# COAGULATION AND FLOCCULATION PROCESS USING CASSAVA PEEL STARCH MODIFIED WITH LEMONGRASS EXTRACT FOR POLLUTANTS REMOVAL IN RAW WATER

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PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

Mak and Abah,

You raised me up with a strong belief that edifice
You told me many times nothing good comes without sacrifice
I am so thankful for your prayers, love and advice
I know gift and gratitude will never suffice
As I am forever indebted for everything you had given me at no price.

Hubby and Hariz,

Since day one we walked down the alley
The sight was weary and it has never been easy
Every time I fall you lift me up so dearly
Thank you for being my strength to climb towards the peak of this journey.

Should there be a knowledge that others benefited from this copy
may Allah count it as sadaqatul jariyah and reward all of you eternally.

Daughter. Wife. Mother,
19.11.19

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# ABSTRACT

Sustainable and greener solution for water treatment problems is the persistent need in the current days. The present research synthesized a novel dual function coagulant using cassava peel starch with incorporation of lemongrass extract and evaluated the synergistic effect between alum and modified cassava peel starch (MCPS) or native cassava peel starch (CPS) as dual coagulants in removing turbidity, total suspended solids (TSS), chemical oxygen demand (COD) and *Escherichia coli* (*E. coli*) in raw water. The effects of pH, coagulant dosage and settling time on coagulation and flocculation performance of the coagulants were also determined. The coagulation and flocculation mechanisms were examined through floc characterization and electrokinetic analyses. Characterization study of coagulants confirmed the efficacy of modification technique as described by significant changes in pores formation, texture roughness and appearance of new element including Cl and Ca on the surface of the modified starch. The presence of citral, an important active group in lemongrass extract which responsible for antimicrobial property was also found in the modified starch. Coagulation and flocculation study indicated alum – MCPS and alum – CPS presented distinctive performance compared to alum, CPS and MCPS as sole coagulants of in terms of both coagulation and antibacterial functionality. Substantial removals of turbidity (93.15%), TSS (92.00%) and *E. coli* (100.00%) were achieved with treatment alum – MCPS within 10 minutes of settling time at effective alum – MCPS dosage of 4.50 – 70.00 mg/L and pH 7. Alum individually prevails over other coagulants in reducing COD (34.06%). Mechanism study indicated that charge neutralization is the main mechanism driving the coagulation process associated with alum. While bridging, ion exchange and complexation mechanism dominated the coagulation process associated with the starches. The favorable dual functionality of the coagulants provides a greener alternative in the effort to reduce the dosage of chemical coagulants and disinfectants, which in turn gives an impact on significant attenuation in the secondary pollution risk of chemical coagulants and disinfectant by-products.

## ABSTRAK

Penyelesaian yang mampan dan lebih hijau untuk masalah rawatan air adalah keperluan yang berterusan pada masa kini. Kajian ini telah mensintesis bahan penggumpal baru dwisifat menggunakan kanji kulit ubi kayu dengan pemasukan ekstrak serai dan menilai kesan sinergistik antara alum dan kanji kulit ubi kayu terubahsuai (MCPS) atau kanji kulit ubi kayu asal (CPS) sebagai bahan penggumpal dual dalam menyingkirkan kekeruhan, pepejal terampai (TSS), keperluan oksigen kimia (COD) dan *Escherichia coli* (*E. coli*) dalam air mentah. Kesan pH, dos bahan penggumpal dan masa enapan terhadap prestasi penggumpalan dan pengelompokan oleh bahan penggumpal turut ditentukan. Mekanisme penggumpalan dan pengelompokan diperiksa melalui analisis pencirian flok dan elektrokinetik. Analisis pencirian ke atas bahan penggumpal mengesahkan keberkesanan teknik pengubahsuaian yang ditunjukkan melalui perubahan signifikan pada pembentukan pori, kekasaran tekstur dan kemunculan elemen baru seperti Cl dan Ca pada permukaan kanji terubahsuai. Kehadiran sitral, iaitu suatu kompaun aktif di dalam ekstrak serai yang bertanggungjawab kepada sifat antibakteria turut ditemui di dalam kanji terubahsuai. Kajian penggumpalan dan pengelompokan menunjukkan alum – MCPS dan alum – CPS mempunyai prestasi terbaik berbanding penggumpal tunggal alum, CPS dan MCPS untuk kedua-dua fungsi penggumpalan dan antibakteria. Penyingkiran yang tinggi bagi kekeruhan (93.15%), TSS (92.00%) dan *E. coli* (100.00%) dicapai dengan rawatan menggunakan gabungan alum – MCPS dalam masa enapan 10 minit dengan dos efektif alum-MCPS 4.50 – 70.00 mg/L dan pH 7. Alum menandingi penggumpal lain dalam mengurangkan COD dengan penyingkiran sebanyak 34.06%. Kajian mekanisme menunjukkan peneutralan cas adalah mekanisme utama yang memacu proses penggumpalan berkait dengan alum. Manakala mekanisme jambatan, pertukaran ion dan pembentukan kompleks mendominasi proses penggumpalan yang berkait dengan kanji. Sifat dwifungsi yang berfaedah pada bahan penggumpal dapat memberi alternatif yang lebih hijau di dalam usaha untuk mengurangkan dos bahan penggumpal dan disinfektan kimia, sekaligus memberi impak pengurangan yang ketara terhadap risiko pencemaran sekunder oleh produk sampingan dari bahan penggumpal dan disinfektan kimia.

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## LIST OF SYMBOLS AND ABBREVIATIONS

| | | |
|---|---|---|
| *BOD* | - | Biological oxygen demand |
| *°C* | - | Degree Celsius |
| *$CaCO_3$* | - | Calcium carbonate |
| *CFU* | - | Colony forming unit |
| *Cl* | - | Chlorine |
| *COD* | - | Chemical oxygen demand |
| *CPS* | - | Cassava peel starch |
| *DO* | - | Dissolved oxygen |
| *EDX* | - | Electron dispersive X-ray |
| *Fe* | - | Ferum |
| *FTIR* | - | Fourier transform infrared spectrometer |
| *Mn* | - | Manganese |
| *mg/L* | - | Milligram per litre |
| *mg/g* | - | Milligram per gram |
| *MCPS* | - | Modified cassava peel starch |
| *min* | - | Minute |
| *NTU* | - | Nephelometric turbidity unit |
| *rpm* | - | Rotation per minute |
| *SEM* | - | Scanning electron microscopy |
| *TSS* | - | Total suspended solids |
| *XRD* | - | X-ray diffraction |
| *v/v* | - | Volume/volume |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background of research

Water is an integral part of the environment that is needed by all organisms to maintain their survival. It regenerates the shape of oceans and seas, rivers, lakes and forests, becoming part of the identity of environments and landscapes. Water holds the paramount importance for socio-economic development and equally important to preserve environmental sustainability. Malaysia is a fortunate country located immediately on the north of the equator that has a tropical rainforest climate. Therefore, this nation is privileged to be humid and rainy throughout the year. Water resources in Malaysia are considered as abundantly available; nonetheless, the resources are becoming very limited in its pure state due to massive urbanization and increasing population growth (Tan *et al*., 2017).

The quality of surface water is usually influenced by external inputs approaching into the reservoir from the water shed, as well as from nutrient cycling and internal loading. The external inputs discharged from point and non-point sources can be in the form of organic and inorganic pollutants and nutrients (Yuk *et al*., 2015). Among various contaminants intruded into surface water, suspended solids, organic contents and bacteria such as *E. coli* are mostly common (Huang *et al*., 2015). Suspended solids that are commonly present in the water body due to natural occurrence can also be contributed by earthworks and land clearing activities. These colloidal particles include organic materials such as algae, and inorganic materials such as silt and sediment. Meanwhile, the potential sources of bacterial contamination are diverse but usually come from grazing livestock, poultry waste, as well as untreated

waste discharge from nearby residential settlements (Pandey *et al*., 2014). Consequently, interventions in water treatment, sanitation, and hygiene are crucial to ensure water impurities can be removed efficiently prior to discharge into receiving bodies.

The provision of clean water supply nearby for to support consumers' daily needs will help in decreasing the health incidence such as skin diseases, eye infections as well as worm infections, especially if the water is of good quality bacteriologically (Yongabi, 2010). But major improvements in health conditions through provision of safe water can only be achieved through domestic hygiene practice and proper methods of water purification. Adequate water treatment and sanitation are essential to remove turbidity, impurities and other pathogenic bacteria which can be guided through the process of coagulation and flocculation.

Coagulation and flocculation have been practiced extensively in water and wastewater treatment for the removal of particulate and dissolved materials. This practice has several advantages such as reduced capital cost and space requirements, as well as effective treatment for excess flowing during storm events. These processes of coagulation and flocculation are elements of total clarification system used in water treatment unit operations in the treatment plants. Hence, it is necessary to optimize the process and the coagulant used that are essential to produce clean water that meet the stringent water quality standards.

Different kinds of coagulant interact effectively with the suspended solids and colloidal particles in the water. Amongst all, aluminium salts such as aluminium sulphate and polyaluminium chloride are the most prominent. However, large dosage of aluminium in treated water has raised concern over the health effect due to prolonged exposure to aluminium in drinking water that can result in Alzheimer disease (Rondeau *et al*., 2006). Besides, inorganic coagulants such as alum in combination with lime have been conventionally used for removal of turbidity from surface waters. The sludge formed from such treatment poses disposal problems because of its aluminium content and tend to accumulate in the environment in a large volume.

Attention therefore being focused on the alternative coagulants which is preferably from natural, renewable sources, biodegradable and safe for human health. Several studies have been done on natural coagulants produced or extracted from plants, animals, or microorganisms (Amagloh & Benang, 2009; Yin, 2010; Choy *et*

# REFERENCES


Aamir, H. M., Khan, R. U., Mujahid, R., Tahir, S. & Ijaz, A. (2014). Removal of anionic dyes by modified cationic starch. *Journal of Pakistan Institute of Chemical Engineers, 42(2),* pp. 69-75.

Abdel Aziz, S. M., Hamed, H. A., Mouafi, F. E. & Abdelwahed, N. A. M. (2011). Extracellular metabolites produced by a novel strain, *Bacillus alvei* NRC-14:3. Synthesis of a bioflocculant that has chitosan-like structure. *Life Science Journal, 8(4),* pp. 883-890.

Abdul Aziz, H. & Mohamad Sobri, N. I. (2012). Extraction and application of starch-based coagulants from sago trunk for semi-aerobic landfill leachate treatment. *Environtal Science and Pollution Research, 22,* pp. 16943-16950.

Abdul Aziz, H., Mohd Nordin, A., Abdul, M. D. M., Sujatha, R., Mohd Koflly, M. I. & Harmizi, M. (2000). A study on the anionic natural coagulant for heavy metals and turbidity removal in water at pH 7.5 and alum concentration 25 mg/L – laboratory scale. *Indian Journal of Engineering and Material Sciences, 7,* pp. 195-199.

Abiola, O.N. (2014). Appraisal of cassava starch as coagulant aid in the alum coagulation of congo red from aqua system. *International Journal of Environmental Pollution and Solutions, 2(1),* pp. 47-58.

Adamu, A., Adie, D. B. & Alka, U. A. (2014). A comparative study of the use of cassava species and alum in wastewater treatment. *Nigerian Journal of Technology, 33(2),* pp. 170-175.

Aderemi, F. A. & Nworgu, F. C. (2007). Nutritional status of cassava peels and root sieviate biodegraded with *Aspergillus niger*. *American-Eurasian Journal of Agricultural and Environmental Science, 2 (3),* pp. 308-311.

Aggarwal, P. & Dollimore, D. (1998). The effect of chemical modification on starch studied using thermal analysis. *Thermochimica Acta, 324*, pp. 1-8.

Aguilar, M. I., Sáez, J., Lloréns, M., Soler, A., Ortuño, J. F., Meseguer, V. & Fuentes, A. (2005). Improvement of coagulation–flocculation process using anionic polyacrylamide as coagulant aid. *Chemosphere, 58(1),* pp. 47-56.

Ahmad Zamri, M. F. M., Suja', F., Yusoff, M. S., Abd Aziz, H. & Bahru, R. (2018). The comparison of *Durio Zibethinus* seed starch extraction for landfill leachate treatment. *Materials Research Express, 5,* pp. 1-11.

Ahmad, A. L., Sumathi, S. & Hameed, B. H. (2006). Coagulation of residue oil and suspended solid in palm oil mill effluent by chitosan, alum and PAC. *Chemical Engineering Journal, 118,* pp. 99-105.

Ahmad, A. L., Wong, S. S., Teng, T. T. & Zuhairi, A. (2008). Improvement of alum and PACl coagulation by polyacrylamides (PAMs) for the treatment of pulp and paper mill wastewater. *Chemical Engineering Journal, 137,* pp. 510-517.

