

Proceedings

Diseases in ruminants associated with *Pteridium aquilinum* ingestion.

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Abstract: *Pteridium aquilinum* (L.) Kuhn, commonly known as bracken-fern, is a cosmopolitan plant species absent only from polar and desert regions. Worldwide, *Pteridium aquilinum* has been rapidly spreading due to the neglect of agricultural fields and the growing wave of forest fires. This plant has several toxic components such as thiaminases, brains, active glucosides, beta-glucopyranosides and ptaquiloside in its constitution that can be lethal to animals. The animals do not normally choose it as food, except in situations of food shortage, in periods of drought, when the ferns are still green or when the animals graze in places with large amounts of the plant in question. In order to revisit the major syndromes caused by *P. aquilinum* major toxins, the authors present several cases of acute and chronic ruminant poisoning associated with ingesting *P. aquilinum* in Portugal in sheep and cattle. The primarily associated syndromes observed in animals that consume this plant were thiamine deficiency, blindness in sheep, acute or subacute poisoning with bone marrow depression, and consequently, leucopenia and bladder tumors in cattle. Given the economic impact of the diseases caused by the toxins of this plant, and possible public health implications, it is imperative to minimize the syndromes in animals and establish measures for their prevention.

Keywords: fern, *pteridium*, ptaquiloside, cattle, tumor, toxicity

1. Introduction

Pteridium aquilinum (L.) Kuhn, commonly referred as common fern, fento or fern of the mountains, or female fern of apothecary, is a cosmopolitan species, absent only in the polar and desert regions (Figure 1) [1–3].

There are two subspecies and, within these, several geographical races. Tyron, quoted by Page, 1976, distinguishes subspecies *Aquilinum* and *Caudatum*, each with different varieties [4].

The global presence of *Pteridium aquilinum* can be attributed to its remarkable adaptability to various environmental conditions. This plant exhibits a highly opportunistic nature and employs a range of mechanisms to sustain its dominance. One such mechanism involves the synthesis of substances that, upon release into the environment or incorporation into the soil following the fern's demise, effectively hinder the emergence and growth of other plants. This attribute grants *P. aquilinum* allelopathic characteristics. Additionally, the fern employs the production of several secondary metabolites as a survival strategy, serving as deterrents for potential predators [1,5,6].

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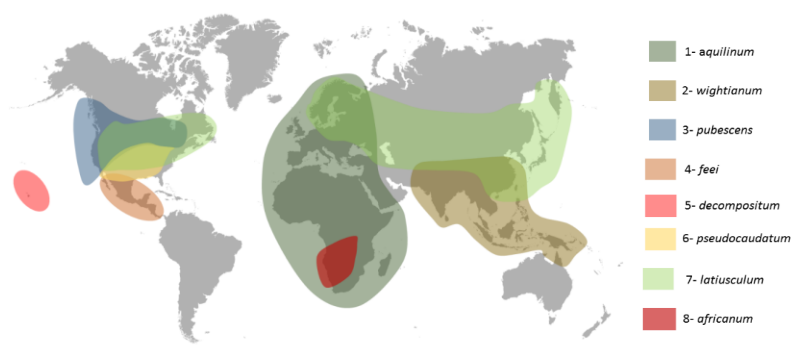


Figure 1. Geographical distribution of *Pteridium aquilinum* subspecies *aquilinum* (Adapted from Page, 1976).

The morphology of the plant can be categorized into three main parts: roots, rhizomes, and fronds, with the fronds featuring fiddleheads in their immature stage (Figure 2). As the Bracken fern (BF) develops, the fiddlehead progressively unfurls, eventually giving rise to mature fronds responsible for the dispersal of essential spores required for reproduction [7,8].



Figure 2. Bracken Fern (Illustration Andreia Garcês and photo Isabel Pires).

In order to revisit the major syndromes caused by *P. aquilinum* major toxins, the authors present several cases of acute and chronic ruminant poisoning associated with ingesting *P. aquilinum* in Portugal in sheep and cattle.

2. Material and Methods

Based on the cases received at the Histology and Anatomical Pathology and at the Veterinary Hospital of UTAD (Vila Real, Portugal), the authors describe the main animal syndromes associated with the ingestion of *P. aquilinum* in ruminants, based on the literature

3. Results and discussion

The primarily associated syndromes observed in animals that consume this plant were thiamine deficiency, blindness in sheep, acute or subacute poisoning with bone marrow depression, and consequently, leucopenia and bladder tumors in cattle.

The plant in question possesses various toxic constituents, namely illudane and illudalane sesquiterpenes, nor-sesquiterpenes, benzoic acid derivatives, cinnamic acid derivatives, enzymes, and thiaminases, which contribute to thiamine (vitamin B1) deficiency, particularly in equines. Also, it contains flavonoid antioxidants such as quercetin and kaempferol, along with an unstable glycoside. Notably, the plant harbours a prominent carcinogenic compound known as ptaquiloside, which is primarily responsible for its carcinogenic properties [9–12].

3.1. Thiamine deficiency

Thiamine deficiencies are frequent, due to the type 1 thiaminase present in this plant. They are mainly affected in monogastric herbivores such as horses since the microbial flora can synthesize this vitamin from its derivatives in ruminants [13–15]. Typical cases of poisoning from bracken fern require relatively high doses over an extended period, such as consuming hay contaminated with 20%–25% bracken fern for at least three months or longer. In horses, the condition known as equine bracken staggers are characterized by symptoms including anorexia, weight loss, lack of coordination, a hunched posture with an arched back and neck, and a wide stance with feet apart. Trembling muscles can be observed when the affected horses are forced to move. In severe cases, tachycardia and arrhythmias may occur, and death usually follows within 2–10 days after the onset of symptoms. Prior to death, convulsions, clonic spasms, and opisthotonos may be observed. The poisoning has been linked to bracken fern thiaminases, as the clinical manifestations resemble those of vitamin B1 deficiency. Thiamine therapy is commonly employed, and most animals respond well to it [16–18].

