STUDY OF NITROGEN CONTAINING COMPOUNDS IN A CLOSED RECIRCULATING WATER OF AN AQUAPONIC SYSTEM GROWING TRITCUM AESTIVUM (WHEATGRASS)

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Report submitted in partial fulfillment of the requirements for the award of the degree of Bachelor of Applied Science (Honours) in Industrial Biotechnology.

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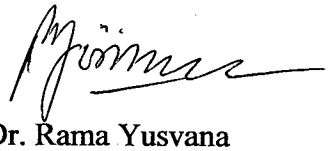
SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Honours) in Industrial Biotechnology.

Signature : 
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STUDENT'S DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

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DEDICATIONS

Special dedication to my beloved father, mother, brother and sister.

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ABSTRACT

A study of nitrogen containing compound in a closed recirculating system of an aquaponic system by using wheatgrass (triticum aesvitum) was conducted. The important point in this study is related to nitrogen cycle in the aquaponics system, where there are interactions of plant, animals (fish) and bacteria. Nitrogen compounds are an essential nutrient for all forms of life but excessive N inputs lead to eutrophication problems. The main N species in waters are dissolved inorganic N (ammonium, nitrite, and nitrate), dissolved N (the largest fraction is made up of amino acids and peptides and it is often called amino N) and particulate organic (due to small organisms: algae and bacteria), and inorganic N (Burt et al., 1993). The objectives of this research are to understand nutrient cycling (nitrogen cycling in particular), to measure level of ammonia, nitrite, nitrate and five physicochemical parameters value (dissolve oxygen, salinity, total dissolved solid, conductivity and pH) in established aquaponics system and to monitor plant growth parameter such as growth rate and to analyses the concentration of nitrogen compound by using ion chromatography and construct graphs of nutrient levels and plant growth rates. In this research the aquaponics already setup, one of the aquaponics system, the fish must be replaced by NH_4Cl in order to gives sufficient amount of NH_3 / NH_4^+ (ammonia). Based on problem statement for this research its shows that water and land resources for agriculture are diminishing and world fisheries are at or past their maximum sustainable yields (Parker 2002). Then improving water quality use by agriculture and food production is critical in order to supply the demand for food in the future, chemical fertilizers from traditional farming discharge pollution leading to eutrophication. Lastly elevated nitrogen and phosphorous levels have been documented to pose negative impacts on aquatic ecosystems by using aquaponic system in future, we can control and recycle the amount of nitrogen produces.

ABSTRAK

Suatu kajian terhadap nitrogen kompoun telah dijalankan di dalam sistem peredaran tertutup akuaponik sistem dengan menggunakan wheatgrass (*triticum aesvitum*).Peranan penting dalam kajian ini adalah berkaitan dengan kitaran nitrogen dalam sistem akuaponik, di mana terdapat interaksi di antara tumbuhan, haiwan (ikan) dan bakteria. Sebatian nitrogen adalah nutrien penting untuk semua bentuk kehidupan tetapi input N yang berlebihan boleh membawa kepada masalah eutrofikasi. Spesies N utama di dalam larutan dibubarkan N bukan organik (ammonium, nitrit, dan nitrat), larutan N (pecahan terbesar terdiri daripada asid amino dan peptida dan ia sering dipanggil amino N) dan zarah organik (disebabkan organisma kecil: alga dan bakteria), dan bukan organik N (Burt et al., 1993). Objektif kajian ini adalah untuk memahami kitaran nutrien (kitaran nitrogen terutamanya), untuk mengukur tahap ammonia, nitrit, nitrat dan lima fizikokimia nilai parameter (kekonduksian, kemasinan, jumlah pepejal terlarut, larutan oksigen dan pH) dalam sistem akuaponik dan ia dibina untuk memantau parameter pertumbuhan seperti kadar pertumbuhan pokok dan untuk menganalisis kepekatan sebatian nitrogen dengan menggunakan kromatografi ion, membina graf tahap nutrien dan kadar pertumbuhan tumbuhan. Dalam kajian ini aquaponik yang ditetapkan, tetapi ikan mesti digantikan oleh ammonium klorida (NH_4Cl) untuk memberikan jumlah yang mencukupi daripada NH_4 (ammonia). Berdasarkan pernyataan masalah bagi kajian ini menunjukkan bahawa sumber air dan tanah untuk pertanian semakin berkurangan dan perikanan dunia adalah pada masa lalu atau hasil maksimum yang berpanjangan (Parker 2002). Kemudian dengan meningkatkan penggunaan kualiti air dengan pertanian dan pengeluaran makanan adalah penting untuk membekalkan permintaan bagi makanan pada masa akan datang, baja kimia dari tradisional pencemaran pembuangan pertanian yang membawa kepada eutrofikasi. Akhir sekali nitrogen yang tinggi dan tahap fosforus telah didokumenkan berkesan untuk menimbulkan kesan-kesan negatif terhadap ekosistem akuatik dengan menggunakan sistem aquaponic pada masa akan datang, kita boleh mengawal dan mengitar semula jumlah yang menghasilkan nitrogen.