Aisyah, I. S., Murshed, M. F. & Norli, I. (2016). Influence of different treatment condition on biopolymer yield production for coagulation-flocculation process. *IOP Conference Series: Materials Science and Engineering, 133,* pp 1-9.

Akbar, N. A., Abdul Aziz, H. & Adlan, M. N. (2015). Potential use of ozonation with limestone adsorption in ground treatment: a case study at Kelantan water treatment plant. *Jurnal Teknologi (Sciences & Engineering), 74(11),* pp. 43-50.

Akinbile, C. O., Yusoff, M. S., Talib, A. H., Zorkefle, A. I., Wan Roslan, S. & Ummunajwa. (2013). Qualitative analysis and classification of surface water in Bukit Merah Reservoir in Malaysia. *Water Science and Technology: Water Supply,* pp. 1138-1145.

Al-Bayatti, K. K., Al-Arajy, K. H. & Al-Nuaemy, S. H. (2012). Bacteriological and physicochemical studies on Tigris river near the water purification stations within Baghdad province. *Journal of Environmental and Public Health,* pp. 1-8.

Alexander, J. T., Hai, F. I. & Al-Aboud, M. T. (2012). Chemical coagulation-based processes for trace organic contaminant removal: Current state and future potential. *Journal of Environmental Management, 111,* pp. 195–207.

Alhassan, M., Lawal, A., Nasiru, Y., Suleiman, M., Safiya, A.M. & Bello, N. (2018). Extraction and formulation of perfume from locally available lemon grass leaves. *ChemSearch Journal, 9(2),* pp. 40-44.

Alkadi, M. Y., Razek, M. A. T., Hafez, A. I., Moursy, E. M. (2015). Cationic modified rice starch for drinking water purification. *Journal of Advanced Scientific Research, 6(2),* pp. 10-13.

Amagloh, F.A. & Benang, A. (2009). Effectiveness of *Moringa oleifera* seed as coagulant for water purification. *African Journal of Agricultural Research, 4,* pp. 119-123.

Amer, H., El-Gendy, A. & El-Haggar, S. (2017). Removal of lead (II) from aqueous solutions using rice straw. *Water Science & Technology,* pp. 1-11.

American Public Health Association (APHA). *Standard methods of chemical analysis of water and waste water, 20th ed.* Washington DC. 2000.

Amin, E. S., Awad, O. & El-Sayed, M. (1970). The mucilage of *Opuntia ficus indica*. *Carbohydrate Research, 15,* pp. 159-161.

Amruta, G. & Munavalli, G. R. (2017). Use of aloe vera as coagulant aid in turbidity removal. *International Journal of Engineering Research and Technology, 10 (1),* pp. 314-317.

An, D., Chen, Y., Gu, B., Westerhoff, P., Hanigan, D., Herckes, P., Fischer, N., Donovan, S., Croue, J.P. & Atkinson, A. (2019). Lower molecular weight fractions of PolyDADMAC coagulants disproportionately contribute to N nitrosodimethylamine formation during water treatment. *Water Research, 150,* pp. 466-472.

An, X., Kang, Y. & Li, G. (2018). Flocculation of gelatinized starch: Flocculation performance and floc characterization. *Korean Journal of Chemical Engineering, 35,* pp. 1-9.

Angreni, E. (2009). Review on optimization of conventional drinking water treatment plant. *World Applied Sciences Journal, 7(9),* pp. 1144-1151.

Arputha, B.M., Selvamani, P. & Latha, S. (2012). In-Vitro antimicrobial evaluation of extracts, oil and fractionated geraniol of *Cymbopogan citratus* - An aromatic grass. *International Journal of Environmental Sciences, 3(1),* pp. 584-590.

Ashraf, M. A., Mohd. Jamil, M. J. & Yusoff, I. (2010). Study of water quality and heavy metals in soil & water of ex-mining area Bestari Jaya, Peninsular Malaysia. *International Journal of Basic & Applied Sciences, 10(3),* pp. 7-23.

Aslam, Z., Christopher, W. K. C., Murshed, F., van Leeuwen, J. L., Drikas, M. & Wang, D. S. (2013). Variation in character and treatability of organics in river water: An assessment by HPAC and alum coagulation. *Separation and*

*Purification Technology,120,* pp. 162-171.

Awang, H., Daud, Z., Tan, L.W. & Mohd Hatta, M.Z. (2015). Hydrology properties at Sembrong dam reservoir in Johor. *Applied Mechanics and Materials, 773-774,* pp. 1370-1374

Awokoya, K. N., Owoade, O. J., Moronkola, B.A., Oguntade, B.K., Ibikunle, A.A., Atewolara-Odule, O.C. & Ogundare, S.A. (2016). Morphological characteristics of cassava peel and its effect on the adsorption of heavy metal ions from aqueous media, *Journal of Multidisciplinary Engineering Science and Technology, 3,* pp. 5342-5348.

Azevedo, A. N., Buarque, P. R., Cruz, E. M. O., Blank, A. F., Alves, P. B., Nunes, M. L. & Santana, L. C. L. de A. (2014). Response surface methodology for optimisation of edible chitosan coating formulations incorporating essential oil against several foodborne pathogenic bacteria. *Food Control, 43,* pp. 1–9.

Azlan, A., Khoo, H. E., Idris, M. A., Ismail, A. & Razman, M. R. (2012). Evaluation of minerals content of drinking water in Malaysia. *The Scientific World Journal,* pp. 1–10.

Baharim, N. B., Yusop, Z., Askari, M., Yusoff, I., Wan Muhd Tahir, W. Z., Othman, Z. & Zainal Abidin, M. R. Preliminary results of stratification study in Sembrong reservoir, Peninsular Malaysia. *2nd International Conference On Water Resources.* Skudai, Johor: Universiti Teknologi Malaysia. 2012. pp. 1-7.

Basera, P., Lavania, M., Agnihotri, A. & Lal, B. (2019). Analytical investigation of *Cymbopogon citratus* and exploiting the potential of developed silver nanoparticle against the dominating species of pathogenic bacteria, *Frontiers in Microbiology, 10,* pp. 1-13.

Belbahloul, M., Zouhri, A. & Anouar, A. (2015). Bioflocculants extraction from Cactaceae and their application in treatment of water and wastewater. *Journal of Water Process Engineering, 7,* pp. 306–313.

Beltran-Heredia, J., Sanchez-Martin, J. & Davila-Acedo M. A. (2011). Optimization of the synthesis of a new coagulant from a tannin extract. *Journal of Hazardous Materials, 186,* pp. 1704–1712.

Benesi, I. R. M., Labuschagne, M. T., Dixon, A. G. & Mahungu, N. M. (2004). Stability of native starch quality parameters, starch extraction and root dry

matter of cassava genotypes in different environments. *Journal of the Science of Food and Agriculture, 84(11),* pp. 1381-1388.

Benesi, I.R.M. *Characterization of Malawian cassava germplasm for diversity, starch extraction and its native and modified properties.* PhD. Thesis. University of The Free State; 2005.

Besaratinia, A & Pfeifer, G. (2007). A review of mechanisms of acrylamide carcinogenicity. *Carcinogenesis, 28 (3),* pp. 519-528.

Bhalkaran, S. & Wilson, L. D. (2016). Investigation of self-assembly processes for chitosan-based coagulant-flocculant systems: A mini-review. *International Journal of Molecular Sciences, 17(1662),* pp. 1-21.

Bina, M. H., Mehdinejad, M., Nikaeen, H. & Attar, M. (2009). Effectiveness of chitosan as natural coagulant aid in treating turbid waters. *Iranian Journal of Environmental and Health Sciences Engineering, 6(4),* pp. 247-252.

Bindar, Y., Efan, A. & Rahmi. (2013). Sodium hydroxide (NaOH) concentration and steeping time duration effects on starch production from dry-milled low quality rice IR 64 grade 3 flour using alkaline-protease enzyme digestion method. *International Food Research Journal, 20(3),* pp. 1353-1358.

Bolto, B. & Gregory, J. (2007). Organic polyelectrolytes in water treatment. *Water Research, 41,* pp. 2301-2324.

Brandt, M. J., Johnson, K. M., Elphinston, A. J. & Ratnayaka, D. D. (2017). Storage, clarification and chemical treatment. *Twort's Water Supply,* pp. 323-366.

Bratby, J. *Coagulation and flocculation in water and wastewater treatment.* 2nd Ed. London: IWA Publishing. 2006.

Broin, M., Santaella, C., Cuine, S., Kokou, K., Peltier, G. & Joel, T. (2012). Flocculant activity of recombinant protein from *Moringa oleifera* seed. *Applied Microbiology and Biology, 60,* pp. 114-119.

Buléon, A., Gallant, D. J., Bouchet, B., Mouille, C., D'Hulst, C., Kossmann, J. & Ball, S. (1997). Starches from A to C. *Chlamydomonas veinhardtii* as a model microbial system to investigate the biosynthesis of the plant amylopectin crystal. *Plant Physiology, 1(15),* pp. 949-957.

Canizares, P., Jimenez, C., Martínez, F., Rodrigo, M. A. & Sáez, C. (2009). The pH as a key parameter in the choice between coagulation and electrocoagulation for the treatment of wastewaters. *Journal of Hazard Materials, 15,163(1),* pp. 158-64.

Carmona-Garcia, R., Bello-Perez, L. A., Aguirre-Cruz, A., Aparicio-Saguilán, A., Hernández-Torres, J. & Alvarez-Ramirez, J. (2016). Effect of ultrasonic treatment on the morphological, physicochemical, functional, and rheological properties of starches with different granule size. *Starch - Stärke, 68,* pp. 972-979.

Chang, C. L. & Liao, C. S. (2011). Assessing the risk posed by high-turbidity water to water supplies. *Environmental Monitoring and Assessment, 184(5),* pp. 3127-3132.

Chang, Y. H, Lina, J. H. & Lii, C. Y. (2004). Effect of ethanol concentration on the physicochemical properties of waxy corn starch treated by hydrochloric acid. *Carbohydrate Polymers, 57,* pp. 89-96.

Chapman, D. & Kimstach, V. *The selection of water quality variable in: water quality assessments* (Chapman, D. Ed.). London: Chapman and Hall Ltd. 1992.

Charles, A. L., Chang, Y. H., Ko, W. C., Sriroth, K. & Huang, T. C. (2005). Influence of amylopectin structure and amylose content on the gelling properties of five cultivars of cassava starches. *Journal of Agriculture and Food Chemistry, 53,* pp. 2717-2725.

Charoenkul, N., Uttapap, D., Pathipanawat, W. & Takeda, Y. (2011). Physicochemical characteristics of starches and flours from cassava varieties having different cooked root textures. *LWT - Food Science and Technology, 44,* pp. 1774-1781.

Chen, W., Westerhoff, P., Leenheer, J. A. & Booksh, K. (2003). Fluorescence excitation emission matrix regional integration to quantify spectra for dissolved organic matter. *Environmental Science Technology, 37 (24),* pp. 5701-5710.

Chew, C. M., Aroua, M. K., Hussain, M. A. & Ismail, W. M. Z. W. (2016). Evaluation of ultrafiltration and conventional water treatment systems for sustainable development: an industrial scale case study. *Journal of Cleaner Production, 112,* pp. 3152-3163.

Chhikara, S. & Dhankhar, R. (2008). Biosorption of Cr (VI) ions from electroplating industrial effluent using immobilized *Aspergillus niger* biomass. *Journal of Environmental Biology and Separation, 29(5),* pp. 773-778.

Chou, F. N. F. & Wu, C. (2010). Reducing the impacts of flood-induced reservoir turbidity on a regional water supply system. *Advances in Water Resources, 33(2),* pp. 146-157.

Choubey, S. (2013). Coagulation-clarification of turbid colored water by natural coagulant (*Strychnos potatoram*) seed extract. *Journal of Applicable Chemistry, 2(1),* pp. 73-80.

Chouhan, S., Sharma, K. & Guleria, S. (2017). Antimicrobial activity of some essential oils—present status and future perspectives. *Medicines, 4(58),* pp. 1-21.

Choy, S. Y., Nagendra-Prasad, K. M., Wu, T. Y., Raghunandan, M. E. & Ramanan, R. N. (2014). Utilization of plant-based natural coagulants as future alternatives towards sustainable water clarification. *Journal of Environmental Sciences, 26,* pp. 2178-2189.

Cotruvo, J. A. (2017). 2017 WHO Guidelines for Drinking Water Quality: First Addendum to the Fourth Edition. Journal - *American Water Works Association, 109,* pp. 44-51.

