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Nutritional value and production of three species of purple non-sulphur bacteria grown in palm oil mill effluent and their application in rotifer culture

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Abstract

Three species of purple non-sulphur bacteria (PB), *Rhodopseudomonas palustris*, *Rhodobacter sphaeroides* and *Rhodovulum sulfidophilum*, grown in palm oil mill effluent (POME) were successfully used for the first time as feed for rotifers (*Brachionus rotundiformis*). *Rp. palustris* cultured in both POME and synthetic medium gave the highest rotifer density (332–395 individuals mL^{-1}) from 3 to 5 days at 10 g L^{-1} salinity. Other PB cultured in synthetic medium generally support higher rotifer density than PB cultured in POME. *Rb. sphaeroides* had the highest biomass (1.91–3.34 g L^{-1}) and growth rate (0.64–1.11 g day^{-1}) in both types of culture medium. Nevertheless, only *Rv. sulfidophilum* grown in POME contained both eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), indicating its ability to biosynthesize them from POME nutrients. Rotifers fed *Rv. sulfidophilum* grown in POME had significantly higher amounts of protein, arachidonic acid, EPA and DHA than rotifers fed *Rv. sulfidophilum* grown in synthetic medium. The nutritional profile of lipid-deficient PB can be improved by growing them in POME, and these enriched PB produced at an estimated cost of USD 8.71–35.35 kg^{-1} dry biomass, depending on species, can support rotifer production in a batch culture system.

KEY WORDS: nutritional value, palm oil mill effluent, purple non-sulphur bacteria, rotifers

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Introduction

The production of high-quality live feed at the cheapest possible cost is crucial for the aquaculture industry. Commercial hatcheries worldwide require live feed of suitable sizes (2–500 μm) (Sorgeloos & Léger 1992) and nutritional value. For instances, most larval fishes require protein levels of 500–600 g kg^{-1} (John & Paul 2012), and both docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) are essential fatty acids vital to the nutrition and survival of fish and invertebrate larvae (Brett 2009). Generally, cultured fishes require an average DHA : EPA ratio of 0.5–2.0, whereas cultured invertebrate species require a ratio of 0.7–1.0 (Rodríguez *et al*. 1997; Sargent *et al*. 1999; Brett 2009; Loo *et al*. 2012a). Live feeds commonly in use are micro-autotrophs and heterotrophs such as microalgae and yeasts with costs of production that range from USD 46 to USD 600 kg^{-1} dry biomass (Moon & Kim 1996; Spolaore *et al*. 2006; Brennan & Owende 2009; Pahl 2010) or 20–70 per cent of hatchery operating costs (Coutteau & Sorgeloos 1992; Michael 1997). However, the costs of producing photosynthetic microalgae in small-scale hatcheries can be even higher from USD 770 to USD 1,000 kg^{-1} dry biomass (Pahl 2010). Little attention has however been given to the use of phototrophic bacteria as a feed for rotifers and other zooplankton, which has increasingly become important as live food in fish culture. Phototrophic bacteria previously known as photosynthetic bacteria are prokaryotes that use light energy to metabolize useful chemical energy via either chlorophyll- or bacteriochlorophyll-mediated processes (Imhoff 1992). They derive energy from light by photophosphorylation to synthesis organic materials from inorganic components during photosynthesis (Imhoff 1992). There are two groups of phototrophic bacteria, namely oxygenic phototrophic bacteria (cyanobacteria) and