The thesis deals with supernilpotence in loops, building on three equivalent definitions of higher commutators in Mal'tsev algebras due to Aichinger and Mudrinski, Bulatov and Opršal. In the thesis, we study identities that occur in 1-, 2- and 3-supernilpotent loops. We prove that a k-supernilpotent loop has a k-nilpotent multiplication group. Moreover, we present results of our implementation of algorithmic testing of supernilpotence in non-associative loops of small orders.