

Comparison of the incidence of kidney damage in cattle, pigs, sheep and goats detected at slaughterhouses as an indicator of animal health

Lenka Válková¹, Eva Voslářová¹, Zsolt Becskei², Vladimír Večerek¹

¹University of Veterinary Sciences Brno, Faculty of Veterinary Hygiene and Ecology, Department of Animal Protection and Welfare and Veterinary Public Health, Brno, Czech Republic

²University of Belgrade, Faculty of Veterinary Medicine, Department of Animal Breeding and Genetics, Belgrade, Republic of Serbia

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Abstract

The incidence of kidney damage in livestock was monitored in the Czech slaughterhouses from 2010 to 2021. The results showed that the incidence of kidney damage was lower in all monitored species ($P < 0.05$) in fattened animals compared to adult ones. In cattle and pigs, the incidence of kidney damage was lower ($P < 0.01$) in fattened animals (bulls, finisher pigs) than in culled young (calves, piglets). When comparing individual categories of adult animals, the lowest incidence of kidney damage was found in does and ewes (2.68% and 3.01%, respectively), then in sows (28.45%), and the highest was in cows (40.46%). Among fattened animals, the incidence of findings in kidneys was increasing in the order of kids (0.21%), lambs (0.42%), bulls (10.46%) and finisher pigs (14.42%). Findings of chronic kidney damage were more frequent than findings of acute ($P < 0.01$) and parasitic ($P < 0.01$) origin in all observed categories of animals. The results show that, from the point of view of the incidence of kidney damage as a major consequence of imbalance between the organism's metabolic needs and the nutrition provided to the animals, there are deficiencies of a significant level, which prove that there is still significant room for further optimization of the nutrition of individual categories of animals, that would take into account not only performance, overall clinical health, but also subclinical animal health, leading to a reduction in the incidence of kidney damage detected in animals at slaughter.

Livestock, slaughter, post mortem examination, veterinary inspection

The kidneys are metabolic organs of the animal organism, participating with their excretory function in the organism's metabolic balance (Skotnicka et al. 2007). Impaired kidney function, or morphologically detected kidney damage usually related to impaired kidney function, negatively affect the overall subclinical or even clinical health of the animal and thus also the degree of animal well-being. The finding of kidney damage thus proves a violation of the animal's metabolism or a parasitic invasion to such an extent that it is manifested by a morphological finding during the inspection of slaughtered animals at the slaughterhouse. The characteristic of kidney damage in distinguishing chronic, acute or parasitic damage makes it possible to determine the closer nature of the origin of kidney damage.

The occurrence of pathoanatomical findings on the kidneys of slaughtered animals is mentioned in some studies that focused on the causes of carcass condemnation of farm animals or pathoanatomical findings detected during a postmortem veterinary inspection at slaughterhouses in general. However, most of these studies focused only on specific species of farm animals, namely cattle (Tabaran et al. 2018; Kaluža et al. 2020, 2021) and pigs (Lis 1999, 2002; Večerek et al. 2004, 2020a,b). Few studies compared the occurrence of pathoanatomical findings in several species or categories of farm animals under the same conditions and in the same period. Januskeviciene et al. (2010) compared the incidence of pathological findings in cattle, pigs, sheep, goats, horses, rabbits, game and

Address for correspondence:

Prof. Ing. Eva Voslářová, Ph.D.
Department of Animal Protection and Welfare and Veterinary Public Health
Faculty of Veterinary Hygiene and Ecology
University of Veterinary Sciences Brno
Palackého tř. 1946/1, Brno 612 42, Czech Republic

