Egyptian Journal of Veterinary Sciences

https://ejvs.journals.ekb.eg/

Evaluation of Infrared Thermography and Histopathological Study of Pneumonia in pre and Post Slaughtered Calves at Abattoir

Assel Anwer Al-Naqshabendy

Department of Medicine and Surgery, College of Veterinary Medicine-University of Duhok-Iraq.

Abstract

THIS study was designed to evaluate the infrared thermography technique (IRT) to detect the pneumonia in calves at Blan abattoir between November 2023 and February 2024 in Zakho city, Iraq. Routine lung inspection procedures were done to investigate the presence of the pathological lesions. Data were collected from 472 male calves, aged 1.5 – 2 years. Infected lungs collected for histopathological examination. For peripheral temperature data collection, focal sampling employing infrared thermal camera. Results revealed that 118 (25%) lungs were found with pneumonic lesions. Although, after histological diagnosis, pneumonia was found in 107 (22.6%) lungs. The eye temperature was significantly ($P<0.01$) lower in infected animals (34.2 ± 0.2 °C) in comparison to healthy animals (36.8 ± 0.2 °C). The sensitivity was 0.97 and the specificity (1 – specificity) was 0.61 according to the findings. According to the results obtained in this study, it can be concluded that examining animals at abattoirs pre-slaughter using IRT is beneficial detecting infected animals. Therefore examining them is vital for human health status, as well as the pathological features was concluded that 3 main forms of different types of pneumonia which recorded according to macroscopical and histological features.

Keywords: Eye temperature, infrared thermography, abattoir, calves, pneumonia.

Introduction

Pneumonia is yet a major disease of ruminant's production in many countries worldwide [1]. In farm animals, high economic losses and rates of mortality are caused by respiratory diseases. This is mainly because of the costs of treatment, productivity reduction, vaccination programs as well as condemnation in slaughterhouses [2]. Pathogenesis of respiration illnesses is multi-factorial as a result of interaction of numerous infectious agents like bacteria, parasites and viruses; environmental reasons such as humidity, temperature and dust; host defense in addition to stress [3,4,5]. The main exposed organ to pneumonia is the lung due to its histological and anatomical particularities [6]. Clinical diagnosis of pneumonia is not simple it mainly involves physical examination, serology, imaging, and identifying the etiological agent from bronchitis, nasal swabs, or feces sometimes [7]. Many animals brought to slaughterhouses may have subclinical or chronic infections that are hardly examined before slaughtering [8]. Thus, in addition to the main role of abattoirs are used for slaughtering animals, it can be used as a source for collecting data easily and inexpensively to detect animal diseases, for instance, pneumonia [9,10]. In some countries, lung disposal in abattoirs is mainly caused by pneumonia in small ruminants. According to [11], 30 to 60% of lungs were condemned at Addis Ababa abattoir in Ethiopia due to pneumonia. In addition, more than 15% of animals brought to Elfora Bishoftu abattoirs were infected with lung diseases [12]. However, here in Iraq, most slaughtered animals are imported from different countries and the infection of lungs of that brought animals may be high.

*Corresponding authors: Assel Anwer Al-Naqshabendy, E-mail: assel.anwer@uod.ac, Tel.: 00964(0)7504806267
(Received 12 June 2024, accepted 08 July 2024)
DOI: 10.21608/EJVS.2024.297312.2171

Therefore, it is crucial to detect infected animals with diseases before importing. Due to the difficulties in the examination, infrared thermal imaging technique (IRT) might assist in detecting infections in animals [14,15,16,17,18]. IRT measures the peripheral temperatures of objects. It is quick, convenience, and non-invasive method [19]. IRT is widely used in animal production. It has been used for detecting pain, stress, estrus and diseases detection [20]. IRT has been barely used in abattoirs. Therefore, this research was aimed to evaluate IRT technique for detect the pneumonia in calves at Blan abattoir in Zakho city, Iraq. In addition, to examine the infected lungs histologically postmortem.

Material and Methods

Study area and animals

The current study was conducted between November 2023 and February 2024 in Blan abattoir, located at northwest of Zakho city, Kurdistan Region of Iraq. It is the abattoir that mainly imports animals for meat from Europe. The population of animals were involved in this study was all calves, Romanian Simmental breed, imported from Romania.

