SCIENTIFIC PAPER

Strategies for the prevention and control of natural intoxication by photosensitizing plants in cattle

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ABSTRACT: The study was conducted at the Livestock Production Enterprise Bacuranao, of the Habana del Este municipality (La Habana province, Cuba), in order to establish a strategy for the prevention and control of natural intoxications by photosensitizing plants in cattle. For such purpose, a presumptive diagnosis on photosensitization was carried out, through the floristic inventory of the plants present in grazing and with the use of the clinical method. Diverse plants which cause hepatogenous photosensitization in the animals were identified, with *Ageratum houstonianum* Mill., *Lantana camara* L., *Crotalaria retusa* L. *Crotalaria incana* L. and *Crotalaria spectabilis* Roth standing out. The density of cattle per quadrant, the areas with higher incidence of this type of plants and the animals with dermatitis were determined through the Epidemiological Surveillance System (SIVE), by quadrants and grids. In the evaluation of the relative risk (RR) with and without the presence of the sun and with regards to the green forage intake, it was found that the animals exposed to sunlight and those that consumed forage had 1,85 and 3,17 times more incidence, respectively, of clinical signs associated to the hepatogenous photodynamic dermatitis, with higher levels for the ones that ingested the toxic plant *A. houstonianum* Mill along with the forage. From these results a plan of general and specific measures was elaborated for the control of toxicosis in the areas contaminated with these plants. It is concluded that the use of SIVE, the botanical census, the support treatments to animals with severe symptoms and the management and feeding measures can improve the efficacy in the control of toxicosis and, in turn, the protection of the animals at risk.

Keywords: floristic inventory, photosensitivity, toxic plants

INTRODUCTION

The control of the toxicoses caused by plants is complex, due to the diverse factors that can cause them and to the different interactions among the components of agroecosystems (Aparicio, 2000). This turns out to be more difficult when the active chemical principles responsible for the process are not known. For such reason, it is important that as part of the diagnosis the presence of the plant that causes it, as well as the knowledge of the chemical principles responsible for the intoxication symptoms, is taken into consideration (García and García, 1988).

It is known (Hubinger *et al*., 2012) that the species *Ageratum houstonianum, Lantana camara, Crotalaria retusa, Crotalaria spectabilis* and *Crotalaria incana* cause hepatotoxic effects, characterized by the presence of hepatocyte apoptosis, distension of the gallbladder and hepatic cholestasis, which are clinically shown, during the physical examination of the animals, with an acute hemorrhagic course, of higher mortality rate, and a subacute one of lower mortality rate and lesions on the skin layers; as well as with complications caused by other pathogens (bacteria, fungi, parasites).

On the other hand, the study of these species is interesting not only for animal health, but also for public heath, because some active principles can be accumulated in the tissues, as in the case of monocrotaline (a pyrrolizidine alkaloid), which can cause toxic effects on humans (Kellerman *et al*., 2005).

Hence the importance of the different methods (physical, mechanical, biological, chemical and ecological), which are used in the eradication of harmful plants, and in the prevention and control of these intoxications in cattle. Taking into consideration these antecedents, the objective of this research was to perform a presumptive diagnosis to establish the main prevention and control measures that are applied against intoxication by photosensitizing plants, using the results of the system of calculated relative risk.

MATERIALS AND METHODS

Location and experimental procedure. The research was conducted in grazing areas of several basic units of cooperative production (UBPC) of the Livestock Production Enterprise Bacuranao, of the Habana del Este municipality (La Habana province, Cuba). At the beginning of it an epidemiological study was conducted which comprised parasitological (in order to discard hepatic parasitism), bacteriological and toxicological examinations of the feed and water, as well as clinical and morphopathological examinations of the affected animals. No correspondence was detected between the water supply source (of deep groundwater level) and the appearance of the intoxication centers. Animal management and feeding were the same, for the herds of affected animals, as well as for the healthy ones, and the diet was constituted by commercial concentrate feed, supplied according to the category of the animals, final molasses, silage and pastures and forages. In this sense it was detected that, in general, only the affected animals consumed forage contaminated by the toxic plants, mainly *A. houstonianum* Mill.

