

# Evaluation of macroscopic lesions of different lung lobes in swine using a percentage classification model

## Evaluación de lesiones macroscópicas de los diferentes lóbulos pulmonares en la especie porcina usando un modelo de clasificación porcentual

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## Abstract

Respiratory diseases in pigs have a great economic impact, considering it is one of the main problems in intensive swine production. The objective of this study was to macroscopically evaluate the different pulmonary lobes in a processing plant located center-west of Risaralda, using a percentage qualification model. Through a descriptive study, 358 lungs were evaluated during the evisceration phase, the specimens came from 9 lots of different farms. Data was collected according to the degree of macroscopic lesion observed for each of the pulmonary lobes in percentages. With this data, averages were taken for each of the lobes and compared between the total of samples observed and for each of the lots. In addition, more specific lesions were evaluated on a scale of 0-5 as indicators of pleurisy and scarring. The analysis of the macroscopic observations showed that the majority of the lungs, presented some degree of lesion with an 85% (305/358) while only 15% (53/358) showed no type of lesion. 13% (43/358) presented lesions indicative of pleurisy and 71% (253/358) showed scarring. The comparison of the lesion averages between the different pulmonary lobes showed that the most affected was the right cardiac lobe with an average value of 2.10% while the least affected was the accessory lobe with an average value of 0.97%. In this study it was found that the right and left cardiac lobes were the most affected out of the totality of lungs evaluated, these results can be related to the respiratory signs, the health status and the productive parameters of the different batches in the farm, helping to determine a presumptive or final etiological diagnosis. This shows that the percentage evaluation method could be a quick and effective tool for the study of postmortem lesions in processing plants.

**Keywords:** macroscopic lesions, respiratory diseases, pulmonary lobes, slaughterhouses.

## Resumen

Las enfermedades respiratorias en porcinos tienen un gran impacto económico, considerándose uno de los principales problemas en la producción intensiva porcina. El objetivo de este estudio fue evaluar macroscópicamente los diferentes lóbulos pulmonares en una planta de beneficio del centro-occidente de Risaralda, usando un modelo de calificación porcentual. Mediante un estudio descriptivo, se evaluaron 358 pulmones durante la fase de eviscerado, provenientes de 9 lotes de diferentes granjas; se recolectaron datos porcentuales según el grado de lesión macroscópica observada para cada uno de los lóbulos pulmonares. Con estos datos se calcularon los promedios para cada uno de los lóbulos y se compararon entre el total de muestras observadas y para cada uno de los lotes. El análisis de las observaciones macroscópicas permitió establecer una prevalencia de lesiones pulmonares del 85% (305/358), mientras que el 15% (53/358) no evidenciaron ningún tipo de lesión. El 13% (43/358) presentaron lesiones indicativas de pleuritis y el 71% (253/358) de cicatrización. La comparación de los promedios de lesión entre los diferentes lóbulos pulmonares mostró que el más afectado fue el cardiaco derecho, con un valor promedio de 2,1%, mientras que el menos afectado fue el accesorio con un valor promedio de 0,97%. En este estudio se encontró que los lóbulos cardíacos derecho e izquierdo fueron los más afectados del total de pulmones evaluados, estos resultados se pueden relacionar con los signos respiratorios, el estado sanitario y los parámetros productivos de los diferentes lotes en la granja, lo que contribuye a establecer, junto con otras pruebas complementarias un diagnóstico presuntivo en el caso de afecciones respiratorias. Mostrando que el método de evaluación porcentual podría ser una herramienta rápida y eficaz de estudio de lesiones postmortem en plantas de beneficio.

**Palabras clave:** lesiones macroscópicas, enfermedades respiratorias, lóbulos pulmonares, mataderos.

## 1. Introduction

Respiratory diseases in swine are highly prevalent and generate a great economic impact represented by a reduction in feed conversion, weight gain and feed intake (Garcia-Morante *et al.*, 2016). There are multiple determinant factors that influence the emergence of these type of conditions, such as, intensive production, breed, exposure to adverse environmental conditions for this species, the bad housing conditions they are exposed to, the microbial load they are in contact with, the deficient waste disposal and inadequate sanitary management, etc. This can lead to a greater predisposition for respiratory tract infections, which, at the same time, affects the profitability of the productive system and causes economic losses due to the confiscation of lots in addition to unnecessary costs of veterinary care (Espinosa y Martínez, 2008; Martín *et al.*, 2017).

The situation exposed above states the necessity to stablish methodologies that allow the prevalence of respiratory conditions in swine under intensive breeding to be calculated and therefore quantify the problem to stablish strategies to mitigate it, as well as to find the association between the risk factors and respiratory conditions. For this purpose, it is important to stablish and validate a macroscopic observation technique that allows the detection and quantification of pulmonary lesions of swine lots in an objective matter (Spillane, 2016). These observations are of great use to articulate the results of the inspections with the improvement of the sanitary plans, the biosafety programs of the farm, in addition to the application of good management practices.

The goal of the present study is to obtain percentage results of the macroscopic pulmonary lesions found in processing plants and therefore to generate information that can be associated to the respiratory disease state in each of the evaluated productions.

## 2. Materials and methods

A transversal cohort study took place with convenience sampling. 358 swine lungs were evaluated; they were sacrificed in a processing plant located in Risaralda – Colombia (central occident of the Andina region). A systematic 30-day sampling was carried out.