Samples

The current study had collected data from 472 male aged 1.5 – 2 years with a medium body condition score during 4 months. The sampling was done 2 days a week (8 days/month) and about 15 animals every time. The infected lungs from gross examination were collected for histopathological examination.

Data collection

Gross examination

The gross examination for lungs was conducted in the slaughterhouse, lungs suspected with presence of different pneumonic lesions were selected and taken for pathologic examination. Small pieces, around 5 mm thickness, were collected in sterile tubes containing 10% neutral buffered formalin and transported to Duhok University, College of Veterinary Medicine Laboratory for examinations.

Temperature data

Focal sampling was used to collect peripheral temperature data. The eye temperature, was measured using an infrared thermal camera (FLIR E4, FLIR Systems, OU, Estonia). The temperature was obtained from every calf subjected to slaughtering, i.e 500 images were taken in total (Fig.1).

Histological investigation

The thickness of the lung samples' specimens was $1cm^3$. They were dehydrated in ethanol and hence embedded in paraffin. Section of about 5 mm in tissue thickness using rotary microtome. Hence, samples were stained using eosin and hematoxylin stains [21]. Afterward, the samples were examined with normal light microscopes by the author. Lastly, the stained-slides were systematically examined at magnifications of 4X and 10X for the presence of lesions and characteristics using the light microscopes.

Statistical analysis

All the collected data were first placed and arranged in a new Microsoft Office spreadsheet. The collected data were then projected to the GenStat software program (12^{th} edition, VSN International, UK). Shapiro-Wilk U normality test showed the data were parametric; therefore, a parametric t-test was used for data analysis. Sensitivity for eye temperature for detecting infected animals was calculated using the ratio of true positives to true positives adding to false negatives; whereas the specificity was calculated as the ratio of true negatives to true negatives adding to false positives. Figures were prepared in the Microsoft Excel program.

Results

Out of the total of 472 calves' lungs subjected to gross macroscopic inspection examination, were 118 (25%) lungs found with pneumonic lesions depend on macroscopic appearance (site of lesion, distribution, texture and exudations). Although, after histological diagnosis of lesions, pneumonia was found in 107 lungs (22.6%) and classified to different forms of pneumonia as shown in Table 1.

Based on the predominant histological results, three types of pneumonic lesions were classified as follows: firstly bronchopneumonia, microscopically showed alveolar spaces and lumens of the air ways are filled with inflammatory cells and exudates with sever congestions. The second form is chronic pneumonia, manifested by chronic bronchitis and presence of the different inflammatory cells with zone of the fibrous connective tissue. The last form was recorded is interstitial pneumonia, microscopically showed thickening of interstitial layers of alveoli (Fig. 2, 3, 4).

Eye temperature, sensitivity and specificity

The mean eye temperatures obtained are shown in Fig.5. The eye temperature was significantly ($P<0.01$) lower in infected animals (34.2 ± 0.2 °C) in comparison to healthy animals (36.8 ± 0.2 °C). The

sensitivity was 0.97 and the specificity (1 – specificity) was 0.61 according to the findings.

Discussions

Results obtained from this study indicated that pneumonia was found in 22.6% of studied animals at abattoir. Diseases, such as respiratory diseases, are the main causes of economic losses in animals. Detecting these diseases is crucial to avoid these economic losses [22]. Different forms of pneumonia were observed in this study using macroscopical and histological examination of the lung samples,

In previous studies, studied hydatid cysts cases in sheep at local abattoirs in Basrah, Iraq [23], they found the infection rate was about 15% in both genders while it was about 23% in females. Similar results were found in the present study with cattle. Studied liver and lung infections in slaughtered animals in Koya, Erbil – Iraq. She found pneumonia in 10.2% of the studied cattle in October [24]. However, this rate of infection is high, it was lower in the present study's findings. Other found high proportions of pneumonia (8.8%) in slaughtered cattle in Zaria abattoir – Nigeria [25]. In another histopathological research at Elfora Abattoir – Ethiopia found more than 17% of small ruminants were affected with pneumonia, the results of this study are in agreement with these findings [12]. Similar to our findings, found high percentage of pneumonia, which was 28.9%, in goats and sheep at Qalyuobia Governorate – Egypt [26]. In Libya, 27% of small ruminants were infected with pneumonia in El-Beyda abattoirs [13]. In addition, that 41% of sheep carcasses slaughtered at the Kermanshah abattoir – in Iran were infected with pneumonia [27]. They found more than 32% of studied animals were infected with bronchopneumonia. In line with the present study, bronchopneumonia was highest in the studied subjects.