In addition, the floristic composition in the areas free from symptoms and in the contaminated ones was explored and, with the use of the clinical method, the level of photosensitization-caused affectation provoked by the different toxic botanical species present in the paddocks and in the forages that were supplied to the animals, was determined.

In this sense, small groups of animals or individual cases with severe affectations received support measures (electrolytic and dextrose solutions, water), and as therapy, antimicrobial, anti-inflammatory and antifungal drugs, according to the clinical symptoms they showed (Peixoto *et al*., 2006; Riet-Correa *et al*., 2011).

Likewise, the relative risk (RR) was evaluated with regards to the presence of different factors that make possible the manifestation of these symptoms of hepatogenous photosensitization, specifically sunlight and forage intake (Van Wyk *et al*., 2002; Hubinger *et al*., 2012). For such purpose, the animals were randomly selected, from a field work based on observation, with the combination of the clinical method of anamnesis and the physical examination of the animals, with exploration of the skin and the mucosae.

Design and treatments. Based on a completely randomized design with factorial arrangement four groups were formed with healthy (129) and affected animals (62) to evaluate the incidence of the sunlight factor; thus, the first lot grouped 48 healthy animals exposed to sunlight and 81 not exposed, while the second lot had 37 sick animals exposed to sunlight and 25 not exposed. Two lots were also formed on this same design, one of healthy animals (107) and another one of sick ones (95) to which the consumption or not of toxic forage was included as factor. Thus, from the group of sick animals, 65 consumed forage and the other 30 did not; while of the healthy animals, 17 ingested forage and 90, did not. As inclusion criteria to form the groups, in the case of the sick animals, those which showed affectations in the white coat and the mucosa were chosen; and in the healthy ones, those that had white coat. The animals that were naturally in contact with the plants in the paddocks or with the forage offered in the facilities were taken into consideration.

To elaborate the strategy for controlling the identified toxic species and for the prevention and eradication of the toxicosis caused by them, the theory of microlocation, through the Epidemiological Surveillance System (SIVE), was used, which allows to verify the population density of animals per quadrants and grids within a territory (Toledo *et al*., 2000).

Statistical analysis. A chi-square comparison test was used to determine the difference among means through 2x2 contingency tables with a significance level of 0,05 (table 1). The calculation of the RR was made according to Aparicio (2000), for such purpose, the statistical package Infostat version 1.1 (Infostat, 2002) was used.

RESULTS AND DISCUSSION

The botanical census of the territories (pasture and forage areas), as well as the inspection of the feed niches, showed the existence of species belonging to the genera *Acacia, Achyranthes, Ageratum, Amaranthus, Argemone, Brachiaria, Cestrum, Crotalaria, Cynodon, Lantana, Melochia, Mimosa, Panicum, Salons, Senna* and *Paspalum*, with preponderance for *Ageratum, Crotalaria, Lantana, Acacia, Achhyranthes, Amaranthus, Brachiaria, Cestrum, Paspalum* and *Solanum*. It is known that *A. houstonianum* Mill., *L. camara* L., *C. spectabilis* Roth, *C. retusa* L. and *C. incana* L. are potentially hepatotoxic, because animals consume them (Aparicio, 2000; Marrero, 2000). The infestation of the offered forages with *A. houstonianum* Mill was also corroborated, which affected most of the

Table 1. Elements that were taken into consideration for the calculation of chi-square.