Poisoning in pigs is relatively rare and presents with less distinct symptoms. Affected pigs typically exhibit anorexia and weight loss. In the terminal phase, the condition may resemble heart failure, and sudden death can occur following recumbency (lying down) and difficulty breathing (dyspnea) (18). However, in sheep fed *P. aquilinum* together with other thiaminase-rich plants, polioencephalomalacia associated with thiamine deficiency has been diagnosed [13–15].

3.2. Blindness in sheep

In sheep, ingestion of *Pteridium aquilinum* appears to be associated with blindness due to progressive retinal atrophy (Figure 3) [19]

The condition known as tapel hyperreflectivity is clinically recognized. These affected animals experience permanent blindness and remain generally alert. The responsiveness of their pupils to light is typically diminished, and advanced cases display narrowed arteries and veins during funduscopic examination. Moreover, the *tapetum nigrum*, a layer of the eye responsible for reflecting light, appears pale with fine cracks and gray spots. Histologically, the affected animals exhibit severe degeneration of retinal rods, cones, and the outer nuclear layer, which is most prominent in the tapetal portion of the retina [16,17,20]. Additionally, these animals often present with various other lesions associated with bracken fern consumption, including bone marrow suppression, hemorrhage, immunosuppression, and urinary tract neoplasia [21]

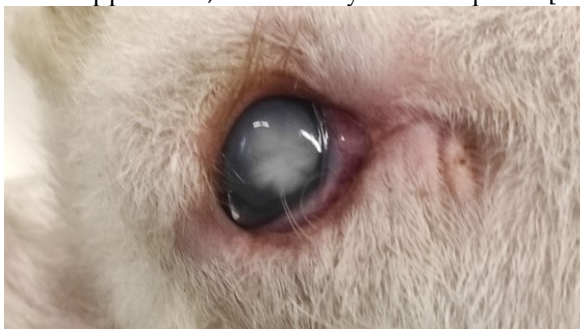


Figure 3: Sheep with blindness.

3.3. Acute or subacute poisoning

Ingestion of bracken fern can lead to acute poisoning and produce various clinical symptoms, including fever, apathy, drooling, haemorrhages in organs such as the gums, nostrils, and gastrointestinal tract. Hematuria and blood in the milk may also occur. Necropsy findings often include red infarcts in the liver and significant bone marrow aplasia [12,22–24].

3.4. Bladder tumours in cattle

Associated with fetus carcinogens are bladder neoplasms (Figure 4), usually with enzootic hematuria and upper alimentary tract neoplasms in cattle [19].

The major carcinogenic compound of *Pteridium* is known as ptaquiloside [9–12,25–27].

Ptaquiloside contains the potent carcinogen dienone 2. Studies have revealed that under weak alkaline conditions, dienone 2 exhibits significant alkylating activity, leading to the cleavage of deoxyribonucleic acid (DNA). Consumption of bracken fern in high doses can cause DNA damage, resulting in programmed cell death and cell cycle arrest even at lower doses [12,28].

PTA shows lower levels in roots and spores but higher concentrations in edible parts and crosiers [29]. Fortunately, hydrothermal methods have been discovered to degrade PTA into a stable form, potentially reducing its toxicity. However, there is a need for further research to provide specific information and evidence on the reduction of toxicity, such as conducting in vitro cytotoxicity tests, and to determine the optimal conditions for PTA degradation, including temperature and heating duration [7,30].

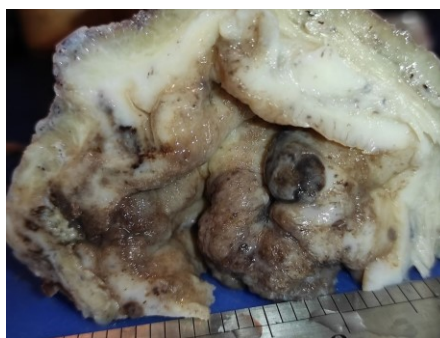


Figure 4: Bladder tumour.

4. Conclusions

Pteridium aquilinum, commonly known as bracken fern, has rapidly expanded its global presence, particularly in Portugal, where it poses a significant potential threat due to favorable environmental conditions. The spread of *P. aquilinum* has been facilitated by the abandonment of certain agricultural crops and the increasing occurrence of forest fires. This fern species has an extensive rhizome system that allows it to survive fires, and while it does not produce spores in shaded areas, exposed regions promote the development of sporangia, leading to the production of a large number of spores. These spores, characterized by their small size, are easily dispersed by wind. Furthermore, *P. aquilinum* is one of the first plants to colonize newly burned areas.

Bracken fern intoxication is incurable, except in cases of thiamin deficiency. Therefore, it is crucial to control and prevent exposure to this plant. Implementing improved grazing management and alternating grazing between fern-contaminated and fern-free areas at three-week intervals can help minimize the risk of poisoning. Measures to stop the growth and density of bracken fern are important and could include regular cutting of mature plants or, if suitable, deep tillage.

Climate change appears to have a favourable impact on the spread of bracken fern, particularly in Northern Europe and mountainous regions. Rising temperatures, extended growing seasons, increased humidity, and additional hours of sunlight contribute to its proliferation. However, it is important to recognize the negative consequences this fern can bring to both humans and animals. Therefore, caution must be exercised to prevent excessive exposure to its hazardous chemicals.

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