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# Cattle mortality due to poisoning in Spain: a cross-sectional epidemiological study

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## Abstract

The lack of nationwide public databases on poisoning in cattle makes it difficult to investigate this issue. Hence, we conducted an epidemiological study using the data on cattle poisoning provided by an insurance company (2000-2005), to determine the mortality rate due to poisoning in cattle in Spain and to assess the influence of the following variables: type of farming, age, sex, time of year, year and region. We observed a mortality rate of 23.25 per 100,000 animals in Spain with a higher rate in beef than dairy cattle (32.14 *vs.* 4.51 per 100,000 animals). There were also differences in the mortality rate between breeding cattle and future breeders, affecting dairy and beef cattle in a different way. In dairy cattle, we found differences between the years analysed. In beef cattle, the time of year with highest risk of poisoning was the last quarter (19.45 per 100,000 animals), while the lowest mortality rate was observed in the first quarter (1.33 per 100,000). There were pronounced differences between regions in beef cattle, differences being non-significant in dairy cattle. Lastly, in beef cattle, no differences were found between sexes. In summary, the mortality rate due to poisoning in cattle in Spain is low, and the risk of poisoning is determined by the farming system, animals' stage of development, time of year and region.

**Additional key words:** intoxication; insurance company; bovine; beef; dairy.
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## Introduction

The lack of national public databases on cattle poisoning is an obstacle for investigating the epidemiology of cattle poisoning (Guitart *et al*., 2010). To overcome this problem, researchers tend to rely on retrospective studies based on cases reported to and diagnosed in toxicology laboratories and universities, descriptions of telephone consultations between veterinary surgeons or owners of animals and toxicological information centres, and reviews of published cases of poisoning (Cortinovis & Caloni, 2013). Most retrospective studies have a local or regional focus (Novoa *et al*., 2012), refer to a single causal agent (Mavangira *et al*., 2008), involve wild animals or pets (Berny *et al*., 2010; Giorgi & Menzgozzi, 2011), or concern the impact of agricultural and industrial pollution on the fauna of certain geographical areas (Mañosa *et al*., 2001; Berny *et al*., 2002).

Moreover, in our literature search, we did not find any reference to the mortality rate due to poisoning in cattle in Spain, or in other countries in Europe, Asia or Australasia. On the other hand, we found a few publications from various different American countries and South Africa that attribute some proportion of all deaths in cattle to poisonous plants. In the USA, Nielsen (1988) estimated that a third of deaths in cattle were due to poisoning by plants, based on data from the U.S. Department of Agriculture (1973) and reported by various authors concerning 17 states in the west of the country. Denogean *et al*. (2008), using the same criteria as Nielsen (1988), found the same proportion of cattle deaths (one third) were attributable to poisonous plants in the State of Sonora in Mexico. Taking into account the opinion of expert veterinary surgeons from all the provinces across South Africa and with a 25-year perspective, Kellerman *et al*. (1996) estimated that deaths due to poisonous plants and mycotoxicosis account for 10% of all dairy cattle deaths. In all three of the aforementioned studies, authors considered 3% of the cattle population for the estimates. Riet-Correa & Medeiros (2001) used 10-year registers of the causes of death in cattle from two laboratories in the state of Rio Grande do Sul, and a 12-year register from the Universidade Federal de Santa Catarina in the state of Santa Catarina, both in Brazil, as well as data from two laboratories in Uruguay, and reported that mortality due to poisonous plants in Brazil may account for between 10 and 14% of all deaths, while in Uruguay the rate was around 14%. However, none of these authors analysed the potential impact of factors such as age, sex, season or type of farming (extensive *vs*. intensive, or beef *vs*. dairy).

In addition to the lack of national public databases, a notable barrier to investigating cattle poisoning at the national level is a lack of data on the number of cattle at risk (Blanco, 2012), meaning that rates cannot be calculated. Other challenges include there being no requirement to notify cases of poisoning to a central organisation (Vandenbroucke *et al*., 2010); a tendency to publish the most striking cases rather than the most common ones (Guitart *et al*., 2010); a lack of qualified professionals to identify cases of poisoning (Rogel & Tamayo, 2007); difficulties in confirming the toxicological diagnosis (Lucena *et al*., 2010); and a lack of habit among farmers to request post-mortem diagnosis (Esselmont & Kossabaibati, 1997).