Craciun, G., Ighigeanu, D., Manaila, E. & Stelescu, M. D. (2015). Synthesis and characterization of poly (acrylamide-co-acrylic acid) flocculant obtained by electron beam irradiation. *Material Research, 18(5),* pp. 984-993.

Crini, G. (2002). Recent developments in polysaccharide-based materials used as adsorbents in wastewater treatment. *Progress in Polymer Science, 30,* pp. 38 - 70.

Dasgupta, S., Kumar Gunda, N. S. & Mitra, S. K. (2016). Evaluation of the antimicrobial activity of *Moringa oleifera* seed extract as a sustainable solution for potable water. *RSC Advances, 6(31),* pp. 25918-25926.

Defloor, I., Swennen, R., Bokanga, M. & Delcour, J. A. (1998). Moisture stress during growth affects the breadmaking and gelatinisation properties of cassava (*Manihot esculenta Crantz*) flour. *Journal of Science and Food Agriculture, 76,* pp. 233-238.

Dehghani, M. & Alizadeh, M. H. (2016). The effects of the natural coagulant *Moringa oleifera* and alum in wastewater treatment at the Bandar Abbas Oil Refinery. *Environmental Health Engineering and Management Journal, 3(4),* pp. 225-230.

Delelegn, A., Sahile, S. & Husen, A. (2018). Water purification and antibacterial efficacy of *Moringa oleifera* lam. *Agriculture and Food Security, 7(1),* pp. 1-10.

Denisova, V., Mezule, L., Juhna, T. (2014). The effect of chlorination on *Escherichia coli* viability in drinking water. *Material Science and Applied Chemistry,* pp.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

45-50.

Department of Environment (DOE). (2005). *Interim National Water Quality Standards (INWQS) for Malaysia.* Retrieved on Feb 18, 2016, from http://www.doe.gov.my

Department of Environment (DOE). (2012). *Malaysia: Environmental Quality Act report, Ministry of Science, Technology and the Environment*. Retrieved on Feb 18, 2016, from http://www.doe.gov.my

Devrimci, H. A., Yuksel, A. M. & Sanin, F. D. (2012). Algal alginate: A potential coagulant for drinking water treatment. *Desalination, 299,* pp. 16-21.

Dohare, D., Shriram Deshpande, S. & Kotiya, A. (2014). Analysis of Ground Water Quality Parameters: A Review. *Research Journal of Engineering Sciences, 3(5),* pp. 26-31.

Dragunski, D. C. & Pawlicka, A. (2001). Preparation and characterization of starch grafted with toluene poly (propylene oxide) diisocyanate. *Materials Research, 4(2),* pp. 77-81.

Drinan, J. E. & Spellman, F. R. *Water and Wastewater Treatment. A guide for the Nanoengineering Professional.* Florida: CRC Press. 2013

Du, Q., Wei, H., Li, A., & Yang, H. (2017). Evaluation of the starch-based flocculants on flocculation of hairwork wastewater. *Science of The Total Environment, 601-602,* pp. 1628-1637.

Duan, J. & Gregory, J. (2003). Coagulation by hydrolysing metal salts. *Advances in Colloid and Interface Science, 100-102,* pp. 475-502.

Duong, L. V., Wood, B. J. & Kloprogge, J. T. (2005). XPS study of basic aluminum sulphate and basic aluminium nitrate. *Materials Letters, 59,* pp. 1932-1936.

Duruibe, J. O., Ogwuegbu, M. O. C. & Egwurugwu, J. N. (2007). Heavy metal pollution and human biotoxic effects. *International Journal of Physical Sciences, 2(5),* pp. 112-118.

Dutta, H., Paul, S. K., Kalita, D. & Mahanta, C. L. (2011). Effect of acid concentration and treatment time on acid–alcohol modified jackfruit seed starch properties. *Food Chemistry, 128(2),* pp. 284-291.

Ebeling, J. M., Ogden, S. R., Sibrell, P. L. & Rishel, K. L. (2004). Application of chemical coagulation aids for the removal of suspended solids (TSS) and phosphorus from the microscreen effluent discharge of an intensive

recirculating aquaculture system. *North American Journal of Aquaculture, 66,* pp. 198-207.

Eisakhani, M. & Malakhahmad, H. (2009). Water quality assessment of Bertam River and its tributaries in Cameron Highlands, Malaysia. *World Applied Sciences Journal, 7(6),* pp. 769-776.

Engineered Services Division Ministry of Health Malaysia. *National Drinking Water Quality Standard*. Kuala Lumpur. 2004.

Espina, L., Gelaw, T. K., de Lamo-Castellvi, S., Pagan, R. & Garcıa-Gonzalo, D. (2013). Mechanism of bacterial inactivation by (+)-limonene and its potential use in food preservation combined processes. *PLoS ONE, 8(2),* pp. 567-569.

Ewansiha J. U., Garba S. A., Mawak J. D. & Oyewole O. A. (2012). Antimicrobial activity of *Cymbopogon citratus* (lemongrass) and its phytochemical properties. *Frontiers in Science, 2(6),* pp. 214-220.

Fakir, M. S. A., Jannat, M., Mostafa, M. G. & Seal, H. (2012). Starch and flour extraction and nutrient composition of tuber in seven cassava accessions. *Journal of Bangladesh Agricultural University, 10(2),* pp. 217-222.

Fan, D., Ma, W., Wang, L., Huang, J., Zhao, J., Zhang, H. & Chen, W. (2012). Determination of structural changes in microwaved rice starch using Fourier transform infrared and Raman spectroscopy. *Starch - Stärke, 64(8),* pp. 598-606.

Faridah, O., Chowdhury, M. S. & Sakai, N. (2014). Assessment of microorganism pollution of Selangor River, Malaysia. *International Journal of Advances in Agricultural and Environmental Engineering, 1(2),* pp. 203-207.

Farrell, C., Hassard, F., Jefferson, B., Leziart, T., Nocker, A. & Jarvis, P. (2018). Turbidity composition and the relationship with microbial attachment and UV inactivation efficacy. *Science of The Total Environment, 624,* pp. 638 -647.

Fatehah, M. O., Hossain, M. S. & Teng, T. T. (2013). Comparative study on natural and commercial coagulants: treatment of semiconductor wastewater in sludge production and removal of heavy metals. *International Journal of Science and Modern Engineering, 1 (7),* pp. 1-8.

Fatombi, J. K., Lartiges, B., Aminou, T., Barres, O. & Caillet, C. (2013). A natural coagulant protein from copra (*Cocos nucifera*): Isolation, characterization, and potential for water purification. *Separation and Purification Technology, 116,*

pp. 35-40.

Fedala, N., Lounici, H., Drouiche, N., Mameri, N. & Drouiche, M. (2015). Physical parameters affecting coagulation of turbid water with *Opuntia ficus-indica* cactus. *Ecological Engineering, 77,* pp. 33-36.

Feuya-Tchouya, G. R., Foundikou, H., Lebibi, J., Choudhary, M. I., Menkem, E. Z., Nantia, E. A., Kezetas, J. J. B. and Tchouankeu, J. C. (2015). Phytochemical analysis, antioxidant and antimicrobial properties of the leaves and stem bark of *Scyphocephalium ochocoa* warb (Myristicaceae). *Journal of Pharmacognosy and Natural Products, 1(111),* pp. 1-6.

Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., Chapin, S. F., Coe, M. T., Daily, G. C., Gibbs, H. K., Helkowski, J. H., Holloway, T., Howard, E. A., Kucharik, C. J., Monfreda, C., Patz, J. A., Colin Prentice, I., Ramankutty, N. & Snyder, P. K. (2005). Global consequences of land use. *Science, 309(5734),* pp. 570-574.

Folkard, G. K., Shaw, Rod. & Sutherland, J. P. (1999). Water Clarification using *Moringa oleifera* seed coagulants. *Waterlines,* pp. 15-18.

Gadekar, M. R. & Ahammed, M. M. (2016). Coagulation/flocculation process for dye removal using water treatment residuals: modelling through artificial neural networks. *Desalination and Water Treatment, 57(55),* pp. 26392-26400.

Gandhimathi, R., Durai, N. J., Nidheesh, P. V., Ramesh, S. T. & Kanmani, S. (2013). Use of combined coagulation-adsorption process as pretreatment of landfill leachate. *Iranian Journal of Environmental Health Sciences & Engineering, 10 (24).* pp. 1-7.

Gao, J., Luo, Z. G. & Luo, F. X. (2012). Ionic liquids as solvents for dissolution of corn starch and homogeneous synthesis of fatty-acid starch esters without catalysts. *Carbohydrate Polymers, 89,* pp. 1215-1221.

Geissler, K., Manafi, M., Amoro, I. & Alonso, J. L. (2000). Quantitative determination of total coliforms and *Escherichia coli* in marine waters with chromogenic and fluorogenic media. *Journal of Applied Microbiology, 88,* pp. 280-285.

Gharibreza, M. & Ashraf, M. A. (2016). Bera Lake water quality, past and present situation. *Journal of Environmental Biology, 37,* pp.1097-1104.

Ghebremichael, K. A., Gunaratna, K. R., Henriksson, H., Brumer, H. & Dalhammar, G. (2005). A simple purification and activity assay ofthe coagulant protein from *Moringa oleifera* seed. *Water Research, 39,* pp. 2338-2344.

Ghernaout, B., Ghernaout, D. & Saiba, A. (2010). Algae and cyanotoxins removal by coagulation/flocculation: A review. *Desalination and Water Treatment, 20(1-3),* pp. 133-143.

Gope, S., Samyor, D., Paul, A. K. & Das, A. B. (2016). Effect of alcohol-acid modification on physicochemical, rheological and morphological properties of glutinous rice starch. *International Journal of Biological Macromolecules, 93,* pp. 860-867.

Gopinath, A., Chandran, R. P., Vysakhi, M. V. & Anu, A. S. (2012). Physical and bacteriological quality of well water samples from Kanakkary Panchayath, Pottayam district, Kerala State, India. *International Journal of Plant, Animal and Environmental Sciences, 2(3),* pp. 134-138.

Gorde, S. P. & Jadhav, M. V. (2013). Assessment of Water Quality Parameters: A Review. *International Journal of Engineering Research and Applications, 3(6),* pp. 2029-2035.

Grant, M. A. (1997). A new membrane filtration medium for simultaneous detection and enumeration of *Escherichia coli* and total coliforms. *Applied and Environmental Microbiology, 63(9),* pp. 3526-3530.

Gregory, J. & Barany, S. (2011). Adsorption and flocculation by polymers and polymer mixtures. *Advances in Colloid and Interface Science, 169,* pp. 1-12.

Guo, B., Yu, H., Gao, B., Rong, H., Dong, D., Ma, D., Li, R. & Zhao, S. (2015). Coagulation performance and floc characteristics of aluminum sulfate with cationic polyamidine as coagulant aid for kaolin-humic acid treatment. *Colloids and Surfaces A: Physicochemical and Engineering Aspects, 481,* pp. 476-484.

Hameed, Y. T., Idris, A., Hussain, S. A. & Abdullah, N. (2016). A tannin-based agent for coagulation and flocculation of municipal wastewater: Chemical composition, performance assessment compared to polyaluminum chloride, and application in a pilot plant. *Journal of Environmental Management, 184,* pp. 494-503.

Hammer, M.J. & Hammer, M.J.J. (2004). *Water and Wastewater Technology, 5th ed.,* New York. Pearson Education International.

Hamzah, A. & Hattasrul, Y. Water quality and bacterial study in Tasik Chini, Pahang. *Proceedings of Taal 2007: The 12th World Lake Conference.* 2008. pp. 184-189.

Harry, T. F., Joel, O. F., Ademiluyi, F. T. & Oduola, K. (2016). Performance evaluation of local cassava starches with imported starch for drilling fluid. *American Journal of Engineering Research, 5(10),* pp. 111-120.

Hayden, H. S., Blomster, J., Maggs, C. A., Silva, P. C., Stanhope, M. J. & Walland, J. R. (2003). Linnaeus was right all along: Ulva and Enteromorpha not distinct genera. *European Journal of Phycology, 38,* pp. 277-29.

Hayder, G. & Ab-Rahim, A. Effect of mixing natural coagulant with alum on water treatment. *The 3rd National Graduate Conference (NatGrad2015).* Universiti Tenaga Nasional, Putrajaya. 2015. pp. 1-8.

Hebeish, A., Aly, A. A., El-Shafei, A. & Zaghloul, S. (2009). Synthesis and characterization of cationized starches for application in flocculation, finishing and sizing. *Egyptian Journal of Chemistry, 52(1),* pp. 73- 89.

Helmig, S., Haibel, N. & Walter, D. (2018). In vitro toxicity studies of aluminum compounds. *Journal of Thermal Analysis and Calorimetry,* pp. 1-9.