E-mail: voslarovae@vfu.cz
<http://actavet.vfu.cz/>

poultry in Lithuania in the period from 2007 to 2009. Ceccarelli et al. (2018) analysed the causes of condemnation of carcasses and organs of cattle, pigs, sheep and horses in selected slaughterhouses in Italy in the period from 2010 to 2016. Lis (2005) monitored the occurrence of pathological findings in cattle, pigs, sheep and horses at slaughterhouses in Poland in 2003. Machold et al. (2007) compared the incidence of pathological lesions in pigs and cattle reared in conventional and organic farms in Germany over a period of one year. Studies that focused in more detail on the incidence of kidney damage, cross-species comparisons and analysis of possible causes and associations tend to have been conducted outside Europe. Elgumaa et al. (2017) compared the pathological lesions on the kidneys in different species of ruminants detected in slaughterhouses in Egypt. The incidence and nature of kidney findings have also been described in slaughtered camels in Iran (Rezaie et al. 2014), in cattle in Peru (Macias et al. 2020) or in pigs in Brasil (Carrijo et al. 2011). For European conditions, however, such studies are almost absent, although Jansen and Nordstoga (1992) found pathological lesions in 59% of 668 pigs slaughtered in Norway and examined in their study. Spiekermeier et al. (2017) and Scheinert et al. (2016) also draw attention to the occurrence of kidney damage in slaughter pigs. Široká et al. (2022) accentuate also the possibility of the occurrence of changes in kidneys of slaughtered pigs as a result of their exposure to mycotoxins in feed.

The aim of the study was to find out 1) the level of kidney damage in individual categories of cattle, pigs, sheep and goats slaughtered at slaughterhouses, 2) whether and possibly to what degree the kidney damage of fattened animals differs from older adult animals, 3) whether and possibly to what degree kidney damage differs in fattened animals from young animals culled from the farm, 4) how the level of kidney health differs between individual categories of adult animals and 5) how the level of kidney health differs between individual categories of fattened animals. The purpose of this comparison was to find out based on the differences in the level of kidney damage for different categories of animals, in which categories kidney damage occurs most often and in which the least, and to suggest possible measures to reduce the incidence of kidney damage in slaughter animals. Furthermore, the aim of the study was to compare the occurrence of chronic, acute, and parasitic kidney damage in the individual categories of animals and from the differences found, to deduce the dominant character of the disorder leading to kidney damage detected during the inspection of slaughtered animals at slaughterhouses with the aim of directing possible measures to increase the level of kidney health in individual categories of slaughter animals.

Materials and Methods

The level of kidney health was compared between individual categories of cattle, pigs, sheep and goats. We determined the level of kidney health based on the incidence of kidney damage detected during the veterinary examination of slaughtered animals at slaughterhouses.

The incidence of kidney damage was monitored in cattle, for the categories of cows, heifers, fattening bulls and calves culled from farms; in pigs, for the categories of sows, finisher pigs, and piglets culled from farms; in sheep, for the categories of ewes and lambs; and in goats, for the categories of does and kids.

The period included in the monitoring represented 12 years from 2010 to 2021. During this period, the incidence of kidney damage was evaluated in animals reared on the Czech farms and slaughtered at slaughterhouses in the Czech Republic. The monitoring included all slaughtered animals; namely, 1,348,393 slaughtered cows, 315,406 slaughtered heifers, 1,214,298 slaughtered fattening bulls, 120,238 slaughtered calves culled from farms for fitness or health reasons; 683,912 slaughtered sows, 29,628,524 slaughtered finisher pigs, 152,088 slaughtered piglets culled from farms for fitness or health reasons; 26,026 slaughtered ewes, 132,553 slaughtered lambs; 1,680 slaughtered does and 7,690 slaughtered kids.

Examination of the kidneys of slaughtered animals was carried out by official veterinarians at the slaughterhouse, who recorded the number of healthy kidneys and the number of damaged kidneys, distinguishing damage of chronic, acute, and parasitic origin.

The numbers detected for the entire monitored period for each category of animals were converted into relative numbers as the ratio of the incidence of kidney damage to the number of slaughtered animals of the respective category of animals, and percentages were calculated.

We compared the incidence of kidney damage between the individual categories of slaughtered animals from the point of view of comparing animals in fattening and adult animals, also from the point of view of comparing animals in fattening and young animals culled from farms for inadequate condition or health, from the point of view of comparing categories of adult animals with each other and further, from the point of view of comparing the categories of animals in fattening with each other. Furthermore, we compared the occurrence of chronic, acute and parasitic kidney damage within the relevant category of animals. Chi-square test was used to statistically compare the numbers of findings.

From the obtained results, we inferred differences in the level of kidney health between fattened animals and adult animals, between fattened animals and culled young, between individual categories of adult animals, between individual categories of fattened animals and also between the occurrence of chronic, acute and parasitic kidney damage. The purpose of the comparisons was to find out differences in the degree of kidney damage for different categories of animals and to determine in which categories kidney damage occurs most often and in which the least often, and to derive the reasons for these differences leading to the definition of measures aimed at reducing the incidence of kidney damage in slaughter animals and increasing the level of kidney health of individual categories of slaughter animals on farms.