For these reasons, we conducted an epidemiological study of cases of death due to poisoning in cattle using data from an insurance company (Agroseguro S.A.). This company is an association of insurance companies offering agricultural insurance in Spain. It is the only company in Spain that offers policies covering death due to poisoning. Using this source of information, we overcame some challenges of investigating this issue at the national level; specifically, the data came from across the country and the number of animals at risk is known, namely, the animals covered correspond to 19.59% of breeding cattle and future breeders in Spain. In addition, the expectation of receiving pay-outs motivates farmers to report all events, making it relatively unlikely that they hide cases of death due to poisoning.

Accordingly, the objectives of this study were to test whether or not the mortality rate due to poisoning in cattle in Spain was low and what were the effects on this rate of the following variables: type of farming, age, sex, time of year, year, and region.

# Material and methods

This was a descriptive observational, cross-sectional study. Data were collected and anonymised from reports written for the insurance company by 120 veterinary surgeons that had made a diagnosis of "death due to poisoning" in cattle. These documents are the same across Spain and contain the following information: name of the owner, name and address of the farm, head of livestock on the farm, type of cattle (beef or dairy), data concerning the animal that has died (individual identification number, age and sex) and diagnosis. In the comments section, veterinary surgeons can note clinical signs, types of lesions observed, requests for tests, cause of the poisoning in such cases, and other information, as deemed appropriate. The data correspond to all the deaths due to poisoning reported between 2000 and 2005 in current and future breeding stock insured in Spain. Cattle in the fattening period and deaths due to foodborne disease were not considered.

The variables analysed were: type of farming, age, sex, time of year, year and region. The type of farming variable classified the animals as beef cattle, which tend to be reared under extensive systems, or dairy cattle, more often farmed intensively. Concerning age, we distinguished between breeding animals, those over 24 months of age, and future breeders, those under 24 months. In addition, dairy breeding animals were grouped by age from 2 to 12 years old. From the date of the event, we identified the year, between 2000 and 2005, and the time of year, in terms of calendar month and quarter. Lastly, the region variable reflects the territorial division of Spain into 17 autonomous regions.

All the diagnoses were made by veterinary surgeons, starting the diagnosis procedure within 72 hours. The diagnostic process involved: anamnesis, clinical signs and assessment of the area, searching for evidence suggesting the consumption of poisonous plants or other potentially toxic substances in 5.14% of cases, while in 74.94% of cases, post-mortem examinations were also carried out, diagnoses being based on the finding of lesions and/or presence of toxins in the digestive tract. As well as the aforementioned procedures, laboratory tests were performed in a further 19.30% of cases. In the other 0.63% of cases, although reported as deaths due to poisoning, it was not possible to ascertain which method was used by the veterinary surgeon for making the diagnosis on the basis of the information available.

## Statistical analysis

The measure selected to assess the frequency of death due to poisoning was the rate per 100,000 animals with 99% and 95% confidence intervals. To control for differences between cattle types, analysis of the mortality rate was stratified into two groups: beef and dairy animals.

Arithmetic means were calculated as the measure of central tendency and standard deviations as the measure of dispersion. Results were described using dynamic tables, as well as percentages, absolute values and linear correlation coefficients.

The hypotheses were tested using Pearson's Chi-square, differences being considered significant for *p* values below 0.05. This statistical analysis was performed using SPSS version 19.0.

## Results

The total head of cattle insured was 5,720,873, representing 19.64% of the current and future breeding cattle in Spain (MAGRAMA, 2008). Of these, 1,954,049 were beef cattle (9.89% of the national beef cattle population) and 3,766,824 were dairy cattle (40.21% of the national dairy cattle population). The estimated overall mortality rate for breeding cattle and future breeders in Spain, between 2000 and 2005, was 23.24 per 100,000 animals (95% confidence interval, CI: 22.7, 23.8).

Tables 1 and 2 summarise the mortality rates, comparing the results as a function of the variables studied, namely, age, sex, year, time of year and region and stratified by type of farming (beef or dairy). Notably, the mortality rate was 7.13 times higher in beef cattle than dairy cattle [32.14 (99% CI: 29.63, 34.65) *vs.* 4.51 (99% CI: 4.00, 5.64) per 100,000 animals]. Regarding age, in beef cattle, the mortality rate was higher in breeding animals than in future breeders ($\chi^2$=28; $p$<0.0001), while in contrast, in dairy cattle, the mortality rate was higher in future than in current breeders ($\chi^2$=105; $p$<0.0001). On the other hand, among the 2- to 12-year-old breeding cattle, differences in mortality rate by age were not significant.