Hicham, B. & Djeddi, S. (2017). Fourier transformed infrared spectroscopy analysis of constituents of lemon essential oils from Algeria. *American Journal of Optics and Photonics, 5(3),* pp. 30-35.

Hidzrami, S.A. *Bukit Merah, Perak lake brief.* Lakes and their basins for sustainable use in Malaysia (lake briefs report series 1). Kuala Lumpur: Akademi Sains Malaysia. 2010.

Horsfall, M., Abia, A. A. & Spiff, A.I. (2003). Removal of Cu (II) and Zn (II) ions from wastewater by cassava (*Manihot esculenta* Cranz) waste biomass. *African Journal of Biotechnology, 2,10,* pp. 360-364.

Hu, W., Zhouzhou, L., Hu, Y. & Aimin, L. (2016). Evaluation of chain architectures and charge properties of various starch-based flocculants for flocculation of humic acid from water. *Water Research, 96,* pp. 126-135.

Huang, M., Wang, Y., Cai, J., Bai, J., Yang, Hu. & Li, A. (2016). Preparation of dual-function starch-based flocculants for the simultaneous removal of turbidity and inhibition of *Escherichia coli* in water. *Water Research, 98,* pp. 128-137.

Huang, Y. F., Ang, S. Y., Lee, K. M. & Lee, T. S. *Quality of water resources in Malaysia. Research and practices in water quality*. Kuala Lumpur: Intech Open. 2015.

Hung, P. V., Nguyen, T. M. H., Nguyen, T. L. P. & Nguyen, N. T. T. (2017). Physicochemical characteristics and in vitro digestibility of potato and cassava

starches under organic acid and heat-moisture treatments. *International Journal of Biological Macromolecules, 95,* pp. 299-305.

Ibrahim, S. S. & Abdel-Khalek, N. (1992). The action of different types of corn starch on the flocculation of phosphate slimes. *Minerals Engineering, 5(8),* pp. 907 - 916.

Ignatius, A. R. & Rasmussen, T. C. (2016). Small reservoir effects on headwater water quality in the rural-urban fringe, Georgia Piedmont, USA. *Journal of Hydrology: Regional Studies, 8,* pp. 145-161.

Irfan, M., Butt, T., Imtiaz, N., Abbas, N., Ahmad Khan, R. & Shafique, A. (2017). The removal of COD, TSS and colour of black liquor by coagulation–flocculation process at optimized pH, settling and dosing rate. *Arabian Journal of Chemistry, 10,* pp. 2307-S2318.

Jadhav, M. V. & Mahajan, Y. S. (2013). Investigation of the performance of chitosan as a coagulant for flocculation of local clay suspensions of different turbidities. *KSCE Journal of Civil Engineering, 17(2),* pp. 328-334.

Jafari, B., Ebadi, A., Mohammadi Aghdam, B. & Hassanzade, Z. (2012). Antibacterial activities of lemon grass methanol extract and essence on pathogenic bacteria. *American-Eurasian Journal of Agriculture and Environmental Sciences, 12(8),* pp. 1042-1046.

Jafar-Tafreshi, M., Bustanafruza, F. & Fazlib, M. (2013). Studies on thermal decomposition of aluminium sulfate to produce alumina nano structure. *Journal of Nanostructures, 2,* pp. 463-468.

Jeon, J. R., Kim, E. J., Kim, Y. M., Murugesan, K., Kim, J. H. & Chang, Y. S. (2009). Use of grape seed and its natural polyphenol extracts as a natural organic coagulant for removal of cationic dyes. *Chemosphere, 77,* pp. 1090-1098.

Jian, H. & Fu, Y. (2018). Study on coagulation effect of composite peel coagulant in treating humic acid simulated water. *Advances in Engineering Research, 170,* pp. 1441-1444.

Jiang, J. Q. (2015). The role of coagulation in water treatment. *Current Opinion in Chemical Engineering, 8,* pp. 36-44.

Johnson, P. D., Girinathannair, P., Ohlinger, K. N., Ritchie, S., Teuber, L. & Kirby, J. (2008). Enhanced removal of heavy metals in primary treatment using coagulation and flocculation. *Water Environment Research, 80(5),* pp. 472-479.

Kaavessina, M., Distantina, S. & Fadilah. (2017). Synthesis of grafted flocculants based on several kinds of starch and its performance in water turbidity removal. *MATEC Web of Conferences, 01003.*

Kacurakova, M., Capeka, P., Sasinkova, V., Wellner, N. & Ebringerova, A. (2000). FT-IR study of plant cell wall model compounds: Pectic polysaccharides and hemicelluloses. *Carbohydrate Polymers, 43,* pp. 195-203.

Kakoi, B., Kaluli, J. W., Ndiba, P. & Thiong'o, G. (2016). Banana pith as a natural coagulant for polluted river water. *Ecological Engineering, 95,* pp. 699-705.

Kato, E. & Daimon, K. (1979). Thermal decomposition of hydrated aluminum sulfate precipitated from acetic acid solution. *Journal of the American Ceramic Society, 62,* pp. 313-320.

Keucken, A., Heinicke, G., Persson, K. & Köhler, S. (2017). Combined coagulation and ultrafiltration process to counteract increasing nom in brown surface water. *Water, 9(9),* pp. 1-29.

Khader, E. H., Mohammed, T. H. J. & Mirghaffari, N. (2018). Use of natural coagulants for removal of COD, oil and turbidity from produced waters in the petroleum industry. *Journal of Petroleum & Environmental Biotechnology, 09(03),* pp. 1-7.

Kigigha, L. T., Uhunmwangho, E. J. & Izah, S. C. (2018). Assessment of hot water and ethanolic leaf extracts of *Cymbopogon citratus* stapf (lemon grass) against selected bacteria pathogens. *Annals of Microbiology and Infectious Diseases, 1(3),* pp. 4-8.

Kizil, R., Irudayaraj, J. & Seetharaman, K. (2002). Characterization of irradiated starches by using FT-Raman and FTIR spectroscopy. *Journal of Agricaltural and Food Chemistry, 50,* pp. 3912-3918.

Klotz, K., Weistenhöfer, W., Neff, F., Hartwig, A., van Thriel, C. & Drexler, H. (2017). The health effects of aluminum exposure. *Deutsches Aerzteblatt Online, 114,* pp. 653-659.

Kolya, H. & Tripathy, T. (2013). Preparation, investigation of metal ion removal and flocculation performances of grafted hydroxyethyl starch. *International Journal of Biological Macromolecules, 62,* pp. 557-564.

Kondakal-Olukemi, Y. I., Mawak, J. D. & Onjo, M. M. (2009). Isolation of enteropathogenic *Escherichia coli* from children with diarrhea attending the

national hospital in Abuja, Nigeria Shiraz. *E- Medical Journal, 10(3),* pp. 99-106.

Kongkiattikajorn, J. & Sornvoraweat, B. (2011). Comparative study of bioethanol production from cassava peels by monoculture and co-culture of yeast. *Kasetsart Journal, 45*, pp. 268-274.

Kosasih, A. N., Febrianto, J., Sunarso, J., Ju, Y. H., Indraswati, N. & Ismadji, S. (2010). Sequestering of Cu(II) from aqueous solution using cassava peel (*Manihot esculenta*). *Journal of Hazardous Materials, 180(1-3),* pp. 366-374.

Kumar, P., Tjoon, T. T., Chand, S. & Wasewar, K. L. (2011). Treatment of paper and pulp mill effluent by coagulation. *International Journal of Chemical and Molecular Engineering, 5(8),* pp. 715-720.

Kuo, W. Y. & Lai, H. M. (2007). Changes of property and morphology of cationic corn starches. *Carbohydrate Polymers, 69,* pp. 544-553.

Kurniawan, A., Kosasih, A. N., Febrianto, J., Jub, Y. H., Sunarso, J., Indraswati, N. & Ismadji, S. (2011). Evaluation of cassava peel waste as lowcost biosorbent for Ni-sorption: Equilibrium, kinetics, thermodynamics and mechanism. *Chemical Engineering Journal, 172*, pp. 158-166.

Lee, L. Y., Lee, X. J., Chia, P. C., Tan, K. W., & Gan, S. (2014). Utilisation of *Cymbopogon citratus* (lemon grass) as biosorbent for the sequestration of nickel ions from aqueous solution: Equilibrium, kinetic, thermodynamics and mechanism studies. *Journal of the Taiwan Institute of Chemical Engineers, 45(4),* pp. 1764-1772.

Lee, N., Ling, T. Y. & Grinang, J. (2012). Physico-chemical characteristics in the filling phase of Bakun Hydroelectric Reservoir, Sarawak, Malaysia. *International Journal of Applied Science and Technology, 2(6),* pp. 91-101.

Lekniute-Kyzike, E., Bendoraitiene, J., Danilovas, P. P. & Zemaitaitis, A. (2016). A novel way to obtain effective cationic starch flocculants. *Desalination and Water Treatment, 57(50),* pp. 23728-23738.

Leonel, M. (2007). Analysis of the shape and size of starch grains from different botanical species. *Ciência e Tecnologia de Alimentos Campinas, 27(3),* pp. 579-588.

Leong, S., Ismail, J., Denil, N., Sarbini, S., Wasli, W. & Debbie, A. (2018). Microbiological and physicochemical water quality assessments of river water

in an industrial region of the northwest coast of Borneo. *Water, 10(11),* pp. 1-12.

Li, H., Ge, W., Ren, Y., Zhao F. & Song, S. (2015). Flocculation of pyrite fines in aqueous suspensions with corn starch to eliminate mechanical entrainment in flotation. *Minerals, 5*, pp. 654-664.

Li, O., Lu, C., Liu, A., Zhu, L., Wang, P. M., Qian, C. D., Jiang, X. H. & Wu, X. C. (2013). Optimization and characterization of polysaccharide-based bioflocculant produced by *Paenibacillus elgii* B69 and its application in wastewater treatment. *Bioresource Technology,* pp. 1-30.

Li, T., Zhu, Z., Wang, D., Yao, C., Tang, H. (2006). Characterization of floc size, strength and structure under various coagulation mechanisms. *Powder Technology 168,* pp. 104-110.

Li, Z., Chen, R. W., Lei, H. Y., Shan, Z., Bai, Tao., Yu, Q. & Li, H. L. (2009). Characterization and flocculating properties of a novel bioflocculant produced by *Bacillus circulans. World Journal of Microbiology and Biotechnology, 25,* pp. 745-752.

Liew, A. G., Noor, M. J. M. M., Muyibi, S. A. A., Fugara, M. S. T., Muhammed, A. & Iyuke, S. E. (2006), Surface water clarification using *M. oleifera* seeds. *International Journal of Environmental Studies, 63(2),* pp. 211-219.

Liew, Y. M., Heah, C. Y., Al Bakri Abdullah, M. M., Hussin, K. & Tan, S. J. (2016). Characterization of alum crystals synthesized from waste aluminium beverage cans. *Materials Science Forum, 857,* pp. 514-518.

Lin, J. H., Lee, S.Y. & Chang, Y. H. (2003). Effect of acid–alcohol treatment on the molecular structure and physicochemical properties of maize and potato starches. *Carbohydrate Polymers, 53(4),* pp. 475-482.

Lindeboom, N., Chang, P. R. and Tyler, R. T. (2004). Analytical, biochemical and physicochemical aspects of starch granule size, with emphasis on small granule starches: A Review. *Starch/Stärke, 56,* pp. 89-99.

Ling, T. Y., Gerunsin, N., Soo, C. L., Nyanti, L., Sim, S. F. & Jongkar, G. (2017). Seasonal changes and spatial variation in water quality of a large young tropical reservoir and its downstream river. *Journal of Chemistry,* pp. 1-16.

Ling, T. Y., Nyanti, L., Muan, T., Grinang, J., Sim, S. F. & Mujahid, A. (2016). Physicochemical parameters of Bakun Reservoir in Belaga, Sarawak,

Malaysia, 13 months after reaching full supply level. *Sains Malaysiana, 45(2),* pp. 157-166.

Liu, Z. M., Li, S. M., Zhang, H. X., Nie, F. H. & Wang, Q. H. (2013). Preparation, characterization and coagulation behaviour of a novel inorganic coagulant–polyferric(III)-magnesium(II) sulfate. *Environment Protection Engineering, 39(3),* pp. 57-71.

Liu, Z. Z., Huang, M., Li. A. & Yang, H. (2017). Flocculation and antimicrobial properties of a cationized starch. *Water Research, 119,* pp. 57-66.

Liu, Z., Wei, H., Li, A. & Yang, H. (2017). Evaluation of structural effects on the flocculation performance of a co-graft starch-based flocculant. *Water Research, 118,* pp. 160-166.