Results

The incidence of kidney damage in cattle, pigs, sheep and goats slaughtered at slaughterhouses is shown in Fig. 1.

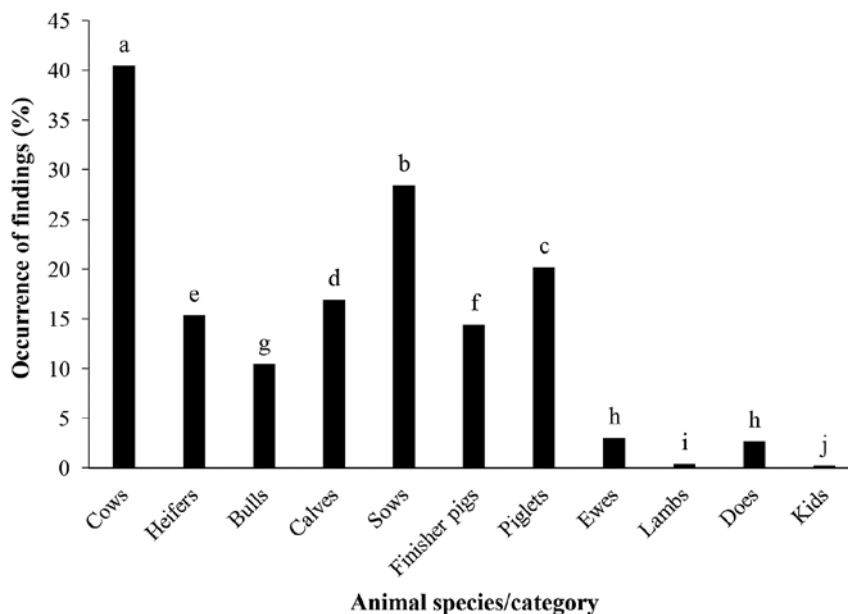


Fig. 1. Total incidence of kidney damage in individual categories of slaughtered cattle, pigs, sheep and goats at slaughterhouses.

^{a-j} different superscripts express a significant difference ($P < 0.05$) between the individual species and categories of animals

The results show that the incidence of kidney damage in fattened animals compared to adult animals was significantly ($P < 0.05$) lower, namely in cattle (bulls 10.46% and heifers 15.38% vs cows 40.46%), and in pigs (finisher pigs 14.42% vs sows 28.45%), in sheep (lambs 0.42% vs ewes 3.01%), and also in goats (kids 0.21% vs does 2.68%).

When comparing fattened animals with young culled from farms, the incidence of findings on the kidneys was significantly ($P < 0.05$) lower in fattened animals than in culled young, namely in cattle (bulls 10.46% and heifers 15.38% vs culled calves 16.93%) and in pigs (finisher pigs 14.42% vs culled piglets 20.21%).

When comparing the individual species in the category of adult animals, the occurrence of findings on the kidneys was significantly ($P < 0.05$) the lowest in does and ewes (2.68% and 3.01%, respectively; no significant difference was found between does and ewes), then in sows (28.45%), and the highest in cows (40.46%).

By comparing individual species in the category of fattened animals, we found that the occurrence of findings on the kidneys was significantly ($P < 0.05$) the lowest in kids (0.21%), followed by lambs (0.42%) and bulls (10.46%), and the highest in finisher pigs (14.42%).

Figure 2 shows the incidence of chronic kidney damage, Fig. 3 shows the incidence of acute kidney damage and Fig. 4 shows the incidence of parasitic kidney damage in individual categories of slaughtered cattle, pigs, sheep and goats at slaughterhouses. Comparison of the occurrence of findings of chronic, acute, and parasitic kidney damage in cattle, pigs, sheep and goats detected at slaughterhouses shows that in all species and categories of slaughtered animals, the most frequent were findings of chronic damage, followed by those of acute damage, and the least frequent were findings of parasitic damage. The occurrence of findings of chronic kidney damage was significantly more frequent than the occurrence of findings of acute ($P < 0.01$) and parasitic ($P < 0.01$) damage in all observed categories of animals. The occurrence of findings of acute kidney damage was significantly more frequent ($P < 0.01$) than the occurrence of findings of parasitic kidney damage in most monitored categories, with the exception of does and kids, in which no findings of acute or parasitic kidney damage were detected, and with the exception of ewes ($P = 0.703$) and lambs ($P = 0.058$), in which findings of acute and parasitic kidney damage were detected only rarely.