Assessing mortality by sex, no significant differences were found in beef cattle ($\chi^2$=2.7; $p$=0.1), while in dairy cattle, the mortality rate was higher in males than in females ($\chi^2$=68; $p$<0.0001). Considering both sex and type of farming, we found differences between female beef and dairy cattle but none between male beef and dairy cattle.

The mean number of deaths per year for the period (2000-2005) was 104.67 (SD=24.61) in beef cattle and 28.33 (SD=11.84) in dairy cattle. In beef cattle, differences between the years of the study were not statistically significant. However, in dairy cattle, the mortality rate in 2001 was lower than in 2003 ($\chi^2$=7.8; $p$<0.005) and in 2004 ($\chi^2$=13; $p$<0.001).

Regarding the time of year, the mortality rate in beef cattle increased from the first to the fourth quarter of the year, all the differences between quarters being statistically significant ([$\chi^2$]; $p$): Q1 *vs.* Q2 ($\chi^2$=16; $p$<0.0001); Q1 *vs.* Q3 ($\chi^2$=95; $p$<0.0001); Q1 *vs.* Q4 ($\chi^2$=309; $p$<0.0001); Q2 *vs.* Q3 ($\chi^2$=40; $p$<0.0001); Q2 *vs.* Q4 ($\chi^2$=225; $p$<0.0001); and Q3 *vs.* Q4 ($\chi^2$=92; $p$<0.0001).

In contrast, in dairy cattle, mortality was stable through the first three quarters and the only significant difference was between the third and fourth quarters ($\chi^2$=11; $p$<0.001). The mortality rate was significantly higher in beef than dairy cattle in all but the first quarter of the year.

To facilitate the description of the results by geographical area (Table 2), three groups were formed for beef cattle by inspection, as a function of the mortality rate. The first is composed of five regions (Asturias, Andalusia, the Basque Country, Cantabria and Castilla y León) with a mean mortality rate of 52.89 per 100,000 (SD=10.71), this group accounting for 54.66% of the beef cattle insured and 57.24% of the total beef cattle population in Spain. In all these regions, the mortality rate was higher in beef than dairy cattle. In a second group, containing eight regions (Extremadura, Catalonia, Navarre, Galicia, Aragón, La Rioja, Madrid and Castilla La Mancha) with 44.41% of the beef cattle insured and 31.23% of all beef cattle in Spain, there was a mean mortality rate of 9.66 per 100,000 animals (SD=4.54). Differences in mortality between beef and dairy cattle were not significant for the regions in this group, except in the case of Catalonia. Thirdly, in a group composed of the Canary Islands, the Balearic Islands, Valencia and Murcia, with 0.96% of the beef cattle insured and 1.69% of all beef cattle in Spain, there were no reports of death due to poisoning.

In dairy cattle, the mortality rate was highest in the Canary Islands, at 60.45 per 100,000 animals (95% CI: 33.25, 87.65). In contrast, the corresponding mean mortality rate in the other regions with deaths attributed to poisoning was just 4.79 per 100,000 (SD=4.45), while no deaths due to poisoning were reported in the regions of Extremadura, La Rioja or Valencia, the animals in these regions representing 1.90% of the dairy cattle insured and 1.97% of all dairy cattle in Spain.

## Discussion

The overall rate of mortality due to poisoning in Spain was estimated to be 23.25 per 100,000 animals (95% CI: 22.7, 23.8), lower than reported for other places, such as the USA (1%, Nielsen, 1988) and the state of Sonora in Mexico (1%, Denogean *et al*., 2008). The rate is also low compared to that calculated from estimates of mortality for this cause reported by other authors including: Kellerman *et al*. (1996) for South Africa (0.28%); Riet-Correa & Medeiros (2001) for Brazil (0.6%) and Uruguay (0.7%); and Tokarnia *et al*. (2002) for Brazil (0.58%).

