Collection and analysis of post mortem inspection outcomes (liver lesions) from different cattle slaughtering plants located in Northern and Southern Italy

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Abstract
The study evaluated the outcomes of cattle liver post mortem examination (64,766 animals) obtained from three slaughterhouses (two located in Lombardy, Northern Italy, and one in Puglia, Southern Italy) through the period 2016-2020. The frequency of specific lesions determining liver condemnation was calculated and the influence of several factors (animal age/category, geographical area, season, plant) was considered. A mean prevalence of 8% was observed, with a significant difference among the plants (range 6.4-12.8%). A significant difference was observed among the animal categories and age classes, with higher condemnation rates in animals aged more than 30 months (mainly cows). Steatosis was the most frequent lesion observed in cows (about half of the total), whereas liver abscesses were the most diffuse in younger animals (half of the total in young bulls). Other frequently observed lesions were distomatosis and perihepatitis. A different pattern was observed between the two geographical areas, with a higher prevalence of steatosis in Lombardy (mainly intensive dairy farming), and of distomatosis in Puglia (animals mainly grazed on pasture). The season influenced the prevalence of lesions, and especially of steatosis (higher in summer). A different lesion prevalence was also observed between the two plants on similar animal populations, suggesting a difference in the notification and classification procedure among the plants. This study highlights the importance of a proper sharing procedure of the information obtained from the post mortem inspection in order to facilitate an optimal use of Food Chain Information and a useful feedback for farmers.

Introduction
Liver is one of the most important organs submitted to veterinary post mortem inspection during cattle slaughtering, as it is the main offal intended for human consumption, but after all it is of particular interest as a “filter” organ, receiving blood from the digestive tract via the portal vein, thus indicating a potential dissemination of pathogenic bacteria or parasites. Moreover, owing to its major metabolic role, its condition can give a picture of the general state of the whole carcass. The economic loss due to liver lesions may be significant: several studies observed a correlation between the presence of liver lesions and systemic dysfunctions, leading to a slower weight increase, a lower final weight (especially in feedlot cattle) and decreased milk production and fertility in cows (Khan et al., 2009; Brown et al., 2010; Schweizer et al., 2015; Montanholi et al., 2017).

The main lesions causing the condemnation of the liver and, in some cases, of the whole carcass and that can be revealed during the gross post mortem inspection of cattle are: circulation disturbances (e.g. congestion); degeneration of liver tissue, the most frequent being steatosis (“fatty liver”), often caused by post partum lipomobilization in milking cows; abscesses, due to the diffusion of pyogenic bacteria from the stomachs or gut, especially in feedlot cattle (due to a lack of fiber in the feed), or to the penetration of metal pieces (traumatic reticulo-portal) or traumatic reticulo-portal; parasitic diseases, typically detected in animals grazed on pastures: the most frequently detected are caused by cestodes (hydatid cyst of Echinococcus granulosus, Cysticercus tenuicollis from Taenia hydatigena) and trematodes (Fasciola hepatica, Dicrocoelium dendriticum); fibrosis/cirrhosis, that represent a sequela of previous lesions, and can affect the functionality of the liver. Other lesions can be very frequent (e.g. melanosis in the liver of calves, telangiectasis in cows, peripathesis with adhesion fibriniae), but are not generally linked to the state of the carcass, and their significance is scarce. Other lesions of great inspective importance (e.g. nodules caused by tuberculosis or actinobacillosis) are rare.

