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Tetrodotoxins: recent advances in analysis methods and prevalence in European waters

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Abstract

Tetrodotoxin (TTX) is one of the most potent natural neurotoxins. TTX has been responsible in the past for many human fatalities, most commonly following the consumption of pufferfish originating from warm waters, especially of the Indian and Pacific Oceans. During the last decade, however, the presence of TTX and its analogues (TTXs) is increasingly reported from different marine species in European waters, raising serious concerns regarding public health protection in Europe, taking into account that TTX is not a regulated toxin in the EU legislation. This paper aims to review recent advances concerning methods of analysis for TTXs, followed by the latest evidence on TTXs occurrence in Europe, in order to highlight the importance of the situation.

1. Introduction

Tetrodotoxin (TTX) is a deadly neurotoxin which selectively blocks the action potentials of voltage-gated Na⁺ channels along nerves, skeletal and cardiac muscle membranes. This occurs without change in the resting membrane potentials. TTX is considered the most lethal toxin coming from the marine environment and was named after the Tetraodontidae family of pufferfish, from which it was first isolated [1,2].

TTX is a colorless, crystalline-weak basic substance, with a molecular formula of C₁₁H₁₇O₈N₃, having to date 29 analogues described, with varying degrees of toxicity. They have been classified into three groups depending on the structure: hemilactal, lactone and 4,9-anhydro types (Figure 1). These are altogether referred to as tetrodotoxins (TTXs) and are present in a variety of taxonomically diverse groups of animals inhabiting terrestrial, marine, fresh water and brackish water environment [3,4]. Although the origin of TTX is known to be associated to bacteria of the phylum

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