



## Sorption Kinetics of the Antiparasitic Drug Ricobendazole onto a Clay Soil

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### Abstract

Benzimidazoles are antiparasitic agents widely employed in Brazil in livestock farming. Albendazole (ABZ), one of the most effective and used drugs of this class, is highly metabolized (99%) in mammals, being ricobendazole (RBZ) the primarily metabolite. These compounds reach the environment through the excreta of the medicated animals and may impact the environment (soil and water). Therefore, studies about the fate of drugs in the soil-water interface are necessary for the environmental risk assessment. This work aimed to evaluate the sorption kinetic of RBZ onto a clay soil following the OECD 106 Guideline.

**Key words:** Ricobendazole, soil, sorption.

### Introduction

Animal husbandry is one of the most important economic activities in Brazil, and its growths intensify the demand and use of veterinary drugs, including benzimidazoles.<sup>1</sup> However, these drugs and their active metabolites are eliminated by animal excretions (*i.e.*, feces and/or urine), which are directly discharged onto soil and water, and depending on their mobility, could spread into the environment reaching the groundwater. The presence of antiparasitic residues in the environment may lead to the development of resistant strains of parasites. Sorption studies are essential to predict the fate of veterinary drugs in the environment. These studies also contribute to assessing the risks to the biota and could prevent those related to improper disposal of residues.<sup>2</sup>

The present study evaluated the sorption kinetic of RBZ, the main metabolite of ABZ, onto a clay soil, following the OECD Guideline 106. The experiments were performed in a batch equilibrium procedure<sup>3</sup>. A validated ultra-high performance liquid chromatography coupled with sequential mass spectrometry (UHPLC-MS/MS) method was used for the RBZ quantitation.

### Results and Discussion

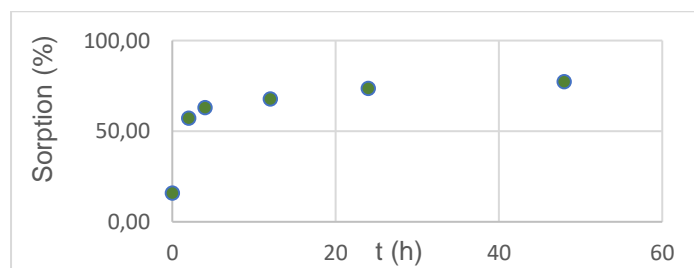
RBZ is commercialized in Brazil as an antiparasitic drug and is the main metabolite of albendazole. Therefore, this compound was selected to be evaluated in this work. Previous studies also shown that ABZ in aqueous solution, in the presence of oxygen, undergoes oxidation to RBZ. For the RBZ quantitation, an analytical method was developed and validated using UHPLC-MS/MS, with an electrospray ionization source operating the positive mode. The calibration curves were prepared by fortifying blank soil sample extracts with RBZ. Albendazole-*d*<sub>3</sub> was used as internal standard and quantitation was performed using the selective reaction monitoring mode (one transition for quantitation and two transitions for identity confirmation). The validation parameters are shown in Table 1.

The kinetic behavior of drugs onto soils are important to be assessed before sorption studies are carried out aiming the determination of the Freundlich sorption coefficients, because the sorption studies needs to be carried out in the steady-state.

**Table 1.** Validation method parameters.

Linear range	1 to 100 ng mL <sup>-1</sup> (10 – 1000 ng g <sup>-1</sup> )
Linearity	r: 0.9989
Precision	35.1% (1 ng mL <sup>-1</sup> ) and 2.3% (60 ng mL <sup>-1</sup> )
Accuracy	89.3% (1 ng mL <sup>-1</sup> ) and 101.6% (60 ng mL <sup>-1</sup> )
LOD	0.3 ng mL <sup>-1</sup>
LOQ	1 ng mL <sup>-1</sup>

To establish the apparent equilibrium time an optimum soil-solution ratio was 1:10 w/v (2 g of soil was added of 20 mL of CaCl<sub>2</sub> at 0.01 mol L<sup>-1</sup>) used (determined in previous work). For the kinetic studies, the soil solution was fortified with RBZ at a concentration of 100 ng mL<sup>-1</sup>. The soil-solution mixtures were agitated at 25 °C in the dark and samples collected at 0, 2, 4, 12, 24 and 48 h. The quantity of RBZ sorbed onto the clay soil at each time point was calculated (Figure 1) and the data fit well to the second-order kinetic model. The data indicates that the apparent equilibrium is reached after 24 h.



**Figure 1.** Percentage of RBZ sorbed in the clay soil.

### Conclusions

The UHPLC-MS/MS method is appropriate for monitoring RBZ in soil solutions, with adequate detectability, selectivity, and accuracy. The results showed that RBZ was stable during the kinetic studies and no degradation was observed. RBZ has a high affinity to the soil particles. And after 48 h 70% of the drug was sorbed.

<sup>1</sup>IBGE. *Agropecuária puxa o PIB de 2017*. 2017; Available from: <http://www.agricultura.gov.br/noticias/agropecuaria-puxa-o-pib-de-2017>.

<sup>2</sup> MacKay, A.A. and D. Vasudevan, *Polyfunctional Ionogenic Compound Sorption: Challenges and New Approaches To Advance Predictive Models*. Environmental Science & Technology, 2012. **46**(17): p. 9209-9223.

<sup>3</sup> OECD, *Test No. 106: Adsorption -- Desorption Using a Batch Equilibrium Method*. 2000: OECD Publishing.