The current legislation (EU Reg. 627/2019) prescribes the official veterinari- an to act only a visual inspection of bovine liver in absence of particular risk elements, but this procedure still allows to detect the most important lesions (Stäkr et al., 2014). It has to be noted that gross post mortem inspection can reveal the presence of diseases or dysfunctions that are not detectable at an ante mortem inspection (Dupuy et al., 2013), but that can have a severe economic impact on the farm. During this activity, a mass of information is supplied: indeed, the slaughterhouse plays the role of “epidemiological observatory”, thanks to the fast observation of a huge number of animals from different farms and areas, and to the availability of complete information on the animals (e.g. origin, age, sex, breed, Food Chain Information, etc.). The registration and communication of the inspection outcomes is particularly useful in order to inform farmers about the health status of the herd and the main problems to be faced at farm level, favoring a preventive approach (Dailidavičienė et al., 2010; Knock and Carroll, 2019). This approach can lead to a classification of the farms based on the risk level, and allows to track the diffusion of infectious agents and parasites. With this aim, the previously cited EU Reg. 627/2019 supplies a model document for communica- tion with the holding of provenance, to communicate every case of disease, welfare issue, or decision concerning meat. This important tool requires a careful identification, codification and registration of the outcomes of post mortem inspection.

The present study aimed to collect and analyze data obtained from the routine post mortem veterinary inspection of bovine liv- ers performed in three abattoirs, located in two Italian regions characterized by different climate patterns and animal husbandry techniques; the prevalence of liver lesions.
was combined with the available information concerning the slaughtered animals, thus highlighting the relative frequency of the different lesions based on animal age and category, season and geographical area.

Materials and methods

The data used for the study were obtained from three abattoirs (indicated as A, B and C) located in Lombardy (Northern Italy, plants A and B) and Puglia (Southern Italy, plant C). A total of 64,766 animals were subjected to post mortem inspection: 31,684 animals in plant A (years 2018-2019), 7,105 animals in plant B (year 2020) and 25,977 animals in plant C (years 2016-2019).

The available information about the composition of the population of slaughtered cattle is reported in Table 1. A clear difference between the plants located in Northern Italy (A and B) was evidenced, with a predominance of older animals (mainly milking cows at the end of their production period), and the plant located in Puglia, which population was mainly composed by animals aging 8-30 months (e.g. young bulls, heifers and young cows).

All the data were obtained from the reports produced by the official veterinarians by using excel sheets or dedicated softwares. The post mortem liver lesions were classified with the following denominations: a) steatosis; b) abscesses; c) distomatosi (fascioliasis or dicrocoeliosis); d) hydatidosis; e) fibrosis (including atrophy/cirrhosis); f) perihepatitis (adhesion); g) telangiectasis; h) other lesions.

For each animal, the following information was recorded, when available: slaughtering plant, slaughtering date (season), category and age class (<8 months, 8-30 months, >30 months).

The frequency of lesions was analyzed by chi-square test or (in the case of a limited number of data) Fisher’s exact test; significance threshold was set at P<0.05.

Results

Frequency of liver lesions

A total of 5,206 livers were condemned due to the presence of lesions, with a mean prevalence of 8.0% (Table 2). Significant differences were detected among the three plants, with a higher rate in plant B towards A and C (P<0.01). These differences can be due to different factors, such as the different composition of animal population, a real difference between animals coming from different areas, or a different notification rate in the plants; these aspects were further deepened. The rate of detection of the specific liver lesions is shown in Table 3. The most frequently detected lesion was steatosis (about 1/3 of the total number of lesions detected), followed by abscesses, distomatosi and perihepatitis. The relative prevalence of these lesions was strongly influenced by the pattern of animal populations, as described below.

Effect of animal age/category

Considering animal age and category, a marked variability was observed (Figure 1): a significantly higher prevalence (P<0.01) was indeed detected in animals older than 30 months and specifically in cows, if compared with all the other categories. Significantly lower rates were observed in calves (aged < 30 months, cat. V) and young cattle (max. 12 months), as expected.