	Sick	Healthy	Total
Risk factor present	Sick animals with risk factor present (a)	Healthy animals with risk factor present (b)	All the animals that have the risk factor (a+b)
Risk factor absent	Sick animals with risk factor absent(c)	Healthy animals with risk factor absent (d)	All the animals that do not have the risk factor (c + d)
	All sick animals (a + c)	All healthy animals (b + d)	Total animals

animal categories (calves, yearlings, heifers and bulls). Although this was related neither to age nor breed, it was linked to the presentation of the clinical symptoms (susceptibility); coinciding with many white-coat animals, which prevailed in the zone and they are known to be highly susceptible to sun irradiation (Muhammad and Riviere, 2012). It should be stated that only *A. houstonianum* Mill was identified within the forage biomass, the other toxic botanical species were distributed in the paddocks and the animals could have access to them naturally. In this sense, those categories that did not receive contaminated forage and the animals that were under shade (fattening animals) were not affected.

This previous study confirmed the existence of a flora potentially toxic for the animals which grazed or consumed feedstuffs that came from the evaluated areas; hence the possibility of poisoning occurring, as well as the presence of clinical cases and sick animals by photosensitization.

When analyzing the sunlight factor, the existence of 62 animals with dermatitis and 129 healthy ones was appreciated (table 2), while due to the consumption factor 95 animals became sick and 107 remained healthy (table 3). Those animals which did not show lesions on the skin were considered healthy, and the ones with dermatitis were considered sick (subacute course of the disease). According to the results, the affected animals had acute hemorrhagic and subacute photosensitization symptoms, lesions that were described by Barbosa *et al*. (2006) and Brum *et al*. (2007), in the presence of photosensitizing plants.

The evaluation of RR constitutes a tool for the establishment of defense barriers against these diseases; if its value is known, measure plans can be established for the control of any disease and, particularly, of toxicosis (Aparicio, 2000).

Regarding the results of table 2, the RR was 1,85; which explains that the animals exposed to sunlight had 1,85 times more possibilities of showing dermatitis than the ones which were not exposed,

Table 2. Sick and healthy animals, with and without risk factor (exposed to sunlight).

	Sick animals	Healthy animals	Total
Animals exposed to sunlight	37 (a)	48 (b)	(a + b) 85
Animals not exposed to sunlight	25 (c)	81 (d)	(c + d) 106
Total	(a + c) 62	(b + d) 129	191

The obtained probability was $p = 0{,}0034$.

Table 3. Sick and healthy animals, with and without risk factor (presence of forage).

	Sick animals	Healthy animals	Total
Animals that consumed forage	65	17	82
Animals that did not consume forage	30	90	120
Total	95	107	202

The calculated probability was $p = 0{,}0001$.

while the ones that consumed forage (table 3) had a RR of 3,17.

From the above-mentioned results, it can be considered that the presence of toxic plants, the exposure of animals to sunlight and the consumption of contaminated green plant material, trigger the process of hepatogenous photosensitization of subacute course (Aparicio, 2000; Marrero, 2000; Riet Correa *et al*., 2006), for which the knowledge of these plants and the risk factors that assist the presentation of the process is vital for the correct control and therapeutics.

In literature it is reported that in most cases the animals which received pharmacological therapy were recovered without major difficulties from the hepatogenous or secondary dermatitises (Peixoto *et al*., 2006; Riet-Correa *et al*., 2011); nevertheless, it is also necessary to establish some measures to prevent and mitigate intoxications. Thus, the access of the animals to the areas with infestation of toxic plants and the contamination of the forage from the areas with photosensitizing botanical species should be avoided, and the consumption of green plant material (forage or pasture) should be temporarily suppressed and the animals should be protected from the sun (Aparicio, 2000; Barbosa *et al*., 2005; Albernaz *et al*., 2010).

Another aspect of interest for the control of toxicoses caused by plants is the knowledge about the presence of the plant and its geographical distribution, for which the SIVE –in which the information of the different instances of veterinary services is gathered– can be used as support, and thus avoid higher losses in the animals (fig. 1).

From this analysis it could be observed that the territories with higher cattle population density were the basic units of cooperative production (UBPC), with a total of 3 829 animals of different categories, which were found in quadrants 030115 and 030116. Such territories coincided with the areas in which there was a higher quantity of photosensitizing plants and a higher number of animals diagnosed as sick, with dermatitis.