The differences in mortality due to poisoning in Spain, on the one hand, and USA, Brazil, Mexico, Uruguay and South Africa (where mortality rates are

**Table 1.** Mortality rates (2000-2005) as a function of age, sex, year, time of year and region, stratified by type of farming (beef or dairy)

| | Type of farming | Cattle insured (n) | Number of deaths | Mortality rate per 100,000 (95% CI)[1] | p value ($\chi^2$) |
|---|---|---|---|---|---|
| **Breeding animals and future breeders** | Beef | 1,954,049 | 628 | 32.14 (29.63, 34.65)* | <0.0001 (704) |
| | Dairy | 3,766,824 | 170 | 4.51 (3.62, 5.4)* | |
| **Age** | | | | | |
| Breeding animals (> 24 months) | Beef | 1,348,387 | 495 | 36.71 (33.48, 39.94) | <0.0001 (799) |
| | Dairy | 2,892,175 | 74 | 2.56 (1.98, 3.14) | |
| Future breeders (<24 months) | Beef | 605,662 | 133 | 21.96 (18.23, 25.69) | <0.0001 (28) |
| | Dairy | 874,649 | 96 | 10.96 (8.07, 13.85) | |
| Age group (years) | | | | | |
| 2-3 | Dairy | 643,903 | 14 | 2.17 (1.03, 3.31) | |
| 3-4 | | 608,308 | 20 | 3.29 (1.85, 4.73) | |
| 4-5 | | 507,391 | 9 | 1.77 (0.61, 2.93) | |
| 5-6 | | 392,663 | 10 | 2.55 (0.97, 4.13) | |
| 6-7 | | 285,064 | 11 | 3.86 (1.58, 6.14) | |
| 7-8 | | 190,890 | 3 | 1.57 (–0.21, 3.35) | |
| 8-9 | | 119,437 | 3 | 2.51 (–0.33, 5.35) | |
| 9-10 | | 68,483 | 2 | 2.92 (–1.13, 6.97) | |
| 10-11 | | 35,869 | 1 | 2.79 (–2.67, 8.25) | |
| 11-12 | | 40,167 | 1 | 2.49 (–2.39, 7.37) | |
| **Sex**[2] | | | | | |
| Female | Beef | 1,280,150 | 407 | 31.79 (28.70, 34.88) | <0.0001 (468) |
| | Dairy | 2,698,578 | 130 | 4.82 (4.00, 5.64) | |
| Male | Beef | 236,742 | 60 | 25.34 (18.93, 31.75) | 0.05 |
| | Dairy | 15,111 | 8 | 52.94 (16.86, 89.02) | |
| **Year** | | | | | |
| 2000 | Beef | 182,971 | 65 | 35.52 (26.89, 44.16) | <0.0001 (94) |
| | Dairy | 413,780 | 16 | 3.87 (1.97, 5.76) | |
| 2001 | Beef | 254,186 | 95 | 37.37 (29.86, 44.89) | <0.0001 (178) |
| | Dairy | 639,355 | 16 | 2.50 (1.28, 3.73) | |
| 2002 | Beef | 318,138 | 104 | 32.69 (26.41, 38.97) | <0.0001 (190) |
| | Dairy | 718,703 | 28 | 3.90 (2.45, 5.34) | |
| 2003 | Beef | 361,547 | 107 | 29.60 (23.99, 35.20) | <0.0001 (99) |
| | Dairy | 696,333 | 39 | 5.60 (3.84, 7.36) | |
| 2004 | Beef | 404,922 | 139 | 34.33 (28.62, 40.03) | <0.0001 (109) |
| | Dairy | 656,973 | 45 | 6.85 (4.85, 8.85) | |
| 2005 | Beef | 432,285 | 118 | 27.30 (22.37, 32.22) | <0.0001 (104) |
| | Dairy | 641,680 | 26 | 4.05 (2.49, 5.61) | |
| **Time of the year**[3] | | | | | |
| Q1 | Beef | 1,954,049 | 26 | 1.33 (0.82, 1.84) | 0.79 |
| | Dairy | 3,766,824 | 47 | 1.25 (0.89, 1.61) | |
| Q2 | Beef | 1,954,023 | 64 | 3.28 (2.48, 4.08) | <0.0001; (30) |
| | Dairy | 3,766,777 | 44 | 1.17 (0.82, 1.52) | |
| Q3 | Beef | 1,953,959 | 158 | 8.09 (6.83, 9.35) | <0.0001; (154) |
| | Dairy | 3,766,733 | 54 | 1.43 (1.05, 1.81) | |
| Q4 | Beef | 1,953,801 | 380 | 19.45 (17.49, 21.41) | <0.0001; (641) |
| | Dairy | 3,766,679 | 25 | 0.66 (0.40, 0.92) | |