A distribution of the main lesions within the age classes and categories is reported in Table 4. Data showed the marked influence of animal age on the frequency of steatosis, that was detected mainly in animals aged > 30 months and in females (about half of the lesions detected in cows) (P<0.01), whereas a higher prevalence of abscesses was

![Table 1. Composition of slaughtered animal population.](image)

| Age class     | Plant A | %     | Plant B | %     | Plant C | %     |
|---------------|---------|-------|---------|-------|---------|-------|
| <8 months     | 674     | 2.1   | n.a.    | n.a.  | 789     | 3.0   |
| 8-30 months   | 8,721   | 27.5  | n.a.    | n.a.  | 22,592  | 87.0  |
| >30 months    | 22,289  | 70.3  | n.a.    | n.a.  | 2,596   | 10.0  |

| Category      | Plant A | %     | Plant B | %     | Plant C | %     |
|---------------|---------|-------|---------|-------|---------|-------|
| V (steers)    | 575     | 1.8   | 585     | 8.2   | n.a.    | n.a.  |
| Z (young cattle) | 200   | 0.6   | 40      | 0.6   | n.a.    | n.a.  |
| A (young bulls) | 4,884 | 15.4  | 243     | 3.4   | n.a.    | n.a.  |
| B (bulls)     | 187     | 0.6   | 57      | 0.8   | n.a.    | n.a.  |
| D (cows)      | 22,392  | 70.7  | 5,346   | 75.2  | n.a.    | n.a.  |
| E (heifers)   | 3,446   | 10.9  | 834     | 11.7  | n.a.    | n.a.  |

n.a.: information not available.

![Table 2. Bovine liver lesions prevalence in the three slaughtering plants.](image)

| Plant | N condemned/total livers | Lesions prevalence (%) |
|-------|--------------------------|------------------------|
| A     | 2,648/31,684             | 8.4^a                  |
| B     | 906/7,105                | 12.8^a                 |
| C     | 1,652/25,977             | 6.4^c                  |
| Total | 5,206/64,766             | 8.0                    |

^a-c: Significant difference among the plants (P<0.01).

![Table 3. Prevalence of the specific liver lesions in the total animal population.](image)

| Lesion                 | N condemned livers | % (total animal population) | % (total lesions) |
|------------------------|--------------------|-----------------------------|-------------------|
| Steatosis              | 1,790              | 2.8                         | 34.2              |
| Abscesses              | 1,009              | 1.6                         | 19.3              |
| Distomatosi            | 790                | 1.2                         | 15.1              |
| Hydatidosis            | 204                | 0.3                         | 3.9               |
| Fibrosis/cirrhosis     | 135                | 0.2                         | 2.6               |
| Perihepatitis          | 678                | 1.0                         | 12.9              |
| Telangiectasis         | 362                | 0.6                         | 6.9               |
| Other lesions          | 268                | 0.4                         | 5.1               |

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observed in younger animals (mainly young bulls), with significantly lower rate in calves (P<0.01). Regarding distomatosis, the higher prevalence observed in young (8-30 months) animals was strongly influenced by the data obtained from plant C, where this lesion was more frequently found. The importance of the high rate of some lesions (e.g. steatosis in calves or distomatosis in bulls) should be considered with care, as a limited number of animals belonging to these categories was slaughtered.

**Influence of the season**

The total prevalence of liver lesions varied through the seasons: higher values were recorded in summer (9.8%) and autumn (8.9%), whereas a decrease was observed in winter and spring (6.5-6.9%). This general trend was influenced by the plant considered, as it was more marked in Northern Italy (and especially in plant A), where the animal population was dominated by cows. Indeed, the seasonal variability was mainly observed for steatosis (Figure 2), whereas no particular trends were observed for other lesions. Considering the rate of specific lesions on the total number of lesions detected, a higher value was observed in summer for steatosis, in winter for abscesses and in spring for distomatosis.

**Influence of geographical area**

Aiming to compare animals slaughtered in different Italian regions (as most slaughtered animals are reared in the same area where they are slaughtered, namely the Pianura Padana and Puglia), data belonging to the same age class but from different regions (plants A and C) were compared. The prevalence of the three main lesions is shown in Figure 3. A higher prevalence of steatosis (P<0.01) was clearly evidenced in animals slaughtered in plant A vs. C, especially in animals aged > 30 months (6.1% vs. less than 1%). A specular picture regard-
ed distomatosis, with significantly higher rates (P<0.01) from plant C both in animals aged 8-30 months and more than 30 months.

