Pharmacology, Biochemistry and Behavior 141 (2016) 18–27

Contents lists available at ScienceDirect

Pharmacology, Biochemistry and Behavior

journal homepage: www.elsevier.com/locate/pharmbiochembeh

Modulatory action of taurine on ethanol-induced aggressive behavior in zebrafish

Barbara D. Fontana [a,1], Daniele L. Meinerz [a,1], Luiz Vinícius C. Rosa [a], Nathana J. Mezzomo [a], Ariane Silveira [a], Giulie S. Giuliani [a], Vanessa A. Quadros [a,b], Gilvan L.B. Filho [c], Rachel E. Blaser [d], Denis B. Rosemberg [a,b,e,*]

[a] Laboratório de Neuropsicobiologia Experimental, Departamento de Bioquímica e Biologia Molecular, Centro de Ciências Naturais e Exatas, Universidade Federal de Santa Maria, Avenida Roraima, 1000, 97105-900 Santa Maria, RS, Brazil
[b] Programa de Pós-graduação em Bioquímica Toxicológica, Universidade Federal de Santa Maria, Avenida Roraima, 1000, 97105-900 Santa Maria, RS, Brazil
[c] Departamento de Engenharia Biomédica, Centro de Tecnologia, Universidade Federal do Rio Grande do Norte, Campus Universitário, Avenida Senador Salgado Filho, 300, 59078-970 Natal, RN, Brazil
[d] Department of Psychology, University of San Diego, 5998 Alcala Park, San Diego, CA 92110, USA
[e] The International Zebrafish Neuroscience Research Consortium (ZNRC), 309 Palmer Court, Slidell, LA 70458, USA

ARTICLE INFO

Article history:
Received 17 August 2015
Received in revised form 11 November 2015
Accepted 26 November 2015
Available online 26 November 2015

Keywords:
Aggression
Ethanol
Mirror-induced aggression test
Taurine
Zebrafish

ABSTRACT

Alcohol is a potent agent for eliciting aggression in vertebrates. Taurine (TAU) is an amino sulfonic acid with pleiotropic actions on brain function. It is one of the most abundant molecules present in energy drinks frequently used as mixers for alcoholic beverages. However, the combined effects of TAU and ethanol (EtOH) on behavioral parameters such as aggression are poorly understood. Considering that zebrafish is a suitable vertebrate to assess agonistic behaviors using noninvasive protocols, we investigate whether TAU modulates EtOH-induced aggression in zebrafish using the mirror-induced aggression (MIA) test. Since body color can be altered by pharmacological agents and may be indicative of emotional state, we also evaluated the actions of EtOH and TAU on pigment response. Fish were acutely exposed to TAU (42, 150, and 400 mg/L), EtOH (0.25%), or cotreated with both molecules for 1 h and then placed in the test apparatus for 6 min. EtOH, TAU 42, TAU 400, TAU 42/EtOH and TAU 400/EtOH showed increased aggression, while 150 mg/L TAU only increased the latency to attack the mirror. This same concentration also prevented EtOH-induced aggression, suggesting that it antagonizes the effects of acute alcohol exposure. Representative ethograms revealed the existence of different aggressive patterns and our results were confirmed by an index used to estimate aggression in the MIA test. TAU did not alter pigment intensity, while EtOH and all cotreated groups presented a substantial increase in body color. Overall, these data show a biphasic effect of TAU on EtOH-induced aggression of zebrafish, which is not necessarily associated with changes in body color.

© 2015 Elsevier Inc. All rights reserved.

1. Introduction

Taurine (TAU) is a β-amino sulfonic acid that acts as an osmoregulator, antioxidant, Ca^{2+} modulator and as an inhibitory neuromodulator in the central nervous system (CNS) (Huxtable, 1992; Oja and Saransaari, 1996; Saransaari and Oja, 2000; Menzie et al., 2013). This molecule appears to exert its inhibitory effects on neurons by enhancing the function of $GABA_A$ and glycine receptors and it also counteracts the action of glutamate and inhibits Ca^{2+} channel influx (Banerjee et al., 2013). In addition to its biosynthetic pathway derived from cysteine oxidation, TAU may be obtained from the diet (Lambert et al., 2015; Vitvitsky et al., 2011). TAU is one of the most abundant molecules present in energy drinks frequently used as mixers for alcoholic beverages, so the interaction of TAU and EtOH may constitute a public health concern (Marczinski and Fillmore, 2014). Evidence has shown that consuming energy drinks in combination with alcohol may decrease perceived intoxication, enhance stimulation, and increase drinking compared to consuming ethanol (EtOH) alone (Franklin et al., 2013; Marczinski et al., 2012).