According to Aparicio (2000) and Toledo *et al*. (2000), the distribution, mapping and location by geographical quadrants and subquadrants, as well as their correlation to the animal population (susceptible species and population density), constitute basic tools for the control of the diseases caused by toxic plants. In addition, it is necessary to instruct the staff linked to livestock production, and the population in general, about the knowledge of these species and the possible effects they cause on the animals (Marrero, 2000).

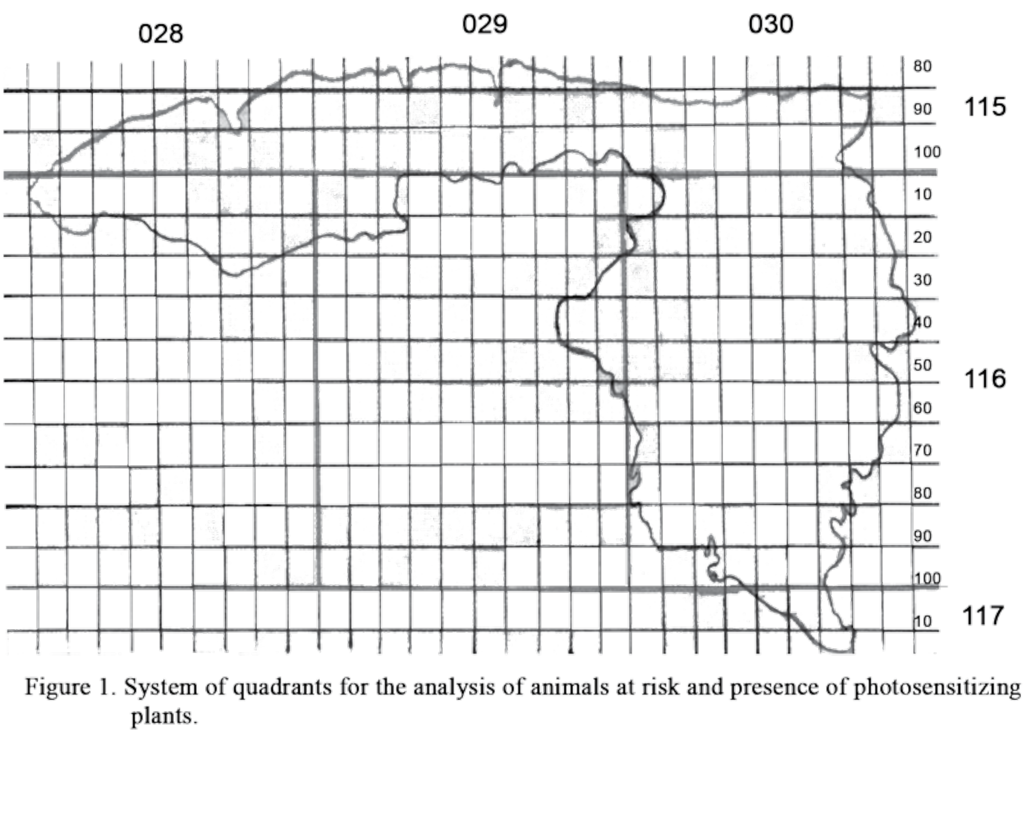

Figure 1. System of quadrants for the analysis of animals at risk and presence of photosensitizing plants.

The data obtained in this research allowed to establish an integral control system for toxicosis by photosensitizing plants, which was based on the report by Hubinger *et al.* (2012), that recommend the use of mechanical (soil plowing up, cutting, weeding and elimination of the toxic plants), physical (artificial burning), chemical (use of herbicides), biological (use of organisms or products that control these plants), agroecological methods (natural balance between the existing flora and fauna in livestock production regions) or the combination, in an integrated way of several of these methods. The strategy is described in fig. 2.

