ABSTRACT

In outdoor batch experiments, algae-based and duckweed (Lemna gibba)-based wastewater containers have been monitored over a period of 15 days in eight experiments with to variable environmental factors (DO and pH). Experiments (1 to 4) were with zero DO, pH ranges (8-9, 7-8, 6-7 and 5-6) and initial total nitrogen concentration of approximately 100 mg-N/l respectively. Whereas experiments (5 to 8) were conducted at approximately the same initial total nitrogen concentration and pH ranges, but at saturated DO. At pH range between (5-7), algae-based and duckweed-based containers removed between (21%-31%) and between (28%-40%) of the initial total nitrogen concentration respectively, while the overall removals at pH range (7-9) were between (76%-86%) in ABC and (72%-74%) in DBC. The nitrogen removal rate in ABC and DBC at pH range (5-7) was 0.4 and 0.5 g-N m^{-2} d^{-1} respectively, while at pH range (7-9) was 1.2 in ABC and 1.1 g-N m^{-2} d^{-1} in DBC.

At pH range between (5-7), the nitrogen losses resulted from the combined effect of ammonia volatilization and denitrification in ABC and DBC were 8% and 5% of the initial total nitrogen concentrations respectively, while at pH range between (7-9) it was 58% in ABC and 40% in DBC. The nitrogen losses via ammonia volatilization in ABC and DBC at pH range between (5-7) were 6% and 3% of the initial total nitrogen concentrations respectively, while at pH range (7-9) it was 55% in ABC and 37% in DBC. The loss due to denitrification in ABC and DBC at zero DO was between (3%-6%) and (3%-4%) of the initial total nitrogen concentrations respectively, while at saturated DO the losses were approximately 0.5% in both container systems.

The nitrogen removal via sedimentation in ABC and DBC at zero DO and pH ranges (5-9) was between (16%-21%) and between (11%-21%) of initial total nitrogen concentration respectively, whereas at saturated DO and the same pH ranges it was between (17%-27%) in ABC and between (10%-23%) in DBC respectively. At high pH range between (8-9), it was observed that part of the sediments consisted of settled died duckweed. Therefore, nitrogen content in

sediments in DBC was nearly equal to that in ABC, but, in general, the nitrogen removal in ABC was higher than that in DBC.

Nitrogen removal via duckweed uptake at pH range between (5-8) and pH (8-9) was 20% and 9% of the initial total nitrogen concentration respectively. The relative growth rate of duckweed at pH range (5-8) was 0.07 d^{-1} and 0.04 d^{-1} at pH range (8-9).

Unlike the DO concentration, pH changes had a significant effect on nitrogen transformations in both algae-based and duckweed-based containers. The overall nitrogen removal in both container systems increased with the increase in pH values, while it was approximately equal at zero and saturated DO.

The nitrogen loss via ammonia volatilization in ABC and DBC increased with the increase in pH, while the influence of DO concentration in both container systems was not significant. The loss due to denitrification in ABC and DBC at zero DO was significant, while at saturated DO it was a negligible small value. The optimum pH range for denitrification in both container systems was between (7-8).

The increase in pH and DO concentration increased the nitrogen removal via sedimentation in both algae-based and duckweed-based container systems. The effect of pH is due to the increase in the growth of nitrifying organisms and reduction organic content and nutrients of the wastewater by bacterial decomposition and by converting them into algal biomass at high pH. With respect to the dissolved oxygen, the rate of biochemical reactions increased with the increase in DO. Besides that, DO is required to the respiration of aerobic microorganisms and nitrification will occur at DO above 1 mg/l.

Nitrogen removal via duckweed uptake decreased when pH increased to a range between (8-9), while the influence of DO concentration on duckweed uptake was not significant. The proper pH range for nitrogen uptake by duckweed was between (6.5-7.5).