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Estimating BioavailablePhosphorus by Some Chemical Extraction Methods for Algae (*Senedesmusobliquus*) in Western River Sediments of the Lake Urmia Basin

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Introduction: Phosphorus (P) is an essential nutrient for all life forms. In aquatic environments, P is a double-edged sword. In some areas, habitat biodiversity is strongly limited by low P bioavailability, while in others, P inputs in excess of plant needs have led to pollution of water bodies and eutrophication. There is little information available on P status in river sediments by single chemical extraction and its correlation with algae growth in Iran. This study was performed to select proper single chemical extraction methods by algal bioassay. The quantity of P estimated by different extractions methods depends on sediment characteristics such as calcium carbonate, pH, clay and organic matter contents. Therefore, this study was conducted in western rivers of the Lake Urmia to get an insight into P status in sediments by using single chemical and biological P assay.

Materials and Methods: The lakeUrmia basin has the second largest water resources in Iran with Mediterranean climate. Italso has the largest hypersaline lake in the world. There is a significant phytoplankton growth and also some dense algal blooms occurring during years with low salinity in wetlands and lagoons. Thirty four river sediment samples from seven main rivers of the Lake Urmia basin were collected from depth of 0-10 cm to evaluate algae (*SenedesmusObliquus*) P bioavalability by single chemical extraction. Selection of extractantis based on different mechanism of extraction. Cluster analysis was conducted on 17 sediment samples selected for algal bioassay.Pearson simple correlation and multivariate analysis were also performed.

Results and Discussion: Average total P concentrations of the sediments were343-654, 456 mg kg^{-1}. Sodium bicarbonate 0.5 *M*extractable P (Olsen-P) varied from 0.48 to 8.42 mg kg^{-1}. Sediments from upper reach had considerably higher total and bioavailable P concentration in comparison with lower reach sediment. The low reach sediments of two rivers had higher Olsen extractable P than the threshold value of 20 mg kg^{-1}indicating possible release which poses a threat to aquatic environment.Upper reach sediments had higher restoration potential, but algal bloom was observed in low reach part of rivers, particularly Simineh and Mahabad Chai. Land use changes, discharge of sewage from rural and urban section, industrial activity and cycling of river borne P are the main reasons for algal bloom in wetlands and lagoons around the lake.Principal component analysis (PCA) performed on the data identified three PC which explained 83.3% of total variation and silt and sand had higher loading values. Active calcium carbonate equivalent (ACCE) was negatively correlated with sand in the first PC. Different extractions were positively correlated with each other. The Mehlich III and Olsen-P extraction methods were significantly correlated and the predicted values were same. The average rank order of P extraction by singleextractantswas Cowell >Mehlich III >NaOH 0.1 M > Olsen > Morgan > AB-DTPA > Bray II.Extractants had different long-term and short-term potential to extract algal available P. The Cowell extractable P concentrations of sediments varied from 1.44 to 88.0 mg kg^{-1}.This extractant was correlated significantly with algal growth and selected as the best P single extraction method among allextractants. The high correlation between 0.1 M NaOH and algae growth indicates the sensitivity of P bioavailability to redox conditions in river system. Algae (*SenedesmusObliquus*) was able to use P from different sediment components because its growth was correlated with Cowell, Mehlich III, NaOH 0.1M, Olsen and Morgan.

Conclusion: Legacy P (sediment P) evaluation by chemical extractants gives new insight into P bioavailability in river sediments of the Urmia Lake. The results of this work showed that Cowell extractant could be used to estimate algal available P in studied river sediments. Similarity between Olsen-P and Mehlich-P in estimating bioavailable P suggests that Mehlich III-P can be substituted for Olsen-P in studied sediments.For sustainable P management, monitoring P status by single chemical extraction methods is necessary. Phosphorous fertilizer application around the Lake Urmia basin lands should be conducted based onthe P soil test to avoid any aquatic pollution. Care must be taken in lower reach river sediments because of fragile ecosystems such as

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wetlands and lagoons. Further investigations are also needed to evaluate legacy P bioavailability by temporal and spatial variability.

Keywords: Bioavailability, Extraction, Algal Growth, suitable