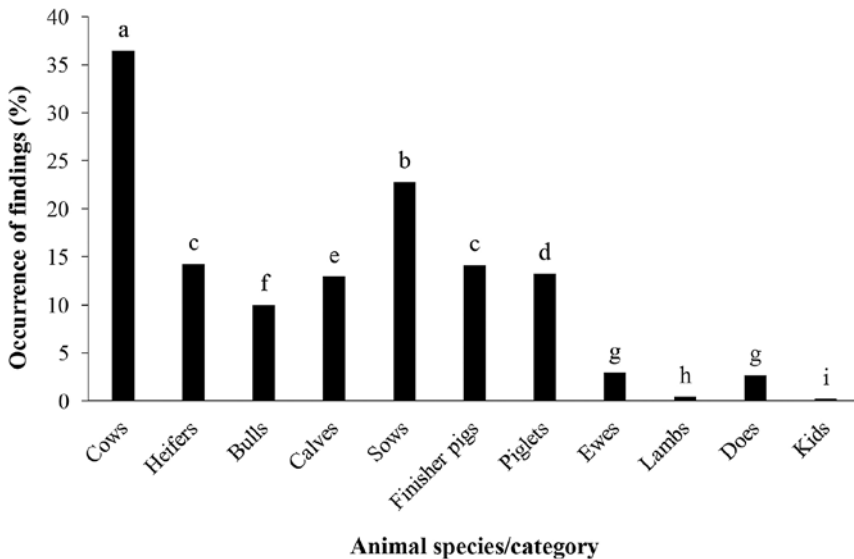


Fig. 2. Incidence of chronic kidney damage in individual categories of slaughtered cattle, pigs, sheep and goats at slaughterhouses.

^{a-h} different superscripts express a significant difference ($P < 0.05$) between the individual species and categories of animals

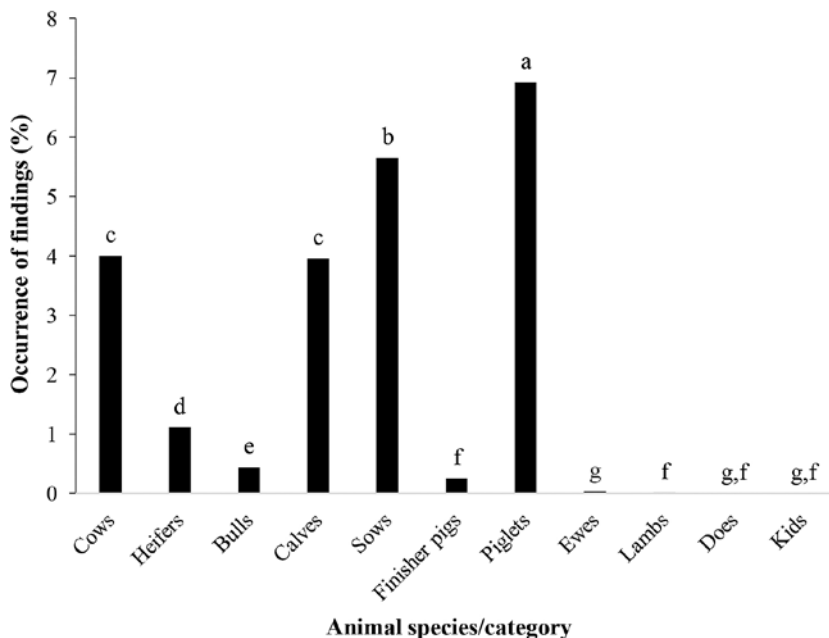


Fig. 3. Incidence of acute kidney damage in individual categories of slaughtered cattle, pigs, sheep and goats at slaughterhouses.