As a result of this strategy, in this study the method of cutting, weeding and elimination of toxic plants was used, with which the affected and invaded areas could be recovered. Nevertheless, it is recommended to perform a previous analysis of the methods to be performed, because many of these species, besides their toxicity, can also offer benefits for men, animals and other plants. In this sense, Aparicio (2000) reported anti-inflammatory, analgesic and antipyretic effect for the species of the *Ageratum* genus, as well as antimicrobial and antifungal activity of extracts based on species of this same genus and of others such as *Lantana* and *Crotalaria*, for which it is suggested to conduct pharmacological studies with these plants, to explore their potential as drug sources. García and García (1988) and Kellerman *et al.* (2005) also state that they can control diseases caused by mycotoxins, especially, aflatoxicoses.

From the above-explained facts it is derived that, although it is essential to establish the control of such plants to prevent toxicoses in the animals, they cannot be totally eliminated, because they could contribute favorable elements to the agroecological systems (Van Wyk *et al.*, 2002; Riet-Correa *et al.*, 2011).

It is concluded that in the studied enterprise there is a high risk of emergence of hepatogenous photodynamic dermatitis, which is related to the existing breed, the level of infestation of paddocks and forages with photosensitizing plants and the long exposure of the animals to sunlight, for which the establishment of an integral control system (epidemiological surveillance system, botanical census, calculation of the risk factor, adjustments in the management and feeding, support treatments, etc.) can substantially improve efficacy in the control of this toxicosis.

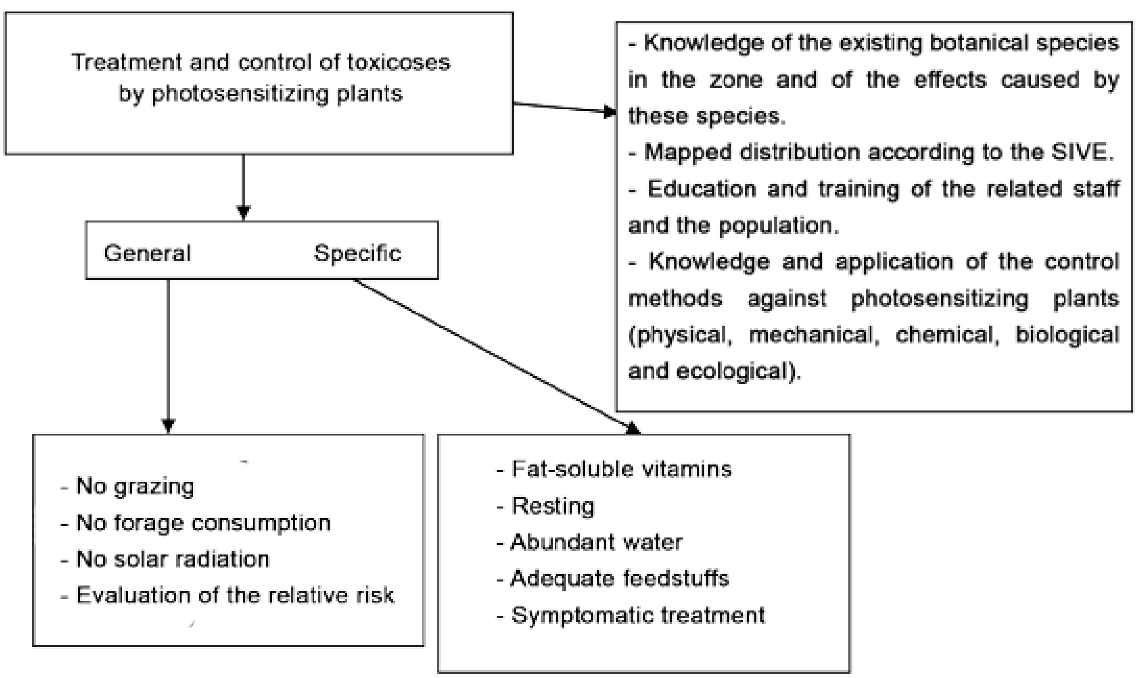

Fig. 2. Medidas de tratamiento y control para la toxicosis por plantas fotosensibilizantes.

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