By considering contrast results to this study, [28] studied the prevalence of pneumonia in sheep, goats and cattle at Maiduguri abattoir in Nigeria. They found out that the highest number of pneumonia cases was in cattle and the lowest in sheep. Pneumonia was only found in 0.21% of studied cattle over five-years period. The results in the current study are higher in comparison with the findings of the Maiduguri abattoir in Nigeria [28] . Another study showed the infection rate of liver and lung diseases in Iraq – Kerbala abattoirs, found infection in 587 cattle (0.66%), the results of this study are not in line with the previous study who found lower infection rates in animals at slaughterhouses [30]. Similarly, pneumonia was found only in 0.79% of slaughtered cattle in Kirkuk abattoir, Iraq [31], as well as in other study found that 1.83% of cattle were infected with pneumonia in Kirkuk abattoir – Iraq [32]. The variation in the infection rates of different types of pneumonia in different study may attributed to the factors variation such as breed, nature of country, nutritional status and environmental conditions as well as effect of stressors including transportation and overcrowding [33, 34].

According to the findings of this research, surface eye temperature in infected subjects was significantly ($P<0.01$) lower by 2.6 °C. The IRT was used to determine the upper (nasal area) and lower respiratory (respiratory tracts and lungs) infections in sheep and described as a useful method to detect infection [22]. Measuring core body temperature has been widely used in animals to detect stress, pain and diseases. It is a vital method for detecting diseases, however is stressful for animals and may lead to inaccurate results [35]. Therefore, using IRT to measure surface temperature is a less stressful and non-invasive method and was used to detect eye temperature in cattle pre-slaughter in abattoirs [36]. In the present study, the eye temperature was measured as previously described which has the highest temperature amongst other peripheral areas and is closer to the rectal temperature [37,38].

Conclusions

From the present study, it can be concluded that examining the eye temperature of the animals at abattoirs pre-slaughter using IRT is beneficial in detecting infected animals with respiratory diseases. More research is required to use video recording IRT in real-time. Pneumonia is high in imported animals, therefore examining them is vital for human health status.

Acknowledgements

The author thanks the Blann abattoir in Zakho for their help in collecting temperature data and cattle lungs. The author would also like to thank the laboratory staff for their assistance in the histological examination of infected lungs.

Conflict of interest

They declared that no conflict of interest.

Funding statement

Self-funding.

TABLE 1. Pneumonic types found in claves' lungs in histological examination.

Type of pneumonia	Number of infected calves	% of infection
Bronchopneumonia	67	63
Chronic pneumonia	27	25
Interstitial pneumonia	13	12

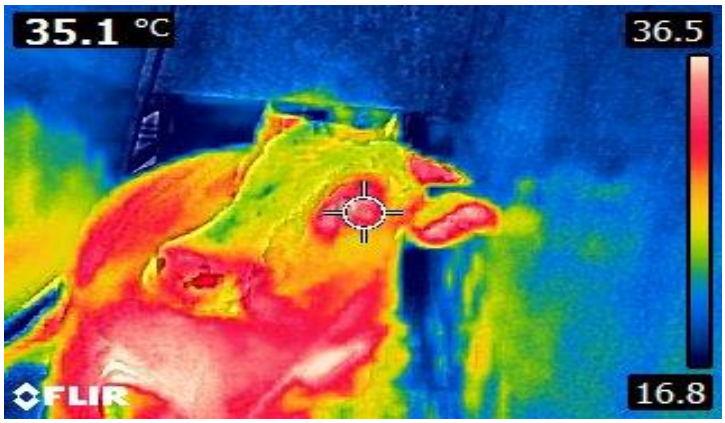

Fig. 1. An infrared thermal image showing the eye temperature of a calf on the top-left corner of the image. The right scale of temperature shows the range of temperature in different colors.