Acute EtOH intake can cause adverse effects on brain function (Collier et al., 2014). The mechanisms by which EtOH affects the CNS are associated with modulation of different neurotransmitter systems, impairment of mitochondrial function, changes in gene expression and alterations of intricate transduction signaling pathways (Davies, 2003; Harper and Corbett, 1990; Harper and Matsumoto, 2005; Tong et al., 2011). In rodents, studies have shown that acute EtOH administration elicits a significant efflux of TAU from neurons and astrocytes, increasing its extracellular levels in different brain regions (Dahchour et al., 1996; Quertemont et al., 1999). It has been postulated that

* Corresponding author at: Departamento de Bioquímica e Biologia Molecular, Centro de Ciências Naturais e Exatas, Universidade Federal de Santa Maria, Avenida Roraima, 1000, 97105-900, Santa Maria, RS, Brazil.
E-mail address: dbrosemberg@gmail.com (D.B. Rosemberg).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.pbb.2015.11.011
0091-3057/© 2015 Elsevier Inc. All rights reserved.

variations in intracellular/extracellular TAU contents could play an adaptive role in the CNS, mediating several of the physiological effects of EtOH in brain (Olive, 2002).

In humans, alcohol consumption is usually associated with cognitive deficits, depression, vulnerability to stress, impulsivity, inattention and boldness (Parker et al., 2014). Although a link between boldness, aggression and acute EtOH consumption is well established, the nature of these phenomena is not completely understood. Considering the pleiotropic actions of EtOH on CNS, the specific pharmacological mechanisms underlying the EtOH-induced aggression are multifaceted (Heinz et al., 2011). Hypotheses concerning the route by which EtOH affects aggression include: I) via cognitive mechanisms, implying a role for learned associations; II) via disinhibition of behavior, by disrupting the frontal regulatory systems after alcohol consumption; III) indirectly, via anxiolytic properties, in which alcohol reduces anxiety, increasing approach behaviors or/and reducing propensities to relent when threatened (Attwood and Mufanò, 2014). Thus, the validation of alternative/complementary models to evaluate agonistic behaviors following acute exposure to different drugs may serve as valuable tools to understand the neural basis of aggression in vertebrates.

The zebrafish (*Danio rerio*) is a model organism that has been widely used in neurobehavioral studies to investigate phenotypes related to drug abuse on a medium/large scale (Stewart et al., 2011; Wyatt et al., 2015; Zon, 1999). As a vertebrate species, it exhibits a considerable genetic and physiological homology to humans and also presents the major neurotransmitter systems described for mammalian models (Kyzar et al., 2012). The drug delivery method is one of its great advantages because soluble drugs can be mixed directly in tank water and promptly absorbed by the immersed zebrafish (Rosemberg et al., 2012; Tran et al., 2015). EtOH also modulates the color of zebrafish, a phenomenon known as the camouflage response (Peng et al., 2009). As an innate response exhibited by many vertebrates, pigment patterning plays a role in facilitating foraging, anti-predator responses and social communication (Fujii, 2000; Nascimento et al., 2003). Additionally, an extensive repertoire of behaviors has been described for zebrafish, providing a sound basis for the use of this model to study complex behaviors such as aggression (Filby et al., 2010).

Aggression in zebrafish can be measured by different protocols (Way et al., 2015). One protocol involves putting two fish in a same tank to observe their behavior (Oliveira et al., 2011). This method allows the observation of all natural interactions between animals in order to quantify agonistic behaviors. However, dyadic measures of aggression may be ethically questionable because fish can harm each other and experience increasing levels of stress during the interaction (Jones and Norton, 2015). Additionally, this procedure offers reduced experimental control since the behavior of the experimental subject will be affected by the activities of its test partner. Another protocol evaluates the reaction of a single fish facing its image in a mirror, known as the mirror-induced aggression test (MIA) (Gerlai et al., 2000). Although it may not represent all natural interactions between fish, this method is relatively simple and does not present ethical concerns. Moreover, the results may be more reliable because there is a greater degree of experimental control over the stimuli. Due to the practical advantages of using zebrafish for modeling behavioral phenotypes, the MIA test represents a time-efficient strategy to screen for potential drugs that modulate aggression. Since the potential actions of TAU and EtOH on aggressive behavior are poorly understood, we evaluate whether TAU modulates agonistic behavior and pigment response in zebrafish acutely exposed to EtOH. For this purpose, we described the behavioral patterns of aggression, exploring how different variables may influence the results of behavioral endpoints using ethograms. Moreover, we have proposed an index for measuring aggression in the MIA test that includes the behavioral endpoints most relevant to the expression of aggression in this task (e.g. approach to the mirror, number, and duration of attacks).

