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Common carp roe is a rich protein and oil source, which is usually discarded with no specific use. The aims of this study were to extract oil from the discarded roe and examine functional, antioxidant, and antibacterial properties of defatted roe hydrolysates (CDRHs) at various degrees of hydrolysis (DH). Gas chromatography (GC) of fatty acid methyl esters (FAMEs) revealed that common carp roe oil contained high level of unsaturated fatty acids. The results of high-performance liquid chromatography-mass spectrometry (HPLC-MS) indicated that enzymatic hydrolysis of defatted roe yielded higher content of essential amino acids. CDRHs displayed higher solubility than untreated defatted roe, which increased with DH. Better emulsifying and foaming properties were observed at lower DH and non-isoelectric points. Furthermore, water and oil binding capacity decreased with DH. CDRHs exhibited antioxidant activity both in vitro and in 5% roe oil-in-water emulsions and inhibited the growth of certain bacterial strains. Common carp roe could be a promising source of unsaturated fatty acids and functional bioactive agents. Unsaturated fatty acid-rich oil extracted from common carp roe can be delivered into food systems by roe oil-in-water emulsions fortified by functional, antioxidant, and antibacterial hydrolysates from the defatted roe.