**Detection rate in different plants**

In order to evaluate the possible difference in the notification rate due to a different registration system adopted in the plants, the data obtained from plants A and B were compared, considering the same category of animals (cows), in order to limit the influence of external factors. The results are shown in Figure 4. Some evident differences were observed, in particular for steatosis (higher in plant A), abscesses and pericarditis (higher in plant B) (P<0.01).

**Discussion**

The results obtained from the liver post mortem examination of cattle from the three abattoirs considered in the study indicated a mean prevalence of 8%: this value is markedly lower if compared to those obtained by other authors, that is around 20-25% (Dailidavičienė et al., 2010; McKeith et al., 2012; Rezac et al., 2014). This situation is particularly frequent in feedlot cattle; in our study, it represented almost half of the lesions in young bulls, that were the most exposed animals: such picture could be linked to a faster growth rate of these animals (Deehan et al., 1995; Nagaraja et al., 1996). The detection of abscesses in milking cows (12% in these study) could be due to increased feed ingestion and feed changes in the pregnancy and lactation phases (Nagaraja, 2000; Dorè et al., 2007).

Distomatosis showed an average prevalence of 1.6%, considering both the lesions caused by Fasciola hepatica or Dicrocoelium dendriticum. Literature data indicate an extremely variable prevalence (0.12-86% in Europe); a previous collection of data indicated a mean prevalence of 11.1% in Italian slaughtered cattle (Mehmod et al., 2017). These diseases are linked to pasture grazing and can be detected in all the animal categories: considering cows and heifers, grazing is the main feeding source in some areas where traditional farming is more diffused. On the other hand, young bulls are bred without grazing.
during the last pre-slaughter period, but it has to be noted that grazing is usual in the previous phases, and the presence of liver flukes is often a chronic situation, lasting for several months.

The slaughtering season had a moderate impact on liver lesion prevalence: in the warmer period (summer and early autumn) a higher prevalence was observed, but this result was mainly due to steatosis in cows: this result was expected, as higher temperatures constitute an additional stressful factor, especially in the post partum/early lactation period.

The comparison among the two geographical areas showed a very evident difference, mainly due to different farming systems: in Northern Italy, where animal population is mainly composed by intensively reared animals, and in particular by milking cows, steatosis was by far the main lesion detected, whereas distomatosis was markedly prevalent in cattle slaughtered in Southern Italy, where more traditional rearing and feeding practices are usually applied.

Finally, the data obtained from plants A and B on similar animal populations (cows) were compared, showing some differences in the detection rate: this result could be due to casual variability, but it could also be influenced by a lack of common registration guidelines, especially for mild lesions, among different plants.

Conclusions

The results of this study highlight the importance of combining data from post mortem inspection with the available information on the animals, to supply a correct feedback to farmers about the diseases and dysfunctions that are influenced by management and feeding practices. The role of the slaughterhouse as epidemiological observatory is widely acknowledged and adopted by the current legislation, highlighting the need for registration and communication of diseases and animal welfare impairment. Indeed, a model for the communication to the farmer of ante mortem and post mortem inspection outcomes, already reported in the repealed EU Reg. 2074/2005, is now included in the current EU Reg. 627/2019. This tool could be useful to apply a preventive approach at farm, and allows to get a proper feedback to the slaughterhouse by the use of Food Chain Information accompanying the further animal lots. Moreover, the simplification of post mortem procedures for cattle set by the EU Reg. 627/2019, prescribing only a visual inspection in absence of particular concerns, requires a particular care in the detection, identification and registration of lesions. In this light, any tool facilitating a homogenous approach can give a useful support to official veterinarians.

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