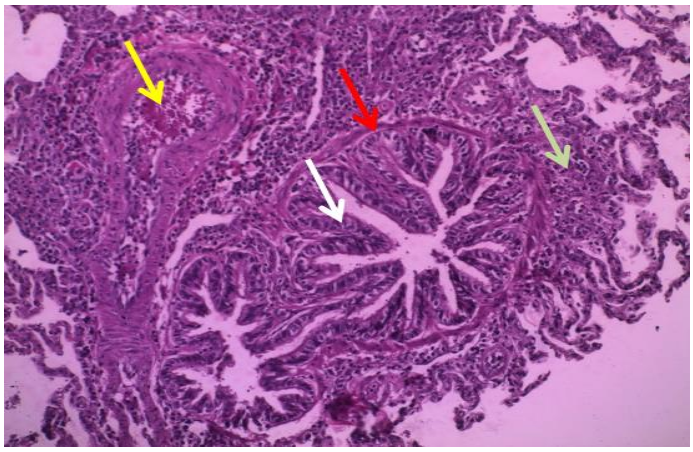

Fig. 2. Microscopical features of lung calf showed Bronchiolitis red arrow, hyperplasia of epithelial cells of bronchiole white arrow with per bronchiolar infiltration of mononuclear inflammatory cells green arrow and congestion of large blood vessels yellow arrow. Hematoxylin (H)& Eosin (E) stains 10x

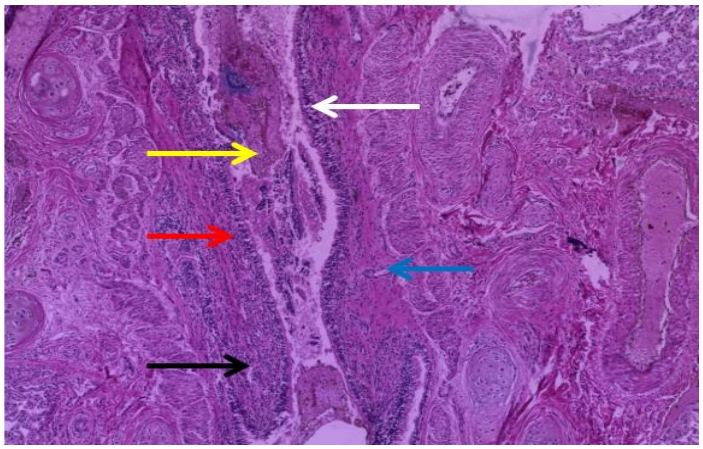

Fig. 3. Microscopical features of lung calf showed chronic bronchitis red arrow, hyperplasia of epithelial cells of bronchi white arrow with per bronchiolar infiltration of mononuclear inflammatory cells black arrow, fibrosis blue arrow and presence of inflammatory exudate inside the lumen of bronchi yellow arrow. H&E 4x

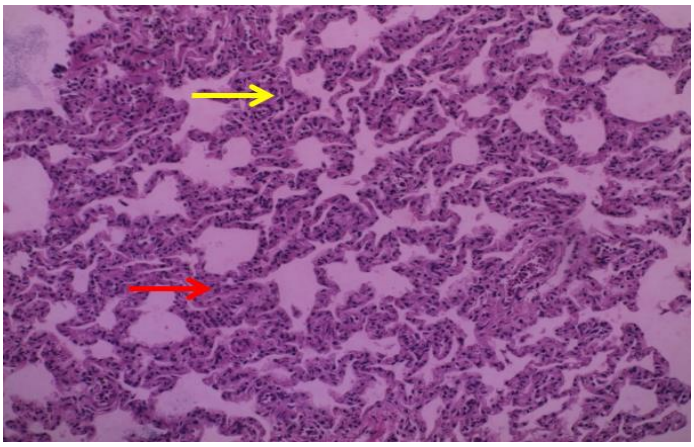

Fig. 4. Microscopical features of the lung calf showed thickening of interstitial layer of alveoli red arrow, mild infiltration of mononuclear inflammatory cells yellow arrow. H&E 10x