[1] CI: confidence interval; *99% CI. [2] Period 2002-2005. [3] Q: quarter

12- to 43-fold higher), on the other, might be due to differences in the methodologies used. In addition, they could also be explained by the fact that much of the cattle farming in Spain is intensive; it being reasonable to suppose that this type of management is associated with lower risks of poisoning by plants than extensive systems. Specifically, practices on extensive farms are based on a system that seeks to take full advantage of food resources available (Sotillo & Vigil, 1978), meaning that animals are more exposed to conditions that may involve a scarcity of food resources (such as droughts and livestock overstocking), and many authors have underlined that such conditions induce animals to eat poisonous plants (Yeruham *et al*., 1998; González *et al*., 1999; Marrero *et al*., 2001; Frutos *et al*., 2005; Rodríguez *et al*., 2005; Denogean *et al*., 2008; Crespo, 2011). In contrast, the risk of poisoning due to plants is likely to be lower in intensive farming systems because animals do not graze; rather they eat food supplied by humans, which would tend to reduce their risk

**Table 2.** Mortality rate (2000-2005) by geographical area and type of farming

| | Type of farming | Cattle insured (n) | Number of deaths | Mortality rate per 100,000 (95% CI)[1] |
|---|---|---|---|---|
| Andalusia | Beef | 48,682 | 31 | 63.68 (41.27, 86.09) |
| | Dairy | 419,545 | 31 | 7.39 (4.79, 9.99) |
| Aragón | Beef | 170,313 | 8 | 4.70 (1.45, 7.95) |
| | Dairy | 97,619 | 1 | 1.02 (–0.99, 3.03) |
| Cantabria | Beef | 148,672 | 71 | 47.76 (36.65, 58.87) |
| | Dairy | 408,433 | 46 | 11.26 (8.01, 14.51) |
| Castilla La Mancha | Beef | 12,098 | 2 | 16.53 (–6.38, 39.44) |
| | Dairy | 52,151 | 1 | 1.92 (–1.84, 5.68) |
| Castilla y León | Beef | 415,521 | 166 | 39.95 (33.87, 46.03) |
| | Dairy | 483,619 | 7 | 1.45 (0.38, 2.52) |
| Catalonia | Beef | 208,658 | 20 | 9.59 (5.93, 13.79) |
| | Dairy | 439,665 | 3 | 0.68 (–0.09, 1.45) |
| Madrid | Beef | 14,905 | 1 | 6.71 (–6.44, 19.86) |
| | Dairy | 69,383 | 2 | 2.88 (–1.11, 6.87) |
| Valencia | Beef | 15,403 | 0 | 0 |
| | Dairy | 42,456 | 0 | 0 |
| Extremadura | Beef | 148,468 | 24 | 16.17 (9.70, 22.64) |
| | Dairy | 10,007 | 0 | 0 |
| Galicia | Beef | 158,374 | 9 | 5.68 (1.97, 9.39) |
| | Dairy | 804,336 | 22 | 2.74 (1.60, 3.88) |
| Balearic Islands | Beef | 2,868 | 0 | 0 |
| | Dairy | 54,650 | 8 | 14.64 (4.50, 24.78) |
| Canary Islands | Beef | 12 | 0 | 0 |
| | Dairy | 31,430 | 19 | 60.45 (33.25, 87.65) |
| La Rioja | Beef | 40,308 | 3 | 7.44 (-0.98, 15.86) |
| | Dairy | 19,042 | 0 | 0 |
| Navarre | Beef | 114,602 | 12 | 10.47 (4.55, 16.39) |
| | Dairy | 184,040 | 7 | 3.80 (0.98, 6.62) |
| The Basque Country | Beef | 75,945 | 37 | 48.72 (33.03, 64.41) |
| | Dairy | 169,723 | 2 | 1.18 (–0.45, 2.81) |
| Asturias | Beef | 379,220 | 244 | 64.34 (56.27, 72.41) |
| | Dairy | 458,820 | 19 | 4.14 (2.28, 6.00) |
| Murcia | Beef | 0 | 0 | — |
| | Dairy | 21,905 | 2 | 9.13 (-3.52, 21.78) |

[1] CI: confidence interval. —: there were no cattle insured.

of poisoning. In line with this, the higher mortality rates due to poisoning in beef cattle in Spain may be due to the fact that this type of cattle is mostly managed under extensive farming systems.

