



Alleles and genotype frequencies of transferrin in common carp (*Cyprinus carpio*) in Southern Iraq

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Abstract

Common carp (*Cyprinus carpio*) is widely found across Asia and Europe. The species is popular for its tolerance to physiological and environmental stresses. Alleles encoding transferrin (Tf) in common carp have been studied for their role in identification of tolerant type and to investigate breeding pattern. However, the data about allelomorphs of common carp Tf from Iraq has been described less frequently. Therefore, this study aimed to determine the frequencies of various Tf alleles in 142 common carp specimens collected from 32 different locations. The allele forms were detected through SDS PAGE and their abundance was correlated with physicochemical parameters of the sampled water. Our results indicated a degree of genetic polymorphism in common carp Tf as presence of C, D, F and G was detected. The allele DD was found to be the most prevalent followed by FF while other alleles were present with reduced frequencies. Hardy-Weinberg equilibrium showed a marked difference from observed values with a high χ^2 value (251.57; $P < 0.001$), suggesting that selective forces, population structuring or environmental factors may have influenced Tf genotype distribution within the study population. The low observed heterozygosity than the expected heterozygosity and Shannon diversity index reflected substantial allelic variation. The allelic dominance was also correlated with the water temperature and iron concentration. Hence, population structuring of common carp may be linked more to physicochemical variability than to random mating. The role of Tf in iron metabolism and immune system necessitates further investigations to support aquafarming and to maintain a sustainable supply of animal protein.

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Introduction

The common carp (*Cyprinus carpio*) is one of the economically and culturally significant freshwater fish species found in various countries. Its aqua-culturing has been dated back to more than two thousand years in East Asia from where it was spread to Middle East and Europe (1). The aquafarming of common carp is favored due to its adaptation, high growth rate, tolerance to environmental stresses and omnivorous feeding habits (2,3). The species can be cultivated in cold temperate lakes to warm irrigation ponds rendering it an important source of food for rural livelihoods, particularly in developing regions (4,5).

In global fish production and local economies, common carp aquaculture contributes significantly along with tilapia, and grass carp. Indeed, it can be cultured with these species and helps in optimizing resource utilization and maintaining ecological balance (6,7). Common carp farming also provides sustainable source of income to small farmers, affordable animal protein to local communities and support ancillary industries such as feed processing and marketing (8). In some regions, such as in South and West Asia, common carp has been used as a model fish for selective breeding programs, aimed at enhancing disease resistance, feed conversion efficiency, and tolerance to the environmental stresses (9,10). Hence, understanding its