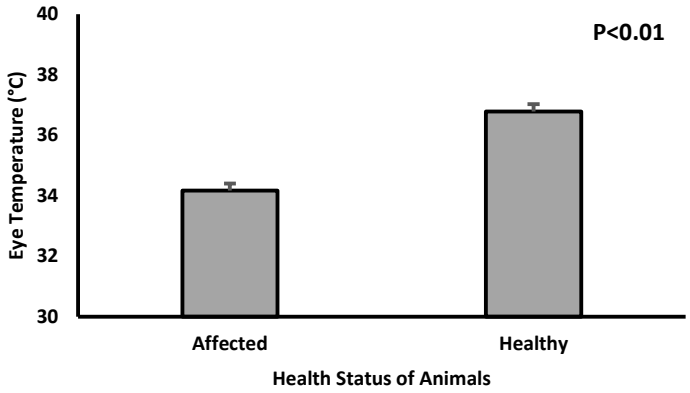

Fig. 5. Eye Temperature of calves before slaughtering.

References

1. Attoh-Kotoku, V., Emikpe, B. O., Obuadey, D., Ishola, O., Emmanuel Kwesi, O., Donkoh, A., & Folitse, R. Patterns and direct financial implications of contagious pleuropneumonia in cattle slaughtered in Kumasi Abattoir, Ghana. *Animal Research International*, **15**(1), 2937-2943(2018).

2. Lacasta, D., Ferrer, L. M., Ramos, J. J., González, J. M., & De las Heras, M. Influence of climatic factors on the development of pneumonia in lambs. *Small Ruminant Research*, **80**(1-3), 28-32(2008).

3. Taylor, J. D., Fulton, R. W., Lehenbauer, T. W., Step, D. L., & Confer, A. W. The epidemiology of bovine respiratory disease: What is the evidence for predisposing factors?. *The Canadian Veterinary Journal*, **51**(10), 1095(2010).

4. Yesuf, M., Mazengia, H., & Chanie, M. (2012). Histopathological and Bacteriological Examination of Pneumonic Lungs of Small Ruminants Slaughtered at Gondar, Ethiopia.

5. Dar, L. M., Darzi, M. M., Mir, M. S., Kamil, S. A., Rashid, A., Abdullah, S. & Parihar, S. Histopathological and histoenzymatic studies on bronchopneumonia in sheep. *Journal of Applied Animal Research*, **42**(3), 289-296 (2014).

6. Caswell, J.L. and Williams, K.J. (2007) "Respiratory system," in Jubb, Kennedy and Palmer Pathology of Domestic Animals, M. G. Maxie, Ed., 5th, pp. 524–650, Elsevier, Edinburgh, Scotland.

7. McRae, K. M., Baird, H. J., Dodds, K. G., Bixley, M. J., & Clarke, S. M. Incidence and heritability of ovine pneumonia, and the relationship with production traits in New Zealand sheep. *Small Ruminant Research*, **145,** 136-141(2016).

8. Mellau, L. S. B., Nonga, H. E., & Karimuribo, E. D. A slaughterhouse survey of lung lesions in slaughtered stocks at Arusha, Tanzania. *Preventive Veterinary Medicine*, **97**(2), 77-82(2010).

9. Edwards, D. S., Johnston, A. M., & Mead, G. C. Meat inspection: an overview of present practices andfuture trends. *The Veterinary Journal*, **154**(2), 135-147(1997).

10. Schweizer, G., Plebani, G. F., & Braun, U. Prevalence of Fasciola hepatica and Dicrocoelium dendriticum in the cow: inspection in an east Switzerland abattoir. *Schweizer Archiv fur Tierheilkunde*, **145**(4), 177-179. (2003).

11. Assefa, D., Gezaheng, E., Abera, B., Eticha, E., Lemma, D., & Hailemariam, T. Major cause of organ and carcass condemnation in apparently healthy small ruminant slaughtered at Addis Ababa Abattoir enterprise, Ethiopia. *Journal of Veterinary Science and Technology*, **8**, 419 (2017).

12. Mekibib, B., Mikir, T., Fekadu, A., & Abebe, R. Prevalence of pneumonia in sheep and goats slaughtered at Elfora Bishoftu export abattoir, Ethiopia: A pathological investigation. *Journal of Veterinary Medicine*, **7**(5), 23-33(2019).

13. Mohammed, Z. M., Ibrahim, W. M., & Abdalla, I. O. Pneumonia in Slaughtered Sheep in Libya: Gross and Histopathological Findings. *European Journal of Veterinary Medicine*, **2**(1), 4-9(2022).