Other factors that may contribute to the overall lower mortality rate observed in Spain include changes in the natural landscape following many centuries of seasonal movements of livestock to access adequate food resources (transhumance) (Zorita, 2001). Indeed, it is known that there are fewer potentially poisonous plants in Spain (250 plants; García-Rollan, 1986) than in many other countries, including the Americas (1000 plants in the USA; James, 1978), where livestock farming started at the time of European colonisation, that is, only about 500 years ago (Benavides, 2004). Changes in the landscape may have led to lower density of poisonous plants in Spain than in some other countries, for example, Bolivia where such plants (particularly, *Pteridium aquilinum*) may represent as much as 50% of the vegetation in contaminated grazing areas (Marrero *et al*., 2001). This high density of poisonous plants mixed with other species in pasture may favour their consumption, as it may be difficult for animals to avoid eating them accidentally as they forage. On the other hand, Benavides (2004) suggested that, in some cases, diseases such as cattle rabies, botulism and anthrax may be mistaken for poisoning.

With regards to age, in dairy cattle, the higher mortality observed in future breeding animals and lack of differences between adult animals (2 to 12 years old) are in agreement with Mavangira *et al*. (2008), who reported a greater mortality due to lead poisoning in younger animals and did not find differences in animals above 4 years of age. For this reason, in the case of dairy cattle, it seems best to classify the risk of poisoning on the basis of the physiological development of animals (young *vs*. adult), rather than as a function of age.

However, the opposite pattern was observed in beef cattle. This may be due to the practice in extensive systems of grouping of livestock based on nutritional requirements. Specifically, the best pastures are used for animals with the greatest nutritional requirements (mothers with young suckling calves, which consume little forage), the pastures with less forage or poorer quality plants being left to other animals with lower requirements (pregnant cows and future breeding cattle in the growth stage). Hence, the latter group may be more likely to experience a scarcity of food resources, and could therefore be induced to consume potentially poisonous plants. The lack of differences in mortality between sexes in beef cattle is consistent with the findings of Sánchez-Villalobos (2006) and Giurgiu *et al*. (2008) regarding bovine enzootic haematuria due to bracken fern poisoning (*Pteridium aquilinum*) and of Mavangira *et al*. (2008) concerning lead poisoning.

The seasonal increase in mortality at the end of the summer and throughout the autumn in beef cattle was due to poisoning by acorns (*Quercus ilex* and *Quercus robur)* or bracken fern (*Pteridium aquilinum*). These types of poisoning are associated with scarcity of food resources leading animals to eat large quantities of certain poisonous plants that need to be consumed in high doses to be lethal, that is, plants that can be safely be consumed in smaller quantities by the same animals. These conditions are considered to be predictable and hence avoidable by improving the assessment of the food available to livestock in extensive farming systems, in order that stocking density can be adapted to forage production. This conclusion is in line with the comments of Schrader *et al*. (2001) regarding the need for inspecting pastures and controlling certain plant species to reduce plant poisoning in ruminants in the northern and eastern Germany.

The uniform diet fed to dairy cattle, throughout the year and in most regions in Spain, to obtain consistently high milk yields and high quality milk, could explain the lack of seasonal changes in mortality and of differences between regions. In contrast, differences observed between regions in beef cattle mortality might be attributable to the distribution of plants across Spain, which influences the exposure of animals to poisonous plants, especially in extensive farming systems. Additionally, these differences may be due to variations in herd management, as well as the practice in certain regions of moving livestock from the valleys to higher ground in the summer, making it more likely that animals are exposed to poisonous plants not common in the environment they are familiar with, which could increase the risk of them consuming poisonous plants in times of food scarcity. In other regions, cattle are not moved around in this way during the low productivity periods, but rather they are fed on the farm itself, as in intensive farming systems, reducing the risk of poisoning. The differences between regions may be also related to the varying concentrations of poisonous substances in some plants depending on their altitude above the sea level; this would be in agreement with Hernández (1997) who found a greater concentration of ptaquiloside in *Pteridium aquilinum* at 1800 m than at 1000 m above sea level (6874 *vs*. 2253 µg/g) and also a greater concentration in *Pteridium arachnoideum* than in the *Pteridium caudatum* in Costa Rica.

