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Avaliação do efeito do benzo(α)pireno em anuros: um estudo descrevendo biomarcadores morfológicos

São José do Rio Preto
2022

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Tese apresentada como parte dos requisitos para obtenção do título de Doutor em Biodiversidade, junto ao Programa de Pós-Graduação em Biodiversidade, do Instituto de Biociências, Letras e Ciências Exatas da Universidade Estadual Paulista "Júlio de Mesquita Filho", Câmpus de São José do Rio Preto.

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26 de agosto de 2022

Dedico essa gota de água a um vasto oceano. Que eles possam ser utilizados da melhor maneira possível.

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“O que prevemos raramente ocorre; o que menos esperamos geralmente acontece.”

Benjamin Disraeli

RESUMO

Os anuros possuem características que os tornam vulneráveis a contaminantes presentes no ambiente aquático e terrestre. Dentre esses, destaca-se o benzo(α)pireno (BαP), um hidrocarboneto com propriedades carcinogênicas, que pode ser absorvido por diferentes vias – cutânea, oral ou respiratória – o que pode alterar sua distribuição e metabolismo. Para avaliar o impacto do BαP são utilizados biomarcadores, que consistem em alterações mensuráveis em células/tecidos/órgãos, que fornecem informações sobre a exposição e efeito do composto. Dessa forma, o objetivo dessa tese é avaliar o efeito do BαP sobre diferentes biomarcadores de anuros e avaliar se a via de administração do composto pode influenciar nesses efeitos. Espécimes de *Physalaemus nattereri* (N = 108) foram coletados e divididos em três grupos (via cutânea, injetável e oral) e tempos experimentais (um, três e sete dias). Os espécimes receberam uma única administração (volume de 0,02 ml) de óleo mineral puro (controle) ou de óleo mineral contendo 2 mg/Kg de BαP (tratamento). Ao término dos experimentos foram coletadas amostras de sangue, fígado, pele e testículos para análise dos biomarcadores morfológicos (anormalidades nucleares, pigmentação e mastócitos) e bioquímicos (catalase, superóxido dismutase, glutationa S-transferase e peroxidação de lipídios). O BαP alterou a área dos pigmentos melanina (fígado, pele e testículo), hemosiderina e lipofuscina (fígado), a frequência de mastócitos (fígado e pele) e a atividade das enzimas superóxido dismutase e glutationa S-transferase (fígado). Essas alterações foram influenciadas pela via de administração, sendo que o efeito da via foi distinto para cada órgão.

Palavras-chave: Células pigmentares. Eritrócitos. Estresse oxidativo. Mastócitos. Vias de exposição.

ABSTRACT

Anurans have characteristics that make them vulnerable to contaminants present in the aquatic and terrestrial environment. Among these, benzo(α)pyrene (BαP) stands out, as a hydrocarbon with carcinogenic properties, which can be absorbed by different routes - cutaneous, oral, or respiratory - which can change its distribution and metabolism and consequently its effects. To assess the impact of BαP biomarkers are used, which consist of measurable changes in cells/tissues/organs, which provide information on the exposure and effect of the compound. Thus, this thesis aims to evaluate the effect of BαP on different anuran biomarkers and assess whether the route of administration of the compound can influence these effects. Specimens of *Physalaemus nattereri* (N = 108) were collected and divided into three groups (cutaneous, injectable, and oral route) and experimental times (one, three, and seven days). Specimens received a single administration (0.02 ml volume) of pure mineral oil (control) or mineral oil containing 2 mg/kg of BαP (treatment). At the end of the experiments, samples of blood, liver, skin, and testes were collected for analysis of morphological (nuclear abnormalities, pigmentation, and mast cells) and biochemical (catalase, superoxide dismutase, glutathione S-transferase, and lipid peroxidation) biomarkers. BαP altered the pigment area melanin (liver, skin, and testis), hemosiderin and lipofuscin (liver), the frequency of mast cells (liver and skin), and the activity of the enzymes superoxide dismutase and glutathione S-transferase (liver). The route of administration influenced these changes, and the effect of the route was different for each organ.

Keywords: Pigment cells. Erythrocytes. Oxidative stress. Mast cells. Exposure routes.

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1. INTRODUÇÃO

1.1. INDICADORES AMBIENTAIS

A classe *Amphibia* (GRAY, 1825) representa o primeiro grupo de vertebrados a explorar com sucesso o ambiente terrestre, enquanto mantinha dependência do ambiente aquático ou de microhábitats úmidos para a reprodução (VITT; CALDWELL, 2014). Atualmente essa classe é constituída por três ordens (8419 sp.): Anura (sapos, rãs e pererecas – 7434 sp.), Caudata (salamandras e tritões – 771 sp.) e Gymnophiona (cecílias – 214 sp.) (FROST, 2021).

Dentre os vertebrados, os anfíbios são os que apresentam um maior número de espécies ameaçadas (IUCN, 2021), sendo seu declínio populacional relacionado à: doenças emergentes, introdução de espécies invasoras, mudanças climáticas, degradação e poluição ambiental (BLAUSTEIN; KIESECKER, 2002; COLLINS; STORFER, 2003; VERDADE et al., 2010). Os anfíbios são particularmente sensíveis a alterações físico-químicas no meio ambiente (VERDADE et al., 2010), devido a características como: ciclo de vida bifásico, ausência de cascas nos ovos, permeabilidade cutânea e baixa dispersão (BLAUSTEIN; WAKE, 1995; BLAUSTEIN; BANCROFT, 2007; VERDADE et al., 2010). Essas características e a sensibilidade a alterações ambientais conferem aos anfíbios o status de indicadores ambientais, podendo ser utilizados como bioindicadores [fornecem informações qualitativas sobre a qualidade do meio ambiente, por meio de sua presença/ausência, comportamento ou fisiologia] e biomonitores [fornecem informações quantitativas sobre o nível de contaminação ambiental, mediante o uso de biomarcadores] (BRODEUR; VERA-CANDIOTI, 2017).

4. CONSIDERAÇÕES FINAIS

- O BαP provoca alterações na atividade das enzimas antioxidantes, na área pigmentar e na frequência de mastócitos. Esse efeito é influenciado pela via de exposição do composto, podendo ser observado na área de melanina do fígado, onde as vias naturais (cutânea e oral) causam uma diminuição da área, enquanto na injetável ocorre um aumento.
- O efeito da via de exposição é variável para cada órgão, sendo observado quando comparamos os resultados pigmentares da pele e do testículo. Na pele, assim como no fígado, as vias naturais causam uma diminuição da área de melanina, e a via injetável um aumento. No testículo, as vias orais e injetáveis diminuem a melanina, enquanto a cutânea provoca um aumento. Isso demonstra que o mesmo tipo celular (melanócito) responde de maneira distinta ao BαP dependendo do órgão analisado.
- A alteração na área de melanina do fígado não está relacionada com a quantidade total de melanina presente no órgão, o que indica uma mudança ligada à dispersão/agregação dos grânulos de melanina nos melanomacrófagos. No testículo, as mudanças pigmentares, em especial na via oral e injetável, seguem o mesmo padrão para outros trabalhos na literatura, demonstrando uma resposta fixa do órgão frente ao BαP.
- As alterações sobre os biomarcadores bioquímicos são indicativos de estresse oxidativo ou desbalanço oxidativo induzido pelo BαP. Entretanto, as alterações significativas foram poucas, o que pode estar relacionado com o tempo de resposta desses biomarcadores, que pode ocorrer em tempos inferiores às 24h – o que implica em encurtar o tempo de exposição para avaliar um efeito imediato inferior à 24h.

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