAL KIMIA*, 9, 226–234.

UNIVERSITAS GADJAH MADA
**Imobilisasi Ditizon pada Silika Gel Berbahan Dasar Pasir Pantai Parangkusumo dan Aplikasinya untuk Adsorpsi Ion Pb(II)**
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Noviadi, Y. dan Setiady, D.D., 2020, Sedimentasi Pasir Sepanjang Pantai Kulon Progo, Daerah Istimewa Yogyakarta, *Jurnal Geologi Kelautan*, 18, 63–72.

Ntoi, L.L.A., 2016, Multiple Chromisms Associated with Dithizone, *Doctoral dissertation*, University of the Free State.

Nurbaiti, U., Arofah, S.K., dan Khumaedi, 2019, Karakterisasi serbuk forsterit produk sintesis metode ultrasonik berbahan baku silika dari pasir Parang Kusumo Info Artikel, *Jurnal Fisika*, 9, 80–85.

Nurianingsih, R., Sriatun, S., dan Darmawan, A., 2019, Polyaniline Modified Natural Zeolite as Adsorbent for Chromium(III) Metal Ion, *Jurnal Kimia Sains dan Aplikasi*, 22, 292–298.

Oktasari, A., 2018, Kulit Kacang Tanah (Arachis hypogaea L.) sebagai Adsorben Ion Pb(II), *ALKIMIA : Jurnal Ilmu Kimia dan Terapan*, 2, 17–27.

Oscik, J., 1982, Adsorption, John Wiley & Sons Inc, Chichester.

Owoeye, S.S., Abegunde, S.M., dan Oji, B., 2021, A novel low temperature synthesis of sodium silicate (water glass) from silica-rich wastes using hydrothermal method, *Global Journal of Engineering dan Technology Advances*, 6, 66–75.

Perdana, R., Ikhsan Sukaria, M., dan Irfandi, R., 2024, Studi Adsorpsi Hg(II) dan Ca(II) oleh Zeolit Alami yang Diimobilisasi Ditizon, *Jurnal Scedule*, 4, 1–9.

Pramudya, N.S., Hasan, A., dan Junaidi, R., 2024, Kinetika Pembentukan Silika Gel dari Bottom Ash Sebagai Adsorben, *Journal Of Social Science Research*, 4, 16309–16331.

Prasojo, W.A. dan Muljani, S., 2024, Kajian Adsorpsi Logam CU Dengan Adsorben Silika Gel, *Algoritma : Jurnal Matematika, Ilmu pengetahuan Alam, Kebumian dan Angkasa*, 2, 115–125.

Ramalah, D., Rohaeti, E., Fulazzaky, M.A., dan Saprudin, D., 2025, Mechanisms dan mass transfer kinetics of Pb(II) adsorption onto rice husk charcoal silica gel, *J. Taiwan Inst. Chem. Eng.*, 167, 105833.

Rettob. Abraham Laurens dan Karbeka, M., 2019, Pengaruh Konsentrasi Larutan HF pada Proses Preparasi terhadap Kadar Unsur Bahan Magnetik Pasir Besi, *Walisongo Journal of Chemistry*, 2, 6–9.

Rettob, A.L., Suyanta, S., dan Nuryono, N., 2025, rettob, *Inorg. Chem. Commun.*, 174, 113954.

Rodrigues Mota, T.L., Marques de Oliveira, A.P., Nunes, E.H.M., dan Houmard, M., 2017, Simple process for preparing mesoporous sol-gel silica adsorbents with high water adsorption capacities, *Microporous dan Mesoporous Materials*, 253, 177–182.

Rosita, Y., Yuliansyah, A.T., dan Cahyono, R.B., 2022, The Kinetic Study of Methylene Blue Adsorption Using the Red Fruit (*Pandanus conoideus*) Waste Biochar, *Konversi*, 11, 19–25.

UNIVERSITAS GADJAH MADA
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**Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/**



Saed, S.A. dan AL-Mammar, D.E., 2021, Influence of acid activation of a mixture of illite, koalinite, dan chlorite clays on the adsorption of methyl violet 6B dye, *Iraqi Journal of Science*, 62, 1761–1778.

Salamah, S. dan Suhendra, S., 2022, Effective Treatment of Industrial Wastewater Contaminated with Mn dan Pb using Mesoporous Silica from Yogyakarta Beach, *Chemica: Jurnal Teknik Kimia*, 8, 80–87.

Sarkar, R., Roy, D., Mondal, S., Malik, S., Sarkar, A., Saha, S., Mishra, S., Chatterjee, M., dan Mandal, B., 2019, Dithizone enriched silica gel surface, {SiO 2 }@DZ obtained in a single step for selective sample clean up of Cd(II) from its congeners employing ion pair, *J. Environ. Chem. Eng.*, 7, 102864.

Setyorini, D., Arninda, A., Syafaatullah, A.Q., dan Panjaitan, R., 2023, Penentuan Konstanta Isoterm Freundlich dan Kinetika Adsorpsi Karbon Aktif Terhadap Asam Asetat Determination of Isotherm Freundlich Constant dan Adsorption Kinetics of Activated Carbon to Acetic Acid, *Jurnal Ilmiah Teknik Kimia*, 20, 149–155.