In summary, cattle mortality rates due to poisoning in Spain are markedly lower than those reported for some American countries and South Africa. The rates vary between beef and dairy cattle, this being attributable to the fact that they tend to be raised using different forms of farming (extensive or intensive), and hence be managed differently with different feeding systems, all of which influence the risk of poisoning. Mortality rates were higher in the summer and autumn in beef cattle but not in dairy cattle, and this may be related to a greater exposure of beef cattle to food scarcity at these times of the year, which could lead to consumption of poisonous plants. Given the lack of information available on poisoning at the national level, we consider that private databases may be a good source of data for investigating livestock poisoning.

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## References

Benavides E, 2004. Causas de muerte súbita en los bovinos en pastoreo en las sabanas de América Tropical. Rev Colomb Cienc Pec 17(2): 182-192.

Berny P, Sadoul N, Dol S, Videman B, Kayser Y, Hafner H, 2002. Impact of local agricultural and industrial practices on organic contamination of little egret (Egretta garzetta) eggs in the Rhone Delta, southern France. Environ Toxicol Chem 21(3): 520-526. http://dx.doi.org/10.1002/etc.5620210308

Berny P, Caloni F, Croubels S, Sachana M, Vandenbroucke V, Davanzo F, Guitart R, 2010. Animal poisoning in Europe. Part 2: Companion animals. Vet J 183(3): 255-259. http://dx.doi.org/10.1016/j.tvjl.2009.03.034

Blanco FJ, 2012. Valores analíticos de ganado vacuno en régimen extensivo expuesto al consumo de helechos. Doctoral thesis. Universidad Complutense, Madrid.

Cortinovis C, Caloni F, 2013. Epidemiology of intoxication of domestic animals by plants in Europe. Vet J 197: 163-168. http://dx.doi.org/10.1016/j.tvjl.2013.03.007

Crespo JM, 2011. Intoxicación por plantas en el toro bravo. X Simposium del Toro de Lidia. Edición digital de la revista del Symposium del Toro de Lidia. Zafra, Badajoz, Spain. Available in http://www.simposiotorozafra.org/ [14 May 2012].

Denogean F, Moreno S, Martín M, Ibarra F, 2008. Impacto económico de las plantas tóxicas para el ganado sobre la producción pecuaria en Sonora. Rev Mex Agronegocios XII(22): 538-549.

Esselmont RJ, Kossaibati MA, 1997. Culling in 50 dairy herds in England. Vet Rec 140: 36-39. http://dx.doi.org/10.1136/vr.140.2.36

Frutos P, Pérez V, Benavides J, Mantecón AR, 2005. Intoxicación del ganado vacuno por el consumo de bellotas, a pesar de las advertencias. Albéitar 86: 42-44.

García-Rollán M, 1986. Plantas mortales en España. Colección Agricultura Práctica nº 38. Ministerio de Agricultura, Pesca y Alimentación, Madrid, Spain. 126 pp.

Giorgi M, Mengozzi G, 2011. Malicius animal intoxications: poisoned baits. Vet Med-Czech 56(4): 173-179.

Giurgiu G, Mircean M, Scurtu I, Popovici C, 2008. Epidemiological, clinical and paraclinical investigations in cattle enzootic haematuria in area from N-W of Transilvania. Bulletin UASVM, Vet Med-US 65(2): 12-15.

Gonzalez M, Mazucchelli F, Blanco J, Parrilla G, González J, 1999. Intoxicaciones de origen vegetal en ganado vacuno. Producción Animal 140: 32-42.

Guitart R, Croubels S, Caloni F, Sachana M, Davanzo F, Vandenbroucke V, Berny P, 2010. Review. Animal poisoning in Europe. Part 1: Farm livestock and poultry. Vet J 183(3): 249-254. http://dx.doi.org/10.1016/j.tvjl.2009.03.002

Hernández H, 1997. Aislamiento y cuantificación del agente cancerígeno del Pteridium aquilinum. Master's thesis. Instituto Tecnológico de Costa Rica, San José.

James LF, 1978. Overview of poisonous plants problems in the United Estates. In: Effects of poisonous plants on livestock (Keeler RF, Van Kampen KR, James LF, eds.). Acad Press, NY, pp: 3-5. http://dx.doi.org/10.1016/B978-0-12-403250-7.50007-8

Kellerman TS, Naudé TW, Fourie N, Onderstepoort J, 1996. The distribution, diagnoses and estimated economic impact of plant poisonings and mycotoxicosis in South Africa. Vet Res 63(2): 65-90.