Lomelí-Ramírez, M. G., Barrios-Guzmán, A. J., García-Enriquez, S., Rivera-Prado, J. J. & Manríquez-González, R. (2014). Chemical and mechanical evaluation of bio-composites based on thermoplastic starch and wood particles prepared by thermal compression. *BioResources, 9(2),* pp. 2960-2974.

Lomelí-Ramírez, M. G., Satyanarayana, K. G., Iwakiri, S., de Muniz, G. B., Tanobe, V. & Flores-Sahagun, T. S. (2011). Study of the properties of biocomposites. Part I. Cassava starch-green coir fibers from Brazil. *Carbohydrate Polymers, 86(4),* pp. 1712-1722.

Lopez-Cordoba, A., Medina-Jaramillo, C., Pineros-Hernandez, D. & Goyanes, S. (2017). Cassava starch films containing rosemary nanoparticles produced by solvent displacement method. *Food Hydrocolloids, 71,* pp. 26-34.

Maaloul, N., Oulego, P., Rendueles, M., Ghorbala, A. & Díaz, M. (2017). Novel biosorbents from almond shells: Characterization and adsorption properties modeling for Cu(II) ions from aqueous solutions. *Journal of Environmental Chemical Engineering, 5,* pp. 2944-2954.

Mabrouk, M. E. M. (2014). Production of bioflocculant by the marine actinomycete *Nocardiopsis aegyptia* sp. *Life Science Journal, 11(12),* pp. 27-35.

Madivoli, E. S., Gitu, L. & Elijah, G. (2012). Isolation and identification of essential oils from *Cymbopogan citratus* (stapf) dc using GC-MS and FTIR. *Materials Research, 2(4),* pp. 13-23.

Maharjan, P., Dey, S., Huff, G., Zhang, W., Phillips, G. K. & Watkins, S. (2017). Effect of chlorine treatment on inhibition of *E. coli* serogroup $O_2$ incorporation into 7-day-old biofilm on polyvinylchloride surface. *Poultry Science, 96,* pp. 2862-

2870.

Maheswari, R. U. & EuginAmala, V. (2015). Analyzing and determining the activity of antimicrobial, functional group and phytochemicals of *Cymbopogon citratus* using Well, FTIR and HPLC. *International Journal of Science and Research (IJSR), 4(3),* pp. 138-141.

Maizura, M., Fazilah, A., Norziah, M. H. & Karim, A. A. (2008). Antibacterial activity of modified sago starch-alginate based edible film incorporated with lemongrass (*Cymbopogon citratus*) oil. *International Food Research Journal, 15(2),* pp. 233-236.

Mandloi, M., Chaudhari, S. & Folkard, G. K. (2004). Evaluation of natural coagulants for direct filtration. *Environmental Technology, 25(4),* pp. 481-489.

Manvitha, K. & Bidya, B. (2014). Review on pharmacological activity of *Cymbopogon citratus. International Journal of Herbal Medicine, 1(6),* pp. 5-7.

Matilainen, A., Vepsalainen, M. & Sillanpaa, M. (2010). Natural organic matter removal by coagulation during drinking water treatment: A review. *Advances in Colloid and Interface Science, 159(2),* pp. 189-197.

Mavura, W. J., Chemelil, M. C., Saenyi, W. W. & Mavura, H. K. (2008). Investigation of chemical and biochemical properties of *Maerua Subcordata* plant extract: A local water clarification agent. *Bulletin of Chemistry Society of Ethiopia, 22(1),* pp. 143-148.

Mcdaniels, A. E., Bordner, R. H., Gartside, R. S., Haines, J. R., Brenner, K. P. & Rankin, C. C. (1985). Holding effects on coliform enumeration in drinking water samples. *Applied and Environmental Microbiology, 50(4),* pp. 755-762.

Meghzili, B., Souad, B. & Abdelkrim, A. (2016). Risk of residual aluminum in treated waters with aluminum sulphate. *Advances in Research, 6(5),* pp. 1-8.

Mehdinejad, M. H., Bina, B., Nikaeen, M. & Attar, H. M. (2009). Effectiveness of chitosan as natural coagulant aid in removal of turbidity and bacteria from turbid waters. *Journal of Food, Agriculture & Environment, 7(4),* pp. 845-850.

Meraz, K. A. S., Vargas, S. M. P., Maldonado, J. T. L., Bravo, J. M. C., Guzman, M. O. & Maldonado, E. A. L. (2015). Eco-friendly innovation for nejayote coagulation–flocculation process using chitosan: Evaluation through zeta potential measurements. *Chemical Engineering Journal, 284,* pp. 536-542.

Merzouk, B., Gourich, B., Madani, K., Vial Sekki, A. (2011). Removal of a disperse red dye from synthetic wastewater by chemical coagulation and continuous

electrocoagulation. A comparative study. *Desalination, 272,* pp. 246-253.

Mirghani, M. E. S., Liyana, Y. & Parveen, J. (2012). Bioactivity analysis of lemongrass (*Cymbopogan citratus*) essential oil. *International Food Research Journal, 19(2),* pp. 569-575

Mitic-Stojanovic, D. L., Zarubica, A., Purenovic, M., Bojic, D., Andjelkovic, T. & Bojic, A. L. (2011). Biosorptive removal of $Pb^{2+}$, $Cd^{2+}$ and $Zn^{2+}$ ions from water by *Lagenaria vulgaris* shell. *Water S.A,* pp. 1-10.

Mohamed Hanaa, A. R., Sallam, Y. I., El-Leithy, A. S., & Aly, S. E. (2012). Lemongrass (*Cymbopogon citratus*) essential oil as affected by drying methods. *Annals of Agricultural Sciences, 57(2),* pp. 113-116.

Mohammad, T. A., Mohamed, E. H., Noor, M. J. M. M. & Ghazali, A. H. (2014). Dual polyelectrolytes incorporating *Moringa oleifera* in the dewatering of sewage sludge. *Desalination and Water Treatment, 55(13),* pp. 3613-3620.

Mohd Omar, F., Rahman, N. N. N. A., & Ahmad, A. (2008). COD reduction in semiconductor wastewater by natural and commercialized coagulants using response surface methodology. *Water, Air, and Soil Pollution, 195(1-4),* pp. 345-352.

Mohd Remy Rozainy M. A. Z., Hasif, M., Syafalny., Puganeshwary, P. & Afif, A. (2014). Combination of chitosan and bentonite as coagulant agents in dissolved air flotation. *APCBEE Procedia,10,* pp. 229-234.

Mohd, N. A., Amini, M. H. M. & Masri, M. N. (2016). Properties and characterization of starch as a natural binder: A brief overview. *Journal of Tropical Resources and Sustainable Sciences, 4,* pp.117-121.

Monroy, Y., Riveroa, S. & García, M. A. (2018). Microstructural and techno-functional properties of cassava starch modified by ultrasound. *Ultrasonics – Sonochemistry, 42,* pp. 795-804.

Monrroy, M., García, E., Ríos, K. & García, J. R. (2017). Extraction and physicochemical characterization of mucilage from *Opuntia cochenillifera*. *Journal of Chemistry,* pp. 1-9.

Mosquera, T., Paco Noriega, R., Cornejo, J.C., de Lourdes Pardo, M. (2017). Biological activity of *Cymbopogon citratus* (DC) stapf and its potential cosmetic activities. *International Journal of Phytocosmetics and Natural Ingredients, 3(7),* pp. 1-7.

Mucci, A., Parenti, F., Righi, V. & Schenetti, L. (2013). Citron and lemon under the lens of HR-MAS NMR spectroscopy. *Food Chemistry, 141,* pp. 3167-3176.

Muhammad, I. M., Abdulsalam, S., Abdulkarim, A. & Bello, A. A. (2015). Water melon seed as a potential coagulant for water treatment. *Global Journal of Researches in Engineering: Chemical Engineering, 15(1),* pp. 17-23.

Mukhtar, A., Ali, W. & Hussain, G. (2015). A preliminary study of *Opuntia stricta* as a coagulant for turbidity removal in surface waters. *Proceedings of the Pakistan Academy of Sciences, 52(2),* pp. 117-124.

Muthuraman, G. & Sasikala, S. (2014). Removal of turbidity from drinking water using natural coagulants. *Journal of Industrial and Engineering Chemistry, 20,* pp. 1727-1731.

Muthuraman, G., Sasikala, S. & Prakash, N. (2013). Proteins from natural coagulant for potential application of turbidity removal in water. *International Journal of Engineering and Innovative Technology (IJEIT), 3(1),* pp. 278-283.

Muyibi, S. A. & Evison, L. M. (1995). *Moringa oleifera* seeds for softening hardwater. *Water Research, 29(4),* pp. 1099-1105.

Naceradska, J., Pivokonska, L. & Pivokonsky, M. (2019). On the importance of pH value in coagulation. *Journal of Water Supply: Research and Technology-Aqua,* pp. 1-9.

NAHRIM. The Current Status of Selected Lakes in Malaysia. *National Seminar on Research and Management of Lakes and their Basins for Sustainable Use: 3rd Series.* Paya Indah Wetlands, Seri Kembangan: National Hydraulic Research Institute of Malaysia. 2013.

Naik, M. I., Fomda, B. A., Jaykumar, E. & Bhat, J. A. (2010). Antibacterial activity of lemongrass (*Cymbopogon citratus*) oil against some selected pathogenic bacterias. *Asian Pacific Journal of Tropical Medicine,* pp. 535-538.

Narasiah, K. S., Vogel, A. & Kramadhati, N. N. (2002). Coagulation turbid waters using *Moringa oleifera* seeds from to distinct sources. *Water Science Technology and Water Supply, 2(5-6),* pp. 83-88.

Natrajan, D., Sharmila Srinivasan, K. & Sundar, A. R. (2015). Formulation of essential oil-loaded chitosan alginate nanocapsules, *Journal of Food and Drug Analysis,* pp 1-9.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Ndabigengesere, A., Narasiah, K. S. & Talbot, B. G. (1995). Active agents and mechanism of coagulation of turbid waters using *Moringa oleifera. Water Research, 29(2),* pp. 703-710.

Negrelle, R. R. B. & Gomes, E. C. (2007). *Cymbopogon citratus* (Dc) Stapf: chemical composition and biological activities. *Revolution of Brasilian Plant Medical Botucatu, 9,* pp. 80-92.

Ni, F., Peng, X., He, J., Yu, L., Zha, J. & Luan, Z. (2012). Preparation and characterization of composite bioflocculants in comparison with dual-coagulants for the treatment of kaolin suspension. *Chemical Engineering Journal, 213,* pp. 195-202.

Niba, L., Bokanga, M., Jackson, F., Schlimme, D. & Li, B. (2002). Physicochemical properties and starch granular characteristics of flour from various *Manihot esculenta* (cassava) genotypes. *Journal of Food Science 67(5),* pp. 1701-1705.

Niquette, P., Monette, F., Azzouz, A. & Hausler, R. (2004). Impacts of substituting aluminum-based coagulants in drinking water treatment. *Water Quality Research Journal of Canada, 39(3),* pp. 303-310.

Nithyanandam, R. & Weng, T. (2015). Case Study: Analysis of water quality in Sungai Batu Ferringhi. *Journal of Engineering Science and Technology EURECA Special Issue,* pp. 15-25.

Nkurunziza, T., Nduwayezu, J. B., Banadda, E. N. & Nhapi, I. (2009). The effect of turbidity levels and *Moringa oleifera* concentration on the effectiveness of coagulation in water treatment. *Water Science and Technology, 59(8),* pp. 1551-1558.

Nobel, P. S., Cacelier, J. & Andrade, J. L. (1992). Mucilage in Cacti: Its aplopastic capantance, associated solutes and influence on tissue relations. *Journal of Experimental Botany, 43*, pp. 641-648.

Nur Ain, A. H., Zaibunnisa, A. H., Halimahton Zahrah, M. S. and Norashikin, S. (2013). An experimental design approach for the extraction of lemongrass (*Cymbopogon citratus*) oleoresin using pressurised liquid extraction (PLE). *International Food Research Journal, 20(1),* pp. 451-455.

Nuwamanya, E., Baguma, Y., Emmambux, N. & Rubaihayo, P. (2010). Crystalline and pasting properties of cassava starch are influenced by its molecular properties. *African Journal of Food Science, 4(1),* pp. 8-15.

Nweke, F. I., Spencer, D. S. C. & Lynem, J. K. *The Cassava Transformation – Africa's Best Kept Secret*. East Lansing: Michigan State Univ. Press. 2002

Nwodoa, U. U., Greena, E., Mabinyaa, L. V., Okaiyetoa, K., Rumboldb, K., Obia, L. C. & Okoha, A. I. (2014). Bioflocculant production by a consortium of Streptomyces and Cellulomonas species and media optimization via surface response model. *Colloids and Surfaces B: Biointerfaces, 116,* pp. 257-264.

