ABSTRACT

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfilment of the requirements for the degree of Master of Science

EFFECT OF SYNTHETIC AND BIODEGRADABLE MICROBEADS ON REPRODUCTION AND DEVELOPMENT FUNCTIONS OF *Nitokra lacustris pacifica*

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2021

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Microplastics can be found in almost every marine environment. They are often mistaken as a food source by a wide range of marine organisms, including zooplankton due to its microscopic size. Microplastic ingestion has been reported to have adverse effects on the biological processes of zooplankton. Copepods predominantly make up the zooplankton taxon in terms of abundance and biomass. They also are the main component of marine food webs that act as a food source for higher trophic levels. Ingestion of synthetic microplastic has been widely observed in copepods, but knowledge gaps still remain over the potential biological effects of biodegradable microplastic. This study aims at investigating the ingestion and egestion of synthetic polystyrene (PS) (6.58 µm) and biodegradable (polyhydroxyalkanoates (PHA)) microbeads (~7 to 140 µm) and compare their biological effects on the harpacticoid copepod, *Nitokra lacustris pacifica*. Copepods exposed to high concentration of microbeads (~700 microbeads mL^{-1}) resulted in a decreased preference of towards the algae (*Nannochloropsis* sp.) (144.5 x 10^3 cells $ind.^{-1}$ d^{-1}). Ingestion rate of PS microbeads (125.3 x 10^2 microbeads $ind.^{-1}$ d^{-1}) was significantly higher compared to

other treatments. No significant differences were observed in egg production rate (9.0-9.6 eggs fem^{-1} d^{-1}) but hatching success was significantly reduced in PS microbead treatment (< 50%). The development times from egg to adult *N. lacustris pacifica* took significantly longer when exposed to PS microbeads compared to the PHA treatment. The survival rate of *N. lacustris pacifica* was also significantly lower (81.4%) in the PS microbead treatment. In the extended exposure experiment using second generation (F2) copepods from the same treatment, no significant differences in egg production rate were observed in all treatments. However, hatching success was significantly lower (15%) when exposed to PS microbeads than in other treatments. These results suggest that PS microbeads have negative impacts on copepods at concentration of about 700 microbeads mL^{-1}, while biodegradable (PHA) microbeads were seen to be less harmful. The findings of this study provide a solid understanding of the use of biodegradable as potential materials to replace synthetic polymers.

ABSTRAK

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk Ijazah Sarjana

KESAN BUTIR MIKRO SINTETIK DAN BIODEGRADASI TERHADAP PEMBIAKAN DAN FUNGSI PERTUMBUHAN *Nitokra lacustris pacifica*

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Mikroplastik boleh dijumpai di hampir keseluruhan persekitaran marin. Ia sering disalah anggap sebagai sumber makanan oleh pelbagai organisma laut termasuk zooplankton disebabkan ukurannya yang bersaiz mikroskopik. Pemakanan mikroplastik telah banyak dilaporkan memberi kesan buruk kepada proses biologi zooplankton. Kopepod membentuk takson zooplankton yang dominan daripada segi kelimpahan dan biomas. Mereka juga merupakan komponen utama dalam jaringan makanan marin yang menyediakan sumber makanan kepada trofik yang lebih tinggi. Pemerhatian pemakanan mikroplastik sintetik telah dilakukan secara meluas melibatkan kopepod, tetapi jurang pengetahuan masih berlaku terhadap potensi kesan biologi mikroplastik biodegradasi. Kajian ini bertujuan untuk membandingkan pemakanan, penyingkiran butir mikro polisterina sintetik (PS) (6.58 μm) dan butir mikro biodegradasi (polyhydroxyalkanoates (PHA)) (~7 μm hingga 140 μm) dan membandingkan kesan biologi harpaktikoid kopepod, *Nitokra lacustris pacifica*. Kopepod yang terdedah kepada kepekatan butir mikro yang tinggi (~700 butir mikro

mL^{-1}) menunjukkan kadar pemilihan alga yang rendah (*Nannochloropsis* sp.) (144.5 x 10^3 sel $ind.^{-1}$ d^{-1}). Kadar pemakanan mikro PS (125.3 x 10^2 butir mikro $ind.^{-1}$ d^{-1}) adalah jauh lebih tinggi berbanding dengan pendedahan lain. Tiada perbezaan yang diperhatikan dalam kadar penghasilan telur (9.0-9.6 telur $betina^{-1}$ $hari^{-1}$) tetapi keberjayaan penetasan berkurang dengan ketara sekiranya didedahkan dengan butir mikro PS (< 50%). Masa pertumbuhan daripada telur hingga dewasa *N. lacustris pacifica* mengambil masa yang lebih lama dalam butir mikro PS berbanding butir mikro PHA. Kadar kelangsungan hidup *N. lacustris pacifica* juga signifikan rendah (81.4%) dalam pendedahan butir mikro PS. Dalam eksperimen lanjutan menggunakan generasi kedua (F2) dengan pendedahan yang sama, tiada perbezaan yang signifikan pada kadar pengeluaran telur dalam semua eksperimen. Walau bagaimanapun, keberjayaan penetasan jauh lebih rendah (15%) dalam butir mikro PS berbanding pendedahan yang lain. Hasil ini menunjukkan bahawa butir mikro PS mempunyai kesan negatif kepada kopepod pada kepekatan kira-kira 700 butir mikro mL^{-1}, sementara butir mikro biodegradasi (PHA) didapati kurang berbahaya. Penemuan kajian ini memberikan pemahaman yang kukuh terhadap keupayaan penggunaan bahan biodegradasi sebagai pengganti polimer sintetik.