14. Eddy, A. L., Van Hoogmoed, L. M., & Snyder, J. R. The role of thermography in the management of equine lameness. *The Veterinary Journal*, **162**(3), 172-181(2001).

15. Berry, R. J., Kennedy, A. D., Scott, S. L., Kyle, B. L., & Schaefer, A. L. Daily variation in the udder surface temperature of dairy cows measured by infrared thermography: Potential for mastitis detection. *Canadian Journal of Animal Science*, **83**(4), 687-693 (2003).

16. Schaefer, A. L., Cook, N., Tessaro, S. V., Deregt, D., Desroches, G., Dubeski, P. L. & Godson, D. L. Early detection and prediction of infection using infrared thermography. *Canadian Journal of Animal Science*, **84**(1), 73-80 (2004).

17. Metzner, M., Sauter-Louis, C., Seemueller, A., Petzl, W., & Klee, W. Infrared thermography of the udder surface of dairy cattle: Characteristics, methods, and correlation with rectal temperature. *The Veterinary Journal*, **199**(1), 57-62 (2014).

18. Siewert, C., Dänicke, S., Kersten, S., Brosig, B., Rohweder, D., Beyerbach, M., & Seifert, H. Difference method for analysing infrared images in pigs with elevated body temperatures. *Zeitschrift für Medizinische Physik*, **24**(1), 6-15 (2014).

19. Planinsic, G. (2011). Infrared thermal imaging: fundamentals, research and applications. iopscience.iop.org

20. Zheng, S., Zhou, C., Jiang, X., Huang, J., & Xu, D. Progress on Infrared Imaging Technology in Animal Production: A Review. *Sensors*, **22**(3), 705 (2022).

21. Bancroft, J. D., Cook, H. C., & Stirling, R. W. (1994). Manual of histological techniques and their diagnostic application. In Manual of histological techniques and their diagnostic application (pp. 457-457).

22. Ferrer, L. M., Ramos, J. J., Castells, E., Ruíz, H., Climent, M., & Lacasta, D. Use of computed tomography and thermography for the diagnosis of respiratory disorders in adult sheep. *Sheep Farming–An Approach to Feed, Growth and Health*, 53-75(2020).

23. Murtaza, M., Al-Azizz, S. A., Abdulhameed, F. M., & Kadhim, LActive survey of hydatid cysts in slaughtered sheep at Basrah abattoirs, Basrah province, Iraq. *Journal of Entomology and Zoology Studies*, **5**(5), 951-954 (2017).

24. Hassan, N. O. Prevalence of some infections in liver and lung of slaughtered ruminants in Koya abattoir, Erbil, Iraq. *Tikrit J. Pure Sci.*, **20**(2), 1-6(2015).

25. Raji, M. A., Salami, S. O., & Ameh, J. A. Pathological conditions and lesions observed in slaughtered cattle in Zaria abattoir. *Journal of Clinical Pathology and Forensic Medicine*, **1**(2), 9-12(2010).

26. El-Mashad, A. B. I., Moustafa, S. A., Amin, A., & Samy, E. M. Pathological Studies on lung affections in sheep and goat at Kalubia Governorate. *Benha Veterinary Medical Journal*, **38**(1), 17-23(2020).

27. Hashemnia, M., Chalechale, A., & Malmir, E. Pulmonary lesions in slaughtered sheep in Western Iran: gross and histopathological findings. *Vet. Ital.*, **55(**1), 47-56(2019).

28. Adamu, J. Y., & Ameh, J. A. Prevalence of pneumonia among slaughtered cattle, goats and sheep in Maiduguri abattoir, Maiduguri, Nigeria. *Sahel Journal of Veterinary Sciences*, **6**(1), 5-8(2007).

29. Ismael, M. T., & Chalabi, K. N. Prevalence of bovine fascioliasis in Hawler modern abattoir, Erbil, Kurdistan Region, Iraq. *Plant Archives*, **21**(1), 785-788(2021).

30. Al-Nassir, H. S. A surveillance study on condemnation of ruminant, s livers and lungs due to common disease conditions in Kerbala abattoirs. *Kufa Journal of Veterinary Medical Sciences*, **5**(1), 233 (2014).