Lucena R, Pierezan F, Kommers G, Irigoyen L, Fighera R, Barros C, 2010. Doenças de bovinos no Sul do Brasil: 6706 casos. Pesquisa Vet Brasil 30(5): 428-434. http://dx.doi.org/10.1590/S0100-736X2010000500010

MAGRAMA, 2008. Anuario de Estadística, Ministerio de Medio Ambiente y Medio Rural y Marino, Madrid. Available in: http://www.magrama.gob.es/estadistica/pags/anuario/2008/AE_2008_Completo.pdf [accessed 22/05/2009].

Mañosa S, Mateo R, Guitart R, 2001. A review of the effects of agricultural and industrial contamination on the Ebro delta biota and wildlife. Environ Monit Assess 71(2): 187-205. http://dx.doi.org/10.1023/A:1017545932219

Marrero E, Bulnes C, Sánchez LM, Palenzuela I, Stuart R, Jacobs F, Romero J, 2001. Pteridium aquilinum (bracken fern) toxicity in cattle in the humid Chaco of Tarija, Bolivia. Vet Hum Toxicol 43(3): 156-158.

Mavangira V, Evans TJ, Villamil JA, Hahn AW, Chigerwe M, Tyler JW, 2008. Relationships between demographic variables and lead toxicosis in cattle evaluated at North American veterinary teaching hospitals. J Am Vet Med Assoc 233(6): 955-959. http://dx.doi.org/10.2460/javma.233.6.955

Nielsen DB, 1988. Economic impact of poisonous plants on the rangeland livestock industry. J Anim Sci 66(9): 2330-2333.

Novoa MC, Melgar MJ, García MA, Alonso J, Pérez-López M, 2012. Análisis de la casuística del Servicio de Atención Toxicológica Veterinaria (SATVe) en el período 2001-2007. Rev Toxicol 29(1): 29-35.

Riet-Correa F, Medeiros R, 2001. Intoxicações por plantas em ruminantes no Brasil e no Uruguai: importância econômica, controle e riscos para a saúde pública. Pesquisa Vet Brasil 21(1): 38-42. http://dx.doi.org/10.1590/S0100-736X2001000100008

Rodríguez L, Ríos E, Macció A, Merlo W, Lectora J, 2005. Intoxicación con Ipomoea fistulosa (aguapié, mandiyurá) en cabras. Efectos sobre el sistema nervioso. Universidad Nacional del Nordeste. Comunicaciones Científicas y Tecnológicas 2005 (resumen v-015) Argentina.

Rogel L, Tamayo R, 2007. Mortalidad de vacas en tres rebaños lecheros: estudio preliminar (1994-2004). Arch Med Vet 39(3): 255-260. http://dx.doi.org/10.4067/S0301-732X2007000300009

Sánchez-Villalobos AJ, 2006. Otras consideraciones etiopatológicas de la hematuria vesical bovina. 1er Encuentro Latinoamericano de Expertos en HVB, Zaruma, Ecuador. Memorias. pp: 1-24.

Schrader A, Schulz O, Völker H, Puls H, 2001. Recent plant poisoning in ruminants of northern and eastern Germany. Communication from the practice for the practice. Berl Munch Tierarztl 114(5-6): 218-221.

Sotillo JL, Vigil E, 1978. Bases fisiozootécnicas de la producción animal. Fac. Veterinaria, Univ. Oviedo, Mijares, León, Spain. 531 pp.

Tokarnia CH, Döbereiner J, Peixoto PV, 2002. Poisonous plants affecting livestock in Brazil. Toxicon 40(12): 1635-1660. http://dx.doi.org/10.1016/S0041-0101(02)00239-8

U.S. Department of Agriculture, 1973. Cattle raising in the United States. US Dep Agr, Econ Res Serv, Agr Econ Rep no. 235.

Vandenbroucke V, Van Pelt H, de Backer P, Croubels S, 2010. Animal poisonings in Belgium: a review of past decade. Vlaams Diergen Tijds 79: 259-268.

Yeruham I, Avidar Y, Perl S, Yakobson B, Shlosberg A, Hanji V, Bogin E, 1998. Probable toxicosis in cattle in Israel caused by the oak Quercus calliprinos. Vet Hum Toxicol 40(6): 336-340.

Zorita E, 2001. La investigación zootécnica española. Las razones de un fracaso. Arch Zootec 50: 441-463.