^{a-g} different superscripts express a significant difference ($P < 0.05$) between the individual species and categories of animals

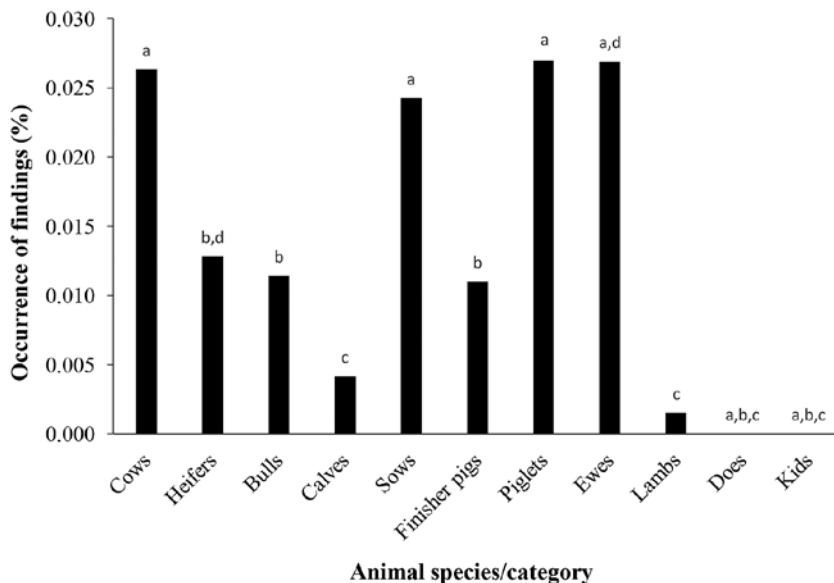


Fig. 4. Incidence of parasitic kidney damage in individual categories of cattle, pigs, sheep and goats slaughtered at slaughterhouses.

^{a-d} different superscripts express a significant difference ($P < 0.05$) between the individual species and categories of animals

Discussion

The results show a significantly lower incidence of findings on the kidneys in fattened animals compared to adult animals. This documents the fact that the kidneys of young fattened animals are in better condition than those of mature animals, because with advancement of age, the duration of action to renal impairment is longer. Kidney changes related to aging were researched in several animal models including nematodes, mice, rats, as well as canines (Bowman and Abdel-Rahman 2018).

When comparing fattened animals with culled young, the incidence of findings on the kidneys was significantly lower in fattened animals than in culled young, namely in cattle and pigs. Obviously, animals kept on farms for fattening have better kidney condition than the young culled from the farm. Young animals culled for poor fitness and/or health have lower levels of kidney health than animals remaining on farms. Stunted growth, which is a common reason for culling animals from the farm (Djang-Fordjour et al. 2004), could result from renal dysplasia and nephrosclerosis, as reported by Philbey et al. (2009).

Comparing individual species in the category of adult animals, we found that the occurrence of findings on the kidneys was significantly the lowest in goats and sheep (2.68% and 3.01%, respectively) with no significant difference between ewes and does, followed by sows (28.45%); the highest occurrence was found in cows (40.46%). The results prove that the lowest metabolic load leading to kidney damage (both chronic and acute) is found in goats and sheep, where feeding is realized to a major extent by natural grazing and where the animals can positively regulate their metabolism by selecting sources of nutrition. Selective feeding is a natural behaviour of sheep and goats based on their dietary needs and the nutritional properties of available feed (Berthel et al. 2022). As a result, the impact on the load and subsequent damage to the kidneys is very small. In sows, feeding is realized mainly with feed mixtures; in comparison to cows, from the point of view of the metabolism, this nutrition puts less burden on the kidneys in sows than in cows. Cow nutrition is based on silages, haylage, and feed mixtures, and can be insufficiently balanced from the point of view of metabolic needs, which results in a significant load on the cow metabolism with an impact on the kidneys leading to their damage. This was manifested by the occurrence of over 40% of damaged kidneys in cows found in our study which, compared to other species, is enormous. Over the past several decades, dairy cows in particular have undergone intensive genetic selection which has increased milk yield to a level where the demand for nutrients from the diet and body tissue reserves often results in ill-health (Mulligan and Doherty 2008).