Nyanti, L., Ling, T. Y. & Jongkar, G. (2012). Physico-chemical characteristics in the filling phase of bakun hydroelectric reservoir, Sarawak, Malaysia. *International Journal of Applied Science and Technology, 2(6),* pp. 92-101.

Odiyo, J. O., Bassey, O. J., Ochieng, A. & Chimuka, L. (2017). Coagulation efficiency of *Dicerocaryum eriocarpum* (DE) plant. *Water SA,43,* pp. 1-6.

Ojima, Y., Nguyen, M. H., Yajima, R. & Taya, M. (2015). Flocculation of *Escherichia coli* cells in association with enhanced production of outer membrane vesicles. *Applied and Environmental Microbiology, 81(17),* pp. 5900-5906.

Okoro, I. A. & Abii, T. (2011). Sorption models of cadmium (II) ion onto edible fruit wastes. *American Journal of Scientific and Industrial Research, 2(3),* 386-390.

Okuda, T., Aloysius U Baes, A. U., Nishijima, W. & Okada, M. (1999). Improvement of extraction method of coagulation active components from *Moringa oleifera* seed. *Water Research, 33(15),* pp. 3373-3378.

Oladoja, N. A. & Aliu, Y. D. (2009). Snail shell as coagulant aid in the alum precipitation of malachite green from aqua system. *Journal of Hazardous Materials, 164,* pp. 1496-1502.

Oladoja, N. A. (2015). Headway on natural polymeric coagulants in water and wastewater treatment operations. *Journal of Water Process Engineering, 6,* pp. 174-192.

Olorunnisola, S. K., Asiyanbi, H. T., Hammed, A. M. & Simsek, S. (2014). Biological properties of lemongrass: An overview. *International Food Research Journal, 21(2),* pp. 455-462.

Omeroglu-Ay, C., Ozcan, A. S., Erdogana, Y. & Ozcan, A. (2012). Characterization of Punica granatum L. peels and quantitatively determination of its biosorption behavior towards lead(II) ions and Acid Blue 40. *Colloids and Surfaces B: Biointerfaces, 100,* pp. 197-204.

Omodamiro, O. D., Nwankwo, C. I. & Ejiofor, E. U. (2014). Antimicrobial and coagulant property of *Moringa oleifera* seed in water purification. *Scholars Journal of Agriculture and Veterinary Sciences, 1(4B),* pp. 279-287.

Onawunmi, G. O. (1989). Evaluation of the antimicrobial activity of citral. *Letters in Applied Microbiology, 9,* pp. 105-108.

Onawunmi, G. O., Yisak, W. A. & Ogunlana, E. O. (1984). Antibacterial constituents in the essential oil of *Cymbopogon citratus* (DC.) *Stapf. Journal of Ethnopharmacology, 12(3),* pp. 279-86.

Orumwense, F. F. O. & Nwachukwu, J. C. (2000). Clarification of colliery effluents using modified starch and synthetic polymer. *Indian Journal of Chemical Technology. 7,* pp. 19-22.

Ozacar, M. & Sengil, A. (2000). Effectiveness of tannins obtained from valonia as a coagulant aid for dewatering of sludge. *Water Research, 34(2),* pp. 1407-1412.

Palacios-Fonseca, A. J., Castro-Rosas, J., Gómez-Aldapa, C. A., Tovar-Benítez, T., Millán-Malo, B. M., del Real, A. & Rodríguez-García, M. E. (2013). Effect of the alkaline and acid treatments on the physicochemical properties of corn starch, CyTA. *Journal of Food, 11(1),* pp. 67-74.

Pandey, P. K., Kass, P. H., Soupir, M. L., Biswas, S. & Singh, V. P. (2014). Contamination of water resources by pathogenic bacteria, *AMB Express, 4(51),* pp. 1-16.

Pang, F. M., Kumar, P., Teng, T. T., Mohd Omar, A. K. & Kailas, L. (2011). Removal of lead, zinc and iron by coagulation–flocculation. *Journal of the Taiwan Institute of Chemical Engineers, 42,* pp. 809-815.

Parikh, S. J., Mukome, F. N. D. & Zhang, X. (2014). ATR–FTIR spectroscopic evidence for biomolecular phosphorus and carboxyl groups facilitating bacterial adhesion to iron oxides. *Colloids and Surfaces B: Biointerfaces, 119,* pp. 38-46.

Patchaiyappan, A., Sarangapany, S., Saksakom, Y. A. & Devipriya, S. P. (2019). Feasibility study of a point of use technique for water treatment using plant-based coagulant and isolation of a bioactive compound with bactericidal properties. *Separation Science and Technology,* pp. 1-12.

Peck, L. K. & Kian, H. C. (2017). Development of fruit-based waste material as bioflocculant for water clarification. *Journal of Mechanical Engineering, 4(5),* pp. 1-10.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Pillai, S. S., Mullassery, M. D., Fernandez, N. B., Girij, N., Geetha, P. & Koshy, M. (2013). Biosorption of Cr(VI)from aqueous solution by chemically modified potato starch: Equilibrium and kinetic studies. *Ecotoxicology and Environmental Safety, 92,* pp. 199-205.

Pontius, F. W. (2016). Chitosan as a drinking water treatment coagulant. *American Journal of Civil Engineering, 4(5),* pp. 205-215.

Postnote. (2002). Access to Sanitation in Developing Countries. Document of the Parliamentry Office of Science and Technology - 190. Retrieved on June 17, 2017, from http://www.parliament.uk/post/home.htm

Pourrezaei, P., Drzewicz, P., Wang, Y., El-Din, G. M., Perez-Estrada, L. A., Martin, J. W., Anderson, J., Wiseman, S., Liber, K. & Giesy, J. P. (2011). The impact of metallic coagulants on the removal of organic compounds from oil sands process-affected water. *Environmental Science and Technology, 45(19),* pp. 4852-4859.

Prado, H. J., Matulewicz, M. C., Bonelli, P. R. & Cukierman, A. L. (2011). Potential use of a novel modified seaweed polysaccharide as flocculating agent. Desalination, 281, pp. 100-104.

Pritchard, M., Craven, T., Mkandawire, T., Edmondson, A. S. & O'Neill, J. G. (2010). A comparison between *Moringa oleifera* and chemical coagulants in the purification of drinking water – An alternative sustainable solution for developing countries. *Physics and Chemistry of the Earth, 35,* pp. 798-805.

Priya, T., Tarafdar, A., Gupta, B. & Mishra, B. K. (2018). Effect of bioflocculants on the coagulation activity of alum for removal of trihalomethane precursors from low turbid water. *Journal of Environmental Sciences, 10,* pp. 1-10.

Qin, C., Li, H., Xiao, Q., Liu, Y., Zhu, J. & Du, Y. (2006). Water solubility of chitosan and its antimicrobial activity. *Carbohydrate Polymers, 63,* pp. 367-374.

Rabiee, A., Ershad-Langroudi, A. & Zeynali, M. E. (2015). A survey on cationic polyelectrolytes and their applications: acrylamide derivatives. *Reviews in Chemical Engineering, 31(3),* pp. 239-261.

Rahaman, Z. A., Che Rus, S. F., Omar, M. A., & Ismail, W. R. (2016). Rivers and lakes as natural heritage: water quality status in the northern states of peninsular Malaysia. *Kemanusiaan, 23(1),* pp. 109-128.

Ramavandi, B. (2014). Treatment of water turbidity and bacteria by using a coagulant extracted from *Plantago ovata*. *Water Resources and Industry, 6,* pp. 36-50.

Ramírez, M. G. L., Satyanarayana, K. G., Iwakiri, S., Bolzon de Muniz, G., Tanobe, V. & Flores-Sahagun, T. S. (2011). Study of the properties of biocomposites. Part I. Cassava starch-green coir fibers from Brazil. *Carbohydrate Polymers, 86*, pp. 1712-1722.

Ranitha, M., Abdurahman, H. N., Sulaiman, Z.A., Nour, A. H. & Thana Raj, S. (2014). A comparative study of lemongrass (*Cymbopogon citratus*) essential oil extracted by microwave-assisted hydrodistillation (MAHD) and conventional hydrodistillation (HD) method. *International Journal of Chemical Engineering and Applications, 5(2),* pp. 104-108.

Rasul, M. G., Sujaul Islam, M., Yahaya, F. M., Alam, L. & Mokthar, M. (2015). Effects of anthropogenic impact on water quality in Bertam catchment, Cameron Highlands, Malaysia. *International Journal of Ecology and Environmental Sciences 41(1-2),* pp. 75-86.

Razak, N. H. A., Praveena, S. M., Aris, A. Z., Hashim, Z. (2015). Drinking water studies: A review on heavy metal, application of biomarker and health risk assessment (a special focus in Malaysia). *Journal of Epidemiology and Global Health, 5,* pp. 297-310.

Razali, A., Syed Ismail, S. N., Awang, S., Praveena, S. M., & Zainal Abidin, E. (2018). Land use change in highland area and its impact on river water quality: a review of case studies in Malaysia. *Ecological Processes, 7(1),* pp. 1-17.

Razali, M. A. A. & Ariffin, A. (2015). Polymeric flocculant based on cassava starch grafted polydiallyldimethylammonium chloride: Flocculation behavior and mechanism. *Applied Surface Science, 351,* pp. 89-94.

Rebah, B. F., Mnif, W. & M. Siddeeg, S. (2018). Microbial flocculants as an alternative to synthetic polymers for wastewater treatment: A review. *Symmetry, 10(11),* pp. 1-19.

Renault, F., Sancey, B., Badot, P. M. & Crini, G. (2009). Chitosan for coagulation/flocculation processes – An eco-friendly approach. *European Polymer Journal, 45*, pp. 1337-1348.

Revathi, K., Ashok Kumar, C. K. & Thamizhvanan, K. (2012). Combined antimicrobial activity of lemon grass oil and tulasi oil. *International Journal of Preclinical and Pharmaceutical Research, 3(2),* pp. 79-81.

Robyt, J. F., Choe, J. Y. & Fox, J. D. (1996). Acid modification of starch granules of in alcohols: reactions in mixtures of two alcohols combined in different ratios. *Carbohydrate Research, 283,* pp. 141-150.

Rodgher, S., Espíndola, E. L. G., Rocha, O., Fracácio, R., Pereira, R. H. G. & Rodrigues, M. H. S. (2005). Limnological and ecotoxicological studies in the cascade of reservoirs in the Tietê River (São Paulo, Brazil). *Brazilian Journal of Biology, 65(4),* pp. 697-710.

Rodríguez-Sandoval, E., Fernández-Quintero, A., Cuvelier, G., Relkin, P. & Bello-Pérez, L. (2005). Starch retrogradation in cassava flour from cooked paenchyma. *Starch/Stärke, 60,* pp. 174-180.

Rondeau, V., Iron, A., Letenneur, L., Commenges, D., Duchene, F., Arveiler, B. & Dartigues, J. F. (2006). Analysis of the effect of aluminum in drinking water and transferrin C2 allele on Alzheimer's disease. *European Journal of Neurology, 13,* pp. 1022-1025.

Rong, H., Gao, B., Dong, M., Zhao, Y., Sun, S., Yanwang, Y. Q. & Li, Q. (2013). Characterization of size, strength and structure of aluminum-polymer dual-coagulant flocs under different pH and hydraulic conditions. *Journal of Hazardous Materials, 15(252-253),* pp. 330-337.

Rosenberg, B. (1971). Some biological effects of platinum compounds new agents for the control of tumors. *Platinum Metals Review, 15(2),* pp. 42-51

Roussy, J., Van-Vooren, M., Dempsey, B. & Guibal, E. (2005). Influence of chitosan characteristics on the coagulation and the flocculation of bentonite suspensions. *Water Research,39,* pp. 3247-3258.

Rusenova, N. & Parvanov, P. (2009). Antimicrobial activities of twelve essential oils against microorganisms of veterinary importance. *Trakia Journal of Sciences, 7 (1),* pp. 37-43.

Sacithraa, R., MadhanMohan, M., Vijayachitra, S. (2013). Quantitative analysis of tapioca starch using FTIR spectroscopy and partial least squares. *International Journal of Computer Applications*, pp 29-33.

Sahu, O. P. & Chaudhari, P. K. (2013). Review on chemical treatment of industrial wastewater. *Journal of Applied Science and Environmental Management, 17(2),* pp. 241-257.

Sakai, K., Matsunaga, M., Minato, K. & Nakatsubo, F. (1999). Effects of impregnation of simple phenolic and natural polycyclic compounds on physical properties of wood. *Journal of Wood Science, 45,* pp. 227-232.

Salehizadeh, H. & Yan, N. (2014). Recent advances in extracellular biopolymer flocculants. *Biotechnology Advances, 32,* pp. 1506-1522.