Shao, P., Liang, D., Yang, L., Shi, H., Xiong, Z., Ding, L., Yin, X., Zhang, K., Luo, X., dan Luo, X., 2020, Evaluating the adsorptivity of organo-functionalized silica nanoparticles towards heavy metals: Quantitative comparison dan mechanistic insight, *J. Hazard. Mater.*, 387, 121676.

Sholikhah, H.I., Putri, H.R., dan Inayati, 2021, Pengaruh Konsentrasi Aktivator Asam Fosfat ($H_3PO_4$) pada Pembuatan Karbon Aktif dari Sabut Kelapa terhadap Adsorpsi Logam Kromium, *Equilibrium Journal of Chemical Engineering*, 5, 45–50.

Simatupang, L., Siburian, R., Sitanggang, P., Doloksaribu, M., Situmorang, M., dan Marpaung, H., 2018, Synthesis dan Application of Silica Gel Base on Mount Sinabung's Fly Ash for Cd(II) Removal with Fixed Bed Column, *Rasayan J. Chem.*, 11, 819–827.

Singh, R. dan Bhateria, R., 2020, Experimental dan Modeling Process Optimization of Lead Adsorption on Magnetite Nanoparticles via Isothermal, Kinetics, dan Thermodynamic Studies, *ACS Omega*, 5, 10826–10837.

Sirijaree, T. dan Praipipat, P., 2023, Adsorption of Lead (II) Ions onto Goethite Chitosan Beads: Isotherms, Kinetics, dan Mechanism Studies, *ChemEngineering*, 7, 1-24.

Slarmanat, R.M., Rampe, J., dan Lombok, Z., 2024, Sintesis SiC (Silikon Karbida) Berbahan Dasar Pasir Putih Dan Arang Tempurung Kelapa, *Fullerene Journ.Of Chem*, 10, 53–59.

Sulastri, S., 2009, Modifikasi Silika Gel dalam Kaitannya dengan Peningkatan Manfaat, *Jurusan Pendidikan Kimia FMIPA UNY*, 16, 367–372.

Susiana, C.A., Rusdiarso, B., dan Mudasir, M., 2024, Enhanced Capacity dan Easily Separable Adsorbent of Dithizone-immobilized Magnetite Zeolite for Pb(II) Adsorption, *Indonesian Journal of Chemistry*, 24, 1058–1070.

UNIVERSITAS
GADJAH MADA
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**Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/**


Ulfa, M., Prasetyoko, D., Trisunaryanti, W., Bahruji, H., Fadila, Z.A., dan Sholeha, N.A., 2022, The effect of gelatin as pore expander in green synthesis mesoporous silica for methylene blue adsorption, *Sci. Rep.*, 12, 15271.

Umar, Y., 2022, Experimental (FT-IR, FT-Raman, dan NMR) dan DFT studies of the structures dan spectral properties of diphenylcarbazone dan diphenylthiocarbazone, *J. Mol. Struct.*, 1264, 133230.

Utami, R., Rismawati, W., dan Sapanli, K., 2018, Pemanfaatan Mangrove untuk Mengurangi Logam Berat di Perairan,141–153.

Wang, J. dan Guo, X., 2023, Adsorption kinetics dan isotherm models of heavy metals by various adsorbents: An overview, *Crit. Rev. Environ. Sci. Technol.*, 53, 1837–1865.

Watthanachai, C., Ngamcharussrivichai, C., dan Pengprecha, S., 2019, Synthesis dan characterization of bimodal mesoporous silica derived from rice husk ash, *Engineering Journal*, 23, 25–34.

Weyrich, J.N., Mason, J.R., Bazilevskaya, E.A., dan Yang, H., 2023, Understanding the Mechanism for Adsorption of Pb(II) Ions by Cu-BTC Metal–Organic Frameworks, *Molecules*, 28, 5443.

Wimarsela, S., Junaidi, R., dan Silviyati, I., 2021, Sintesis Silika Gel dari Abu Cangkang dan Serabut Kelapa Sawit Terimobilisasi Difenilkarbazon dengan Metode Sol-Gel, *Jurnal Penelitian Inovatif*, 1, 165–174.

Yulirohyami, Puspasari, I., Kundari, N.A., dan Nadia, A.A., 2024, Green synthesis of chitosan-silica/chitosan-silica immobilized dithizone as bioadsorben heavy metals,. In, *AIP Conference Proceedings*, American Institute of Physics.

Yustinah, Hudzaifah, Aprilia, M., dan AB, S., 2019, Kesetimbangan Adsorpsi Logam Berat (Pb) Dengan Adsorben Tanah Diatomit Secara Batch, *Konversi*, 9, 17–28.

Zango, Z.U., Ibnaouf, K.H., Keshta, B.E., Idriss, H., Rahali, S., Belhocine, Y., dan Modwi, A., 2025, Unveiling adsorptive performance of a novel Cr@TiO2 nanocomposite for efficient removal of toxic Pb(II) ions from aqueous solution: Experimental dan theoretical insight of DFT simulations, *J. Mol. Struct.*, 1348, 143528.

Zein, R., Nofita, D., Refilda, R., dan Aziz, H., 2019, Penyerapan Timbal(II) dan Cadmium(II) di dalam Larutan Menggunakan Limbah Kulit Buah Kapuk, *Chimica et Natura Acta*, 7, 37–45.