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LIST OF SYMBOL

mg	**Miligram**
mg/L	**Milligram per Liter**
mm	**Milimeter**
ppm	**Part per million**
mM	**Milimolar**
µL	**Microliter**

LIST OF ABBREVIATIONS

DO	**Dissolved oxygen**
TDS	**Total dissolve solid**
NH_3	**Ammonia**
NH_4^+	**Ammonium ion**
NO_2-	**Nitrite ion**
NO_3-	**Nitrate ion**
IC	**Ion chromatography**
ON	**Organic Nitrogen**
UPW	**Ultra pure water**
BOD	**Biochemical oxygen demand**
RAS	**Recirculating aquaculture system**
AOB	**Ammonia oxidizing bacteria**
UV	**Ultraviolet**
NOB	**Nitrite Oxidizing Bacteria**

LIST OF PICTURE

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Aquaponics system is derived from combination of "aquaculture" means fish farming and "hydroponics" means soilless plant system.Aquaponics is a closed recirculating system that contains living components of both plants and animals that forms artificial ecosystem. This is different from outside or natural ecosystem. In aquaponics system it is consists of nitrogen compound and also other nutrient such as calcium, fluoride, magnesium and etc. Based on this study the main source of nitrogen is in the air but when in water media, nitrogen can be divided into suspended and dissolved organic (from a living material) and inorganic (ammonia, nitrate, and nitrite) compounds. There is a huge variety of nitrogen organic compounds in the environment. The component of cleaning agent,discarded food material and bodily waste are route for Organic nitrogen (ON) enter to the systems. The nitrogen cycle further comprises the transformation of nitrogen compounds in inorganic compounds. The nitrogen compound converted ammonia (NH_3) into ammonium ion (NH_4^+) when in the liquid. It will indicates the onset of oxidation process, nitrite (NO_2^-) and then converted nitrite into nitrate (NO_3^-). The process called nitrification.

Nitrate and nitrite are naturally occurring ions that are part of the nitrogen cycle. The nitrate ion (NO_3-) is the stable form of combined nitrogen for oxygenated systems. Reduced microbial action in nitrate become it is chemically unreactive. Usually the nitrogen in the nitrite ion is unstable form. Nitrite will converted into nitrate through several chemical and biological processes (ICAIR Life Systems, Inc., 1987).

1.2 PROBLEMSTATEMENT

High ammonia, nitrite and nitrate concentrations cause environmental problems. Studying the factors that affect the conversion of nitrogen containing compound in mini aquaponics system leads to better undenstanding of natural nitrogen cycle.Water and land resources for agriculture are diminishing and world fisheries are at or past their maximum sustainable yields (Parker 2002). Improving the water quality that is used by agriculture for food production is critical in order to supply the demand for food in the future. Chemical fertilizers from traditional farming discharge pollution leading to eutrophication. Elevated nitrogen and phosphorous levels have been documented to pose negative impacts on aquatic ecosystems. resources for agriculture are diminishing and world fisheries are at or past their maximum sustainable yields (Parker 2002). Improving the water quality that is used by agriculture for food production is critical in order to supply the demand for food in the future. Chemical fertilizers from traditional farming discharge pollution leading to eutrophication. Elevated nitrogen and phosphorous levels have been documented to pose negative impacts on aquatic ecosystems.

1.3 HYPOTHESIS

Nitrogen cycle efficiency can be increased by increasing population density of the two major components in the system, the plant (and the naturally-occuring root bacteria) and the animal (fish) population. Nitrogen-rich compounds have significant effect on plant growth.