31. Kadir, M. A., Ali, N. H., & Ridha, R. G. M. Prevalence of helminthes, pneumonia and hepatitis in Kirkuk slaughter house, Kirkuk, Iraq. *Iraqi Journal of Veterinary Sciences*, **26**, 83-88(2012).

32. Abass, K. S., Mohammed, N. S., Taleb, M., & Raheem, Z. S. Study of bovine and ovine pulmonary and hepatic abscessation at Kirkuk abattoir. *Plant Archives*, **19**(2), 1640-1644(2019).

33. Ezzi,A., Moradi,B., & Jabbari, A. Survey on pneumonic pasteurellosis in slaughtered sheep and goats at the Ziaran abattoir. *Archives of Razi Institute*, **62**(4), 235-239 (2007).

34. Ertan, O. The pathologic and bacteriologic comparison of pneumonia in lambs. *Turk. J. Vet. Anim. Sci.*, **30**, 593 -599 (2006).

35. Naylor, J. M., Streeter, R. M., & Torgerson, P. Factors affecting rectal temperature measurement using commonly available digital thermometers. *Research in Veterinary Science*, **92**(1), 121-123(2012).

36. Cuthbertson, H., Tarr, G., & González, L. A. Methodology for data processing and analysis techniques of infrared video thermography used to measure cattle temperature in real time. *Computers and Electronics in Agriculture*, **167,** 105019(2019).

37. Kessel, L., Johnson, L., Arvidsson, H., & Larsen, M. The relationship between body and ambient temperature and corneal temperature. *Investigative Ophthalmology & Visual Science*, **51**(12), 6593-6597(2010).

38. George, W. D., Godfrey, R. W., Ketring, R. C., Vinson, M. C., & Willard, S. T. Relationship among eye and muzzle temperatures measured using digital infrared thermal imaging and vaginal and rectal temperatures in hair sheep and cattle. *Journal of animal science*, **92**(11), 4949-4955 (2014).

تقييم التصوير الحراري بالأشعة تحت الحمراء ودراسة التغيرات المرضية للكشف عن الالتهاب الرئوي في العجول قبل وبعد الذبح في المجزرة

أصيل أنور ألنقشبندي

فرع الطب الباطني والجراحة ،كلية الطب البيطري ، جامعة دهوك ، دهوك ، العراق.

الملخص

صممت هذه الدراسة باستخدام تقنية التصوير الحراري بالأشعة تحت الحمراء للكشف عن مدى انتشار الالتهاب الرئوي في العجول في مجزرة بلان في مدينة زاخو، العراق. تم الفحص الروتيني للرئتين للكشف عن وجود الآفات المرضية. أجريت الدراسة الحالية في الفترة ما بين تشرين الثاني 2023 وشباط 2024. وتم جمع البيانات من 472 عجلاً من الذكور تتراوح أعمارهم بين 1.5 إلى 2 سنة. تم جمع الرئتين المصابة من الفحص العياني لغرض الفحص النسيجي. كما تم اخذ درجة الحرارة المحيطية باستخدام الكاميرا الحرارية التي تعمل بالأشعة تحت الحمراء. أظهرت النتائج وجود 118 رئة مصابة بآفات رئوية (25%). على الرغم من أنه بعد التشخيص النسيجي، تم العثور على الالتهاب الرئوي في 107 رئة (22.6٪). كانت درجة حرارة العين أقل بشكل ملحوظ في ($P < 0.01$) في الحيوانات المصابة (34.2 ± 0.2 درجة مئوية) مقارنة بالحيوانات السليمة (36.8 ± 0.2 درجة مئوية). وكانت الحساسية 0.97 والنوعية (1 - خصوصية) 0.61 وفقا للنتائج. من خلال الدراسة الحالية، ووفقاً للنتائج التي تم الحصول عليها ، استنتج أن فحص الحيوانات قبل الذبح باستخدام تقنية التصوير الحراري مفيد للحيوانات المصابة. ولوحظ انتشار الالتهاب الرئوي بشكل كبير في الحيوانات المستوردة، وبالتالي فإن فحصها أمر مهم وحيوي للصحة العامة.

الكلمات المفتاحية: درجة حرارة العين، التصوير الحراري بالأشعة تحت الحمراء، المجزرة ، العجول، الالتهاب الرئوي