Sanchez-Martin, J., Gonzalez-Velasco, M. & Beltran-Heredia, J. (2010). Surface water treatment with tannin-based coagulants from Quebracho (*Schinopsis balansae*). *Chemical Engineering Journal, 165,* pp. 851-858.

Sanchez-Rivera, M. M., Flores-Ramírez, I., Zamudio-Flores, P. B., González-Soto, R. A., Rodríguez-Ambrí, S. A. & Bello-Pérez, L. A. (2010). Acetylation of banana (*Musa paradisiaca L.*) and maize (*Zea mays L.*) starches using a microwave heating procedure and iodine as catalyst: Partial characterization. *Starch, 62,* pp. 155-164.

Sangita, S., Nayak, N. & Panda, C. R. (2017). Extraction of aluminium as aluminium sulphate from thermal power plant fly ashes. *Transactions of Nonferrous Metals Society of China, 27(9),* pp. 2082-2089.

Santos, A. F. S., Paiva, P. M. G., Teixeira, J. A. C., Brito, A. G., Coelho, L. C. B. B. & Nogueira, R. (2012). Coagulant properties of *Moringa oleifera* protein preparations: application to humic acid removal. *Environmental Technology, 33(1),* pp. 69-75.

Sapis, A., Nyanti, L., Lin, T. Y., Sim, S. F. & Grinang, J. (2017). Assessing water quality of Murum reservoir halfway through impoundment. *Sains Malaysiana, 46(12),* pp. 2367-2374.

Saravanan, R. & Ravikumar, L. (2015). The use of new chemically modified cellulose for heavy metal ion adsorption and antimicrobial activities. *Journal of Water Resource and Protection, 7,* pp. 530-545.

Sardool Singh, G. K., Kuppan, P., Goto, M., Sugiura, N., Megat Mohd Noor, M. J. & Ujang, Z. (2013). Physical water quality and algal density for remediation of algal blooms in tropical shallow eutrophic reservoir. *Journal of Novel Carbon Resource Sciences, 7,* pp. 33-41.

Saritha, V., Srinivas, N. & Dwarapureddi, B. (2015a). Connotation of natural coagulants on total organic carbon content of water. *International Journal of Innovative Research in Science, Engineering and Technology, 4(6),* pp. 3910-3918.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Saritha, V., Srinivas, N. & Srikanth Vuppala, N. V. (2015b). Analysis and optimization of coagulation and flocculation process. *Applied Water Science,* pp. 1-10.

Sasakova, N., Gregova, G., Takacova, D., Mojzisova, J., Papajova, I., Venglovsky, J. & Kovacova, S. (2018). Pollution of surface and ground water by sources related to agricultural activities. *Frontiers in Sustainable Food Systems, 2,* pp. 1-11.

Sciban, M., Klasnja, M. & Stojimirovic, J. (2005). Investigation of coagulation activity of natural coagulants from seeds of different leguminose species. *Acta Periodica Technology, 36,* pp. 81-87.

Segura, M. E. M. & Sira, E. E. P. (2003). Characterization of native and modified Cassava starch by scanning electron microscopy and X-Ray diffraction techniques. *Cereal Foods World, 48(2),* pp. 78-81.

Shafad, M. R., Ahamad, I. S., Idris, A. & Zainal Abidin, Z. (2013). A preliminary study on dragon fruit foliage as natural coagulant for water treatment**.** *International Journal of Engineering Research & Technology, 2(12),* pp. 1057-1063.

Shak, K. P. Y. & Wu, T. Y. (2014). Coagulation-flocculation treatment of high-strength agro-industrial wastewater using natural *Cassia obtusifolia* seed gum. Treatment efficiencies and flocs characterization. *Chemical Engineering Journal, 256,* pp. 293-305.

Shamsnejati, S., Chaibakhsh, N., Pendashteh, A. R. & Hayeripour, S. (2015). Mucilaginous seed of *Ocimum basilicum* as a natural coagulant for textile wastewater treatment. *Industrial Crops and Products, 69,* pp. 40-47.

Shannon, J. C., Garwood, D. L. & Boyer, C. D. (2009). Genetics and Physiology of Starch Development: Chapter 3. In: BeMiller, J. and Whistler, R. *Starch: Chemistry and Technology,* pp. 24-25.

Shariffa, Y. N., Uthumporn, U., Karim, A. A. & Zaibunnisa, A. H. (2017). Hydrolysis of native and annealed tapioca and sweet potato starches at subgelatinization temperature using a mixture of amylolytic enzymes. *International Food Research Journal, 24(5),* pp. 1925-1933.

Sharip Z. & Zakaria S. Lake and reservoir in Malaysia: management and research challenges. In: M. Sengupta & R. Dalwani (Ed). *TAAL 2007: The 12th World Lake Conference.* Japan: International Lake Environment Committee Foundation. pp. 1349–55; 2007.

Sharip, Z., Zaki, A. T. A., Shapai, M. A. H. M., Suratman, S., & Shaaban, A. J. (2014). Lakes of Malaysia: Water quality, eutrophication and management. *Lakes & Reservoirs: Research & Management, 19(2),* pp. 130-141.

Shi, C., Zhao, X., Liu, Z., Meng, R., Chen, X., & Guo, N. (2016). Antimicrobial, antioxidant, and antitumor activity of epsilon-poly-L-lysine and citral, alone or in combination. *Food & Nutrition Research, 60(1),* pp. 1-9.

Shuhaimi-Othman, M., Ahmad, A. and Lim, E. C. Seasonal influence on water quality and heavy metals concentration in Tasik Chini, Peninsular Malaysia. In: M. Sengupta & R. Dalwani (Ed). *TAAL 2007: The 12th World Lake Conference*. Japan: International Lake Environment Committee Foundation. pp. 300-303; 2008.

Sieliechi, J. M., Kayem, G. H. & Sandu, I. (2010). Effect of water treatment residuals (aluminum and iron ions) on human health and drinking water distribution systems. *International Journal of Conservation Science, 1(3),* pp. 175-182.

Simate, G. S. & Ndlovu, S. (2015). The removal of heavy metals in a packed bed column using immobilized cassava peel waste biomass. *Journal of Industrial and Engineering Chemistry, 21,* pp. 635-643.

Singh, R. P., Tripathy, T., Karmakar, G. P., Rath, S. K., Karmakar, N. C., Pandey, S. R., Kannan, K., Jain, S. K. & Lan, N. T. (2000). Novel biodegradable flocculants based on polysaccharides. *Current Science, 78(7),* pp. 798-803.

Sodhi, N. S., Chang, Y. H., Kaur, N. & Kohyama, K. (2009). Effect of acid–methanol treatment on the molecular structure and physicochemical properties of lentil (*Lens culinaris Medik*) starch. *Food Hydrocolloids, 23(8),* pp. 2219-2225.

Sommerauer, A., Sussman, D. L. & Stumm, W. (1986). The role of complex formation in the flocculation of negatively charged sols with anionic polyelectrolytes. *Kolloid-zeitschri und zeitschrit fur poiymere,* pp. 147-154.

Somolinos, M., Garcia, D., Condón, S., Mackey, B. & Pagan, R. (2009). Inactivation of *Escherichia coli* by citral. *Journal of Applied Microbiology, 108(6),* pp. 1928-1939.

Somolinos, M., Garcia, D., Manas, P., Condon, S. & Pagan, R. (2008). Effect of environmental factors and cell physiological state on pulsed electric fields resistance and repair capacity of various strains of *Escherichia coli. International Journal of Food Microbiology,124,* pp. 260-267.

Song, Z., Williams, C. J. & Edyvean, R. G. J. (2004). Treatment of tannery wastewater by chemical coagulation. *Desalination, 164,* pp. 249-259.

Sowmeyan, R., Santhosh, J. & Latha, R. (2011). Effectiveness of herbs in community water treatment. *International Research Journal of Biochemistry and Bioinformatics, 1(11),* pp. 297-303.

Srinivasan, P. T., Viraraghavan, T. & Subramanian, K. S. (1999). Aluminium in drinking water: An overview. *Water SA, 25(1),* pp. 55-56.

Sriroth, K., Santisopasri, V., Petchalanuwat, C., Kurotjanawong, K., Piyachomkwan, K. & Oates, C. G. (1999). Cassava starch granule structure-function properties: infuence of time and conditions at harvest on four cultivars of cassava starch. *Carbohydrate Polymers, 38,* pp. 161-170.

Stojanovic, D. L. M., Zarubica, A., Purenovic, M., Bojic, D., Andjelkovic, T. & Bojic, A.L. (2011). Biosorptive removal of $Pb^{2+}$, $Cd^{2+}$ and $Zn^{2+}$ ions from water by *Lagenaria vulgaris* shell. *Water SA, 37(3),* pp. 303-312.

Su, Z., Liu, T., Yu, W., Li, X., Graham, N. J. D. (2017). Coagulation of surface water: Observations on the significance of biopolymers. *Water Research, 126,* pp. 144-152.

Subashree, R., Praba, N. S. & Anusha, G. (2017). Investigation of coagulation activity of lemon and banana peel powder in water treatment. *International Journal on Advanced Research in Science and Engineering, 6(10),* pp 852-855.

Subehi, L., Ismail, S. N., Ridwansyah, I., Hamid, M. A., & Mansor, M. (2018). Analysis of the influence of reservoirs utilization to water quality profiles in Indonesia (Saguling – Jatiluhur) and Malaysia (Temengor – Chenderoh) with special references to cascade reservoirs. *IOP Conference Series: Earth and Environmental Science, 118,* pp. 1-8.

Subramonian, W., Wu, T. Y. & Chai, S. P. (2014). A comprehensive study on coagulant performance and floc characterization of natural *Cassia obtusifolia* seed gum in treatment of raw pulp and paper mill effluent. *Indian Crops Production, 61,* pp. 317-324,

Suharso & Buhani. (2011). Biosorption of Pb(II), Cu(II) and Cd(II) from aqueous solution using cassava peel waste biomass. *Asian Journal of Biochemistry, 23(3*), pp. 1112-1116.

Sujaul Islam, M., Ismail, B.S., Muhammad Barzani, G., Sahibin, A. R. & Mohd Ekhwan, T. (2012). Hydrological assessment and water quality characteristics

of Chini Lake, Pahang, Malaysia. *American-Eurasian Journal of Agriculture and Environmental Sciences, 12(6),* pp. 737-749.

Supardan, M. D., Annisa, Y., Arpi, N., Satriana. & Wan Mustapha, W. A. (2016). Cassava starch edible film incorporated with lemongrass oil: characteristics and application. *International Journal on Advanced Science, Engineering and Information Technology, 6(2),* pp. 216-220.

Suruhanjaya Perkhidmatan Air Negara (SPAN). *Water demand management:* 1st Ed. Cyberjaya: SPAN Wilayah Selatan. 2017.

Syed Ismail, S. N., Kather Mahiddin, N. & Praveena, S. M. (2018). The used of dragon fruit peels as eco-friendly wastewater coagulants. *Asian Journal of Agriculture and Biology, Special Issue,* pp. 66-71.

Tajidin, N. E., Ahmad, S. H, Rosenani, A. B., Azimah, H. & Munirah, M. (2012). Chemical composition and citral content in lemongrass (*Cymbopogon citratus*) essential oil at three maturity stages. *African Journal of Biotechnology, 11(11),* pp. 2685-2693.

Tan, K.C., Tan, M. L., Lim, H. S., Mat Jafri, M. Z. (2017). Analysis of ozone observation at atmospheric monitoring network station using Brewer ozone spectrophotometer. *Proceedings of SPIE, 10428,* pp. 1-7.

Tan, S. L. (2015). Cassava – silently, the tuber fills. *UTAR Agriculture Science Journal, 1(2),* pp. 12-24.

Tan, S. L. Potential and constraints of starch crops as feedstuffs. *Conference of Animal Feedstuffs in Malaysia: Issues, Strategies and Opportunities*. 15-16 April 2008 "Animal Feedstuffs in Malaysia. Putrajaya, Kuala Lumpur: Akademi Sains Malaysia. 2009. pp. 39-55.

Tang, H., Xiao, F. & Wang, D. (2015). Speciation, stability, and coagulation mechanisms of hydroxyl aluminum clusters formed by PACl and alum: A critical review. *Advances in Colloid and Interface Science, 226,* pp. 78-85.

Tang, W., Song, L., Li, D., Qiao, J., Zhao, T. & Zhao, H. (2014). Production, characterization, and flocculation mechanism of cation independent, pH tolerant, and thermally stable bioflocculant from Enterobacter sp. *ETH-2. PLoS ONE, 9(12),* pp. 1-19.