1.4 OBJECTIVE

1) To understand nutrient cycling (nitrogen cycling in particular)
2) To measure level of ammonia, nitrite, nitrate and five physicochemical parameters value (salinity, TDS, DO, conductivityand pH) in established aquaponics system and to monitor plant growth parameter such as growth rate
3) To analyses the concentration of nitrogen compound by using ion chromatography, and construct graphs of nutrient levels and plant growth rates

1.5 SCOPE OF STUDY

This standard describes the pretreatment and extraction method for the nitrogen compounds such as ammonia, nitrate and nitrite in mini aquaponics system. The determination of the nitrogen compound can be done manually or by automated methods. Based on this research, time lapsed for the measurement concentrations of nitrogen compound in every 6 days for 4 weeks. This is because wheatgrass easily to grow and grow faster in 30 days only.

REFERENCES

1. Adnan Aydin. 2009. *Nitrite and Nitrate, Handbook of Water Analysis,* Third Edition(**11**): 283EPA, Drinking Water Contaminants, U.S. Environmental Protection Agency, EPA 816-F-09-0004.

2. ASTM D 5542-94, 1995. '*Standard Test Methods for Trace Anions in High Purity Water by Ion Chromatography*', ASTM, Philadelphia, PA, 696–703, Vol. **11.01**.

3. Clesceri, L.S., Greenberg, A.E., and Eaton, A.D., (Eds). 2005. APHA-AWWA-WEF, *Standard Methods for the Examination of the Water and Wastewater*, 21st ed., American Public Health Association, American Water Work Association, Water Environment Federation, Washington, DC.

4. Cornell Cooperative Extension, Pesticide Safety Education Program, *Nitrate: Health Effects in Drinking Water*, http://psep.cce.cornell.edu/facts-slides-self/facts/nit-heef-grw85aspx - Accessed 1/12/14

5. *Determination of Ammonia Nitrogen by Semi-Automated Colorimetry*, 1993.

6. Fundamental of Enviromental Measurement. 2014. *pH of water*, http://www.fondriest.com/environmental-measurements/parameters/water-quality/ph/ (09/10/14)

7. G. Wilson. 2005.*Australian barramundi farm goes aquaponic, Aquaponics Journal*37, 12–16.

8. Metrohm. 2009. *Water analysis. Quality assurance of water.* http://water.metrohm.com (1 November 2014)

9. Informission Co. Florida. 2008. *How do I know if nitrification is happening in my new system*, www.informission.org/survival/aquaponics/ (4/12/14)

10. James W. O'Dell. *Inorganic Chemistry Branch,Chemistry Research Division,Method* 350.1,

11. Rakocy J. and Hargreaves J. (Eds.). 23 June 1993, *Integration of vegetable Hydroponics with fish culture*: A review.In: Techniques for Modern Aquaculture, Proceedings of Aquaculture Engineering Conference,Washington, 21.

12. Juliana Antunes Galvao, Alexandre Matthiensen, Marilia Oetterer, Moliner Y. -Martinez,R. A. Gonzalez-Fuenzalida, Munoz M. -Ortuno, Herraez R.-Hernandez, Verdu-Andres J. ,C. Molins-Legua, and Campins P. Falco. 2014, *Determination of Ammonia in Water Sample, Handbook of Water Analysis*, Third Edition (**10**):283-284, 249-251.

13. Lindsey, R., & Scott, M. 2010, July. *What are Phytoplankton?. In NASA Earth Observatory*. Retrieved from http://earthobservatory.nasa.gov/Features/Phytoplankton/ (27 Nov 2014)

14. M. Timmons, J. Ebeling, F.Wheaton, S. Summerfelt and B. Vinci (Eds), 2002. *Recirculating Aquaculture Systems, Northeastern Regional Aquaculture Center*, Cayuga Aqua Ventures, New York.

15. Mohamed Noor. N. Syamim.2012. *(Heavy Metal Content in Pahang River Stream Sendiment; upper and Lower Baseline Studies)*. Faculty of Industrial Science and Technology.

16. Parker and Rick, 2002. *Aquaculture Science, Second Edition.* Delmar Albany, New York.

17. Peter E. Jackson. 2000.*Sample storage and Presevation., Ion Chromatography in Enviroment Analysis.*

18. WHO (World Health Organization. 2011. *Nitrate and nitrite in drinking-water* WHO/SDE/WSH/07.01/16/Rev/1