2. Materials and methods

2.1. Animals

Wild type adult zebrafish (*D. rerio*) (4–6 months-old, ~50:50 male:female ratio, short fin strain) were obtained from a commercial supplier (Hobby Aquarios, RS, Brazil) and kept for two weeks in a 50-L thermostatic aquarium under constant mechanical and chemical filtration before the experiments to acclimate to the laboratory facility. The water was previously treated with AquaSafe™ (Tetra, USA) and the temperature was set at 27 ± 1 °C, pH 7.2. Room illumination was provided by ceiling-mounted fluorescent light tubes on a 14/10 light/dark photoperiod cycle (lights on at 7:00 am and off at 9:00 pm). Fish were fed thrice daily with commercial flake fish food (alcon BASIC™, Alcon, Brazil). Animals were maintained in accordance with the National Institute of Health Guide for Care and Use of Laboratory Animals. The protocols were approved by the Ethics Commission on Animal Use of the Federal University of Santa Maria (process number 026/2014).

2.2. Pharmacological manipulations

EtOH and TAU were purchased from Merck (Darmstadt, Germany) and Sigma Aldrich (St. Louis, MO, USA), respectively. All exposure periods were set for 1 h as previously described and the animals were placed individually in a 500-mL beaker in the presence or absence of drugs (Rosemberg et al., 2010). The following groups were tested: i) Control group; ii) Taurine groups at 42 mg/L (TAU 42), 150 mg/L (TAU 150) and 400 mg/L (TAU 400); iii) EtOH group (EtOH, 0.25% *v*/*v*); Cotreatment groups (TAU 42/EtOH, TAU 150/EtOH and TAU 400/EtOH). The control group was kept only in non-chlorinated water, in the absence of drugs. The 0.25% EtOH concentration was chosen because it induces anxiolytic-like effects in zebrafish, characterized by increased vertical exploration in novel apparatuses, decreased scototaxis in the light–dark test, and increased aggression without inducing sedation (Dlugos and Rabin, 2003; Gerlai et al., 2000). TAU treatments were performed as described elsewhere (Rosemberg et al., 2010), varying from 0.33 to 3.2 mM. Previous studies demonstrated that these TAU concentrations modulate EtOH-induced changes in locomotion and vertical activity of zebrafish, antagonizing the oxidative effects caused by acute EtOH exposure in brain (Rosemberg et al., 2010, 2012). TAU solutions were prepared just before the experiments and buffered to pH 7.0 using 0.1 M NaOH.

2.3. Mirror-induced aggression test

The MIA test was based on the protocol described previously (Gerlai et al., 2000). After each treatment, fish were individually placed in the test apparatus (25 cm length × 15 cm height × 6 cm width). In one back wall of the tank, an inclined mirror was placed with an angle of 22.5° so that the left vertical edge of the mirror was touching the side of the tank and the right edge was further away. All other tank sides were covered with opaque partitions in order to keep a minimal distraction and to allow the simultaneous recording of behavior from two animals. The tanks were virtually divided into four areas related to their proximity to mirror: a1 and a2 (proximal), a3 and a4 (distal), in which a1 and a3 represent the close area, while a2 and a4 are the far area in relation to the inclined mirror (Fig. 1).

The behavioral tests were recorded at the same time period (between 09:00 am and 4:00 pm). All apparatuses were filled with non-chlorinated water and the experimental procedures were performed on a stable surface in an isolated environment with minimal external interference. Behavior was recorded in a single 6-min trial immediately after the exposure period using a webcam connected to a laptop with appropriate video-tracking software (ANY-maze™, Stoelting CO, USA) at a rate of 30 frames/s.

Aggressive behavior was analyzed by the following parameters: number of aggressive episodes, duration of aggressive episodes, average

Download English Version:

https://daneshyari.com/en/article/2012664

Download Persian Version:

https://daneshyari.com/article/2012664

Daneshyari.com