Tarleton, E. S. & Wakeman, R. J. Computer software for the simulation of solid/liquid separation equipment. *Proceedings of the International Conference and*

*Exhibition for Filtration and Separation Technology*. 27 February- 1 March 2007. Wiesbaden, Germany: Filtech. 2007. pp. 11-18.

Tatiana, M. T., Paco, N. R., Juan, C. C. & María de Lourdes, P. (2016). Biological activity of *Cymbopogon citratus* (dc) stapf and its potential cosmetic activities. *International Journal of Phytocosmetics and Natural Ingredients, 3(7),* pp. 1-7.

Teerawanichpan, P., Manassawe, L., Supatcharee, N., Saiyavit, V., Opas, B. & Jarunya, N. (2008). Influence of cassava storage root development and environmental conditions on starch granule size distribution. *Starch - Stärke, 60*, pp. 696-705.

Teh, C. Y., Wu, T. Y. & Juan, J. C. (2014). Potential use of rice starch in coagulation–flocculation process of agro-industrial wastewater: Treatment performance and flocs characterization. *Ecological Engineering, 71,* pp. 509-519

Thakur, S. S. & Choubey, S. (2014). Use of tannin based natural coagulants for water treatment: An alternative to inorganic chemicals. *International Journal of Chemical Technology Research, 6(7),* pp. 3628-3634.

Theodoro, J. D. P., Lenz, G. F., Zara, R. F. & Bergamasco, R. (2013). Coagulants and natural polymers: Perspectives for the treatment of water. *Plastic and Polymer Technology, 2(3),* pp. 55-62.

Tirado, D. F., Herrera, A. P. & Correa, D. A. (2017). Evaluation of the coagulant capacity of starch obtained from topocho pelipita plantain clone (musa abb) for turbidity and color removal in raw waters. *Revista Internacional de Contaminacion Ambiental, 33*, pp. 125-134.

Tivana, L. D. *Cassava Processing: Safety and Protein Fortification.* PhD. Thesis. LTH Lund University, Sweden; 2002.

Tongnuanchan, P. & Benjakul, S. (2014). Essential oils: extraction, bioactivities, and their uses for food preservation. *Journal of Food Science, 79(7),* pp. 1231-1249.

Tukomane, T., Leerapongnun, P., Shobsngob, S. & Varavinit, S. (2007). Preparation and characterization of annealed-enzymatically hydrolyzed tapioca starch and the utilization in tableting. *Starch/Stärke, 59,* pp. 33-45.

Unnisa, S. A. & Bi, S. Z. (2018). Carica papaya seeds effectiveness as coagulant and solar disinfection in removal of turbidity and coliforms. *Applied Water Science, 8(6),* pp. 1-8.

Usefi, S. & Asadi-Ghalhari, M. (2019). Modeling and optimization of the coagulation–flocculation process in turbidity removal from aqueous solutions using rice starch. *Pollution, 5(3),* pp. 623-636.

Van Hung, P., Nguyen Thi, M. H., Nguyen Thi, L. P. & Nguyen Ngoc, T. T. (2017). Physicochemical characteristics and in vitro digestibility of potato and cassava starches under organic acid and heat-moisture treatments. *International Journal of Biological Macromolecules, 95,* pp. 299-305.

Vasconcelos, L. M., Brito, A. C., Carmo, C. D., Oliveira, P. H. G. A. & Oliveira E. J. (2017). Phenotypic diversity of starch granules in cassava germplasm. *Genetics and Molecular Research, 16 (2),* pp. 1-15.

Ventura, M., Canchaya, C., Tauch, A., Chandra, G., Fitzgerald., G. F., Chater, K. F. & Van Sinderen, D. (2007). Genomics of actinobacteria: tracing the evolutionary history of an ancient phylum. *Microbiology and Molecular Biology, 71(3),* pp. 495-548.

Wahab, M. A., Boubakri, H., Jellali, S. & Jedidi, N. (2012). Characterization of ammonium retention processes onto Cactus leaves fibers using FTIR, EDX and SEM analysis. *Journal of Hazardous Materials, 241– 242,* pp. 101– 109.

Walker, D. B., Baumgartner, D. J., Gerba, C. P. & Fitzsimmons, K. (2019). Surface water pollution. *Environmental and Pollution Science,* pp. 261-292.

Wan Kamar, W. I. S., Abdul Aziz, H. & Ramli, S. F. (2015). Removal of suspended solids, chemical oxygen demand and color from domestic wastewater using sago starch as coagulant. *Applied Mechanics and Materials, 802,* pp. 519-524.

Wang, J. P., Yuan, S. J., Wang, Y. & Yu, H. Q. (2013). Synthesis, characterization and application of a novel starch-based flocculant with high flocculation and dewatering properties. *Water Research, 47(8),* pp. 2643-2648.

Warren, F. J., Gidley, M. J. & Flanagan, B. (2015). Infrared spectroscopy as a tool to characterise starch ordered structure- a joint FTIR-ATR, NMR, XRD and DSC study. *Carbohydrate Polymers,* pp. 1-27.

WHO. *Guidelines for drinking water quality,* 2nd Ed. Geneva, Switzerland. 1997.

Wikaningtyas, P. & Sukandar, E. Y. (2015). The antibacterial activity of selected plants towards resistant bacteria isolated from clinical specimens. *Asian Pacific Journal of Tropical Biomedicine,* pp. 1-12.

Won, C., Jin, Y., Kim, M., Lee, Y. & Chang, Y. H. (2017). Structural and rheological properties of potato starch affected by degree of substitution by octenyl

succinic anhydride. *International Journal of Food Properties, 20(12),* pp. 3076-3089.

Wongsagonsup, R., Shobsngo, S., Oonkhanond, B. & Varavinit, S. (2005). Zeta potential analysis for the determination of protein content in rice flour. *Starch/Stärke, 57*, pp. 25-31.

Wu, H., Liu, Z. Z., Yang, H. & Li, A. (2016). Evaluation of chain architectures and charge properties of various starch-based flocculants for flocculation of humic acid from water. *Water Research, 96,* pp. 126-135.

Wu, L., Zhang, X., Chen, L., Zhang, H., Li, C., Li, Y. & Guo, X. (2018). Amphoteric starch derivatives as reusable flocculant for heavy-metal removal. *RSC Advances, 8(3),* pp. 1274-1280.

Wu, X., Ge, X., Wang, D. & Tang, H. (2009). Distinct mechanisms of particle aggregation induced by alum and PACl: Floc structure and DLVO evaluation. *Colloids and Surfaces A: Physicochemistry and Engineering Aspects, 347,* pp. 56-63.

Xia, H., Li, B. Z. & Gao, Q. (2017). Effect of molecular weight of starch on the properties of cassava starch microspheres prepared in aqueous two-phase system. *Carbohydrate Polymer, 1(177),* pp. 334-340.

Xiao, H. X., Lin, Q. L., Liu, G. Q. & Yu, F. X. (2012). A comparative study of the characteristics of cross-linked, oxidized and dual-modified rice starches. *Molecules, 17,* pp. 946-957.

Xu, Y. P., Fuyi Cui, T. C. & Shi, W. (2016). Effect of reused alum-humic-flocs on coagulation performance and floc characteristics formed by aluminum salt coagulants in humic-acid water. *Chemical Engineering Journal, 287,* pp. 225-232.

Xue, Y., Liu, Z., Li, A. & Yang, H. (2019). Application of a green coagulant with PACl in efficient purification of turbid water and its mechanism study. *Journal of Environmental Sciences,* pp. 1-14.

Yang, C., Yeong, T. & Ching, J. (2014). Optimization of agro-industrial wastewater treatment using unmodified rice starch as a natural coagulant. *Industrial Crops and Products, 56,* pp. 17-26.

Yang, K., Li, Z., Zhang, H., Qian, J. & Chen, G. (2010) Municipal wastewater phosphorus removal by coagulation. *Environmental Technology, 31(6),* pp. 601-609.

Yang, Z., Wu, H., Yuan, B., Huang, M., Yang, H., Li, A. M., Bai, J. F. & Cheng, R. S. (2014). Synthesis of amphoteric starch-based grafting flocculants for flocculation of both positively and negatively charged colloidal contaminants from water. *Chemical Engineering Journal, 244,* pp. 209-217.

Yasir A. J. A., Yusoff, M. S., Muhammad Umar, Bashir, M. J. K. & Adlan, M. N. (2011). Application of psyllium husk as coagulant and coagulant aid in semi-aerobic landfill leachate treatment. *Journal of Hazardous Materials, 190,* pp. 582-587.

Yin, C.Y. (2010). Emerging usage of plant-based coagulants for water and wastewater treatment. *Process Biochemistry, 45,* pp. 1437-1444.

Yiu, P. H., Loh, S. L., Rajan, A., Wong, S. C. & Bong, C. F. J. (2008). Physiochemical properties of sago starch modified by acid treatment in alcohol. *American Journal of Applied Sciences, 5(4),* pp. 307-311.

Yongabi, K. A. (2010). Biocoagulants for water and waste water purification: A review. *International Review of Chemical Engineering, 2(3),* pp. 445-458.

Yu, J., Liu, H. & Chen, J. (2000). Flocculation and characterization of protein by anionic copolymer containing reactive functional groups. *Colloids and Surfaces. A: Physicochemical and Engineering Aspects, 163,* pp. 225-232.

Yuan, S. J., Guo, P. M., Yinli, W. W., Yao, R. S. & Yu, H. Q. (2011). Identification of key constituents and structure of the extracellular polymeric substances excreted by bacillus megaterium TF10 for their flocculation capacity. *Environtal Science Technology, 45,* pp. 1152-1157.

Yuk, F. H., Shin, Y. A., Khia M. L. & Teang, S. L. (2015). Quality of water resources in Malaysia. *Research and Practices in Water Quality,* pp. 65-94.

Yukselen, M. A. & Gregory, J. (2004). The effect of rapid mixing on the break-up and reformation of flocs. *Journal of Chemical Technology and Biotechnology, 79,* pp. 782-788.

Yusoff, M. S., Abdul Aziz, H.,. Alazaiza, M. Y. D. & Lo, M. R. (2019). Potential use of oil palm trunk starch as coagulant and coagulant aid in semi-aerobic landfill leachate treatment. *Water Quality Research Journal,* pp. 1-17.

Yusoff, M. S., Mohamad Zuki, N. A. & Ahmad Zamri, M. F. M. (2016). Effectiveness of jackfruit seed starch as coagulant aid in landfill leachate treatment process. *International Journal of GEOMATE, 11(26),* pp. 2684-2687.

Yussof, N. S., Utra, U. & Alias, A. K. (2013). Hydrolysis of native and cross-linked corn, tapioca, and sweet potato starches at sub-gelatinization temperature using a mixture of amylolytic enzymes. *Starch/Starke, 65,* pp. 285-295.

Zahrim, A. Y., Dextera, Z. D., Joseph, C. G. & Hilal, N. (2017). Effective coagulation-flocculation treatment of highly polluted palm oil mill biogas plant wastewater using dual coagulants: Decolourisation, kinetics and phytotoxicity studies. *Journal of Water Process Engineering, 16,* pp. 258-269.

Zdenek, F., Hermann, S. & Demnerová, K. (2008). FTIR spectroscopic characteristics of differently cultivated *Escherichia coli. Czech Journal of Food Science, 26(6),* pp. 458-463.

Zhao, S., Gao, B., Li, X. & Dong, M. (2012). Influence of using Enteromorpha extract as a coagulant aid on coagulation behavior and floc characteristics of traditional coagulant in Yellow River water treatment. *Chemical Engineering Journal, 200–202*, pp. 569-576.

Zheng, M. & Zhang, H. J. (2013). Synthesis and application of starch modified flocculant. *Advanced Materials Research, 821-822,* pp. 1014-1018.

Zhou, F. S., Wang, X., Zhou, L. & Liu, Y. (2015). Preparation and coagulation behavior of a novel multiple flocculant based on cationic polymer, hydroxyl aluminum, and clay minerals. *Advances in Materials Science and Engineering*, pp. 1-9.

Zhou, Y., Liang, Z. & Wang, Y. (2008). Decolorization and COD removal of secondary yeast wastewater effluents by coagulation using aluminum sulfate. *Desalination, 225,* pp. 301-311.

Zhu, F. (2017). NMR spectroscopy of starch systems. *Food Hydrocolloids, 63,* pp. 611-624.

Zhu, Z., Li, T., Lu, J., Wang, D. & Yao, C. (2009). Characterization of kaolin flocs formed by polyacrylamide as flocculation aids. *International Journal of Mineral Process, 91,* pp. 94-99.

Ziolkowska, D., Shyichuk, A., Cysewski, P. & Organiściak, A. (2011). Flocculation efficiency of cationic potato starch in the presence of coagulants. *Chemik, 65(4),* pp. 309-314.