Comparing individual species in the category of fattened animals, the occurrence of findings on the kidneys was significantly the lowest in kids (0.21%), followed by lambs (0.42%) and bulls (10.46%); the highest occurrence was found in finisher pigs (14.42%). The lowest metabolic load leading to kidney damage (both chronic and acute) is found in kids and lambs, as their nutritional needs are covered by natural grazing and thus, the animals can positively regulate their metabolism (Berthel et al. 2022); consequently, the impact on kidney damage is very small. In terms of metabolic needs, the nutrition of fattening bulls is partially insufficiently balanced, which puts a strain on their metabolism leading to kidney damage, but the intensity of the load is lower than in finisher pigs. The growth of finisher pigs is significantly more intensive than that of fattening bulls, and therefore, the demands for nutrition corresponding to this intensive metabolism are significantly higher. However, feed mixtures for finisher pigs do not sufficiently cover their metabolic needs, and these imbalances are manifested by the increased load and subsequent kidney damage, as evidenced by its higher occurrence compared to fattening bulls. Jansen and Nordstoga (1992) found pathological lesions in 59% of 668 pigs examined in Norway. The frequency of kidney damage in slaughtered pigs was also pointed out by Spiekermeier et al. (2017)

and Scheinert et al. (2016). In contrast, Januskeviciene et al. (2010) found kidney lesions to be the least frequent pathologies determined at postmortem examinations in slaughterhouses in Lithuania and they found the species-related variation to be also low. Detected kidney lesions accounted for 8.9% in pigs and 9.6% in cattle. However, it is not clear whether the cattle and pigs inspected in their study were only finisher pigs and beef animals or whether culled animals were also included. The results of our study show a great variability among different cattle and pig categories in the frequency of kidney findings. Similarly, Ninčáková et al. (2022) demonstrated significant differences in the level of health of different species and categories of slaughtered animals.

The results show that when the metabolic needs of the organism and animal nutrition are imbalanced, the metabolic load on the kidneys is mostly of a lower degree and acts over a longer period of time, having an impact on chronic kidney damage. Occurrence of acute kidney damage related to a sudden major change in animal nutrition with an increased load on the metabolism impacting the kidneys is significantly less frequent in the monitored categories of animals. Parasitic damage to the kidneys occurs significantly less often compared to chronic and acute findings and is more or less very rare. This is due to the fact that kidneys are not the target organs for endoparasitic invasion in cattle, pigs, sheep and goats. Depending on the species, various organs of the host organism are affected, namely the digestive tract, the liver, the circulatory system, the respiratory tract, the skin and the subcutaneous tissue, the muscles and the tendons, the eyes, the central nervous system, and the serous cavities (Troumbis 2001).

In conclusion, from the point of view of the occurrence of kidney damage as a major consequence of the imbalance between the organism's metabolic needs of the organism and the nutrition provided to it, there are major deficiencies proving that there is still ample room for further optimization of the nutrition of individual categories of animals, that would take into account not only the animals' performance and overall clinical health but also their subclinical health, which will lead to reduction of the incidence of kidney damage detected in animals at slaughter.

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References

- Berthel R, Simmler M, Dohme-Meier F, Keil N 2022: Dairy sheep and goats prefer the single components over the mixed ration. *Front Vet Sci* **9**: 1017669
- Bowman BT, Abdel-Rahman EM 2018: Models of aging kidney: Implications on kidney health and disease. In: Ram JL, Conn PM (Eds): *Conn's Handbook of Models for Human Aging*. Academic Press, 2nd edn, London, pp. 863-871
- Carrizo KD, do Nascimento ER, Tortelly R 2011: Porcine enzootic pneumonia: Relationship between microscopic lung and kidney lesions in Santa Catarina, Brazil. *Biosci J* **27**: 439-443
- Ceccarelli M, Leprini E, Sechi P, Iulietto MF, Grispoldi L, Goretti E, Cenci-Goga, BT 2018: Analysis of the causes of the seizure and destruction of carcasses and organs in a slaughterhouse in central Italy in the 2010-2016 period. *Ital J Food Saf* **7**: 6899
- Djang-Fordjour KT, Oppong-Anane K, Annor SY 2004: Herd/flock structure and culling patterns in rural livestock farming systems in northern Ghana. *Discov Innov* **16**: 64-70
- Elgumaa MM, Mohammed FF, Elmady MM, Bakeer AM, Gad MH 2017: Pathological characterization of renal lesions developed in some ruminant species in Egyptian slaughter house. *Res J Pharm Biol Chem Sci* **8**: 1867-1878
- Jansen JH, Nordstoga K 1992: Renal lesions in Norwegian slaughter pigs - macroscopic and light microscopic studies. *J Vet Med A* **39**: 582-592
- Januskeviciene G, Paulauskas V, Dailidaviciene J, Juozaitiene V 2010: Analysis of pathologic lesions in the livestock and poultry slaughtered in the meat establishments of Lithuania. *Vet Zootec* **52**: 33-42
- Kaluža M, Večerek V, Voslařová E, Semerád Z, Passantino A 2020: Assessing the standard of health and welfare in individual categories of cattle from the viewpoint of intravital pathological changes. *Agriculture-Basel* **10**: 619

- Kaluža M, Večerek V, Voslářová E, Semerád Z, Passantino A 2021: Incidence of characteristic findings during veterinary carcass inspections 2010–2019 in the Czech Republic and the relation to the level of health and welfare of individual classes of cattle. *Animals* **11**: 537
- Lis H 1999: An evaluation of veterinary inspection of slaughtered animals and meat in Poland between 1987-1997. *Med Weter* **55**: 243-246
- Lis H 2002: Results of veterinary inspection of slaughtered animals and meat in Poland in 2000. *Med Weter* **58**: 267-269
- Lis H 2005: Results of veterinary inspection of slaughter animals and meat in Poland in 2003. *Med Weter* **61**: 1160-1161
- Macias DIB, Goicochea CAB, Ruano MP, Ruales APR, Flores MAF, Loor LV, Rodriguez RAJ, Rodriguez OF 2020: Association between the presence of antibodies against *Leptospira* and kidney lesions in cattle. *Rev Invest Vet Peru* **31**: 19028
- Machold U, Troeger K, Moje M 2007: Organic versus conventional livestock production systems. *Fleischwirtschaft* **87**: 89-93
- Mulligan FJ, Doherty ML 2008: Production diseases of the transition cow. *Vet J* **176**: 3-9
- Ninčáková S, Večerek V, Válková L, Voslářová E, Kaluža M, Zavřelová V 2022: Health status of slaughtered animals as indicated by postmortem inspection at slaughterhouses. *Acta Vet Brno* **91**: 99-106
- Philbey AW, Mateus A, Bexiga R, Barrett DC, Haining HA, McCandlish IA, Thompson H 2009: Renal dysplasia and nephrosclerosis in calves. *Vet Rec* **165**: 626-630
- Rezaie A, Mohamadian B, Anbari S, Hossein Zadeh K 2014: Histopathological investigations on renal lesions in slaughtered camel (*Camelus dromedarius*) in North East of Iran. *Kafkas Univ Vet Fak* **20**: 501-506
- Scheinert J, Muller K, Meiler H, Schoon HA 2016: The pig kidney in the 21st century - which diagnoses could be made in the abattoir and how should they be interpreted? *J Food Saf Food Qual* **67**: 64-71
- Skotnicka E, Muszczynski Z, Dudzinska W, Suska M 2007: A review of the renal system and diurnal variations of renal activity in livestock. *Irish Vet J* **60**: 161-168
- Spiekermeier I, Freitag M, Baumgartner W 2017: Interstitial nephritis in pigs. *Tieraerztl Prax G N* **45**: 350-356
- Šíroková Z, Linhart P, Honzlová A, Vlasáková V, Rosmus J, Macharáčková P, Svobodová Z, Svoboda M 2022: A survey on occurrence of ochratoxin A in the kidneys of slaughtered pigs in the Czech Republic during the years 2012–2021. *Acta Vet Brno* **91**: 409-415
- Tabaran A, Dan SD, Reget O, Tabaran AF, Mihaiu M 2018: Slaughterhouse survey on the frequency of pathologies found in bovine post-mortem inspections. *Bull UASVM Vet Med* **75**: 251-255
- Troumbis A 2001: Cattle, sheep, and goats, ecological role of. In: Levin SA (Ed.): *Encyclopedia of Biodiversity*. Academic Press, Oxford, pp. 651-663
- Večerek V, Kozák A, Malena M, Chloupek P, Pištěková V 2004: Organs of slaughter pigs as a source of potential risk for human health in the Czech Republic during the years 1995–2002. *Vet Med – Czech* **49**: 75-78
- Večerek V, Voslářová E, Semerád Z 2020a: Patho-anatomic findings in finisher pigs, sows and piglets detected during veterinary slaughterhouse inspection. *Acta Vet Brno* **89**: 341-347
- Večerek V, Voslářová E, Semerád Z, Passantino A 2020b: The health and welfare of pigs from the perspective of post mortem findings in slaughterhouses. *Animals* **10**: 825