### Macroscopic evaluation

Percentage data of the most representative macroscopic lesions were recollected during the postmortem inspection of the swine lungs selected at convenience. The pigs weighed around 115 to 140 kilograms, the most affected parts were photographed with a digital camera (Sony, DSC H9, Japan) to obtain a data log for posterior analysis of the observed lesions.

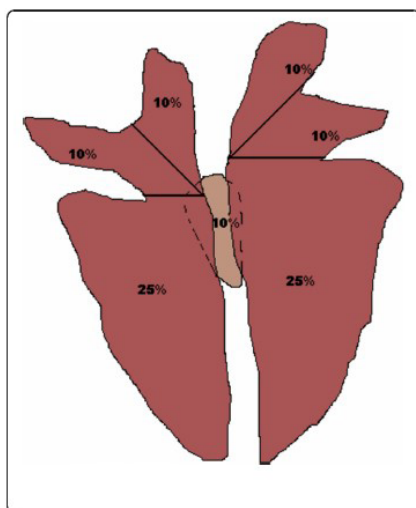
The size of the sample was taken according to the size of the animals that entered the farms that authorized the sampling, during a 4-week period. The inspected lots came from different farms, with the exception of one farm from which animals were received on two occasions, therefore, it had a second inspection, this situation is reflected in the results and is named as the second moment (sixth farm). The data recollected during the inspection were registered in an Excel table and were analyzed on the Infostat software.

### Pulmonary tissue inspection

The pulmonary lesion patterns possibly responsible for the respiratory diseases were evaluated to homogenize the measurements made by both and to therefore minimize the observer bias, in addition to making an objective evaluation of the lesions. Even though the farm selection was made through convenience, the sample of each lot was randomized according to the order of arrival at the processing plant.

The inspection was conducted through macroscopic visualization of the different pulmonary lobes and the information was systematically registered like this: left apical lobe, left cardiac lobe and left diaphragmatic lobe. Afterwards, the same observations were made on the right side and lastly the accessory lobe was evaluated. A percentage according to what was observed, was assigned to each of these lobes following what was proposed by Steinmann *et al* (2014), as is shown on figure 1. In addition to the above, a log of the lungs with pleuritic and scarring suggestive conditions was made, with which a percentage of organ affectation was established.

**Figure 1.** Simplified pulmonary scheme (posterior view) standardized evaluation of the base for pulmonary lesions (“Rule of the tens”). Taken from Steinmann (2014).



### 3. Results and discussion

The data analyzed corresponds to the inspection of 358 animal lungs from different pig farms, which were macroscopically evaluated to determine the degree of lesion using a percentage classification model that appears reflected on table 1.

**Table 1. Percentage of lesions found on each evaluated farm**

Number of evaluated animals*		16	30	25	19	39	55	57	37	80
Variable		G1 %	G2 %	G3 %	G4 %	G5 %	G6a %	G6b %	G7 %	G8 %
<b>Lobe</b>	<b>Side</b>									
Apical	Left	1,25	0,33	2,12	0,84	0,13	1,47	1,40	0,92	1,06
Cardiac	Left	4,38	3,10	1,36	1,37	0,69	1,85	1,86	2,78	1,96
Diaphragmatic	Left	1,31	0,77	1,04	1,79	0,21	1,76	1,25	1,27	1,49
Apical	Right	2,56	1,53	1,68	2,26	0,725	2,09	2,32	2,08	1,46
Cardiac	Right	4,31	2,13	1,68	1,42	0,59	2,45	2,26	2,73	2,03
Diaphragmatic	Right	2,63	1,00	1,08	2,79	0,26	1,96	1,33	1,65	1,79
Accessory		2,19	1,33	0,88	1,05	0,31	1,04	0,65	1,19	1,00
Total		18,63	10,20	9,84	11,53	2,90	12,64	11,07	12,62	10,79
Scar		1,13	0,73	1,64	1,42	1,00	1,11	1,74	2,05	0,90
Pleurisy		0,31	0,17	0,28	0,00	0,10	0,09	0,13	0,11	0,31

G: farm

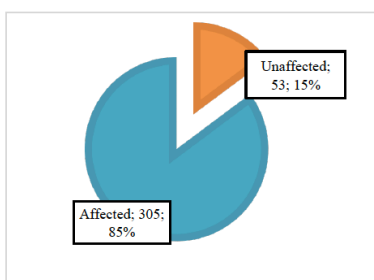
G6a: farm 6 first measurement

G6b: farm 6 second measurement

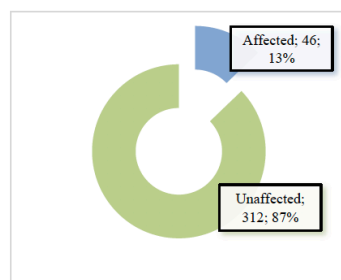
\*Number of animals: expressed in absolute value

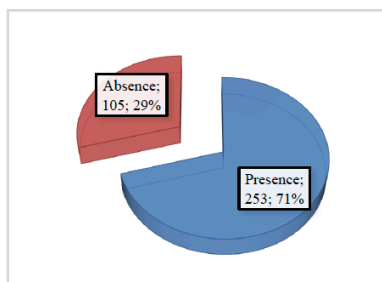
It was possible to establish that 85% (305/358) of the totality of lungs inspected evidenced some degree of macroscopic lesion observable as is seen on figure 2; in relation to the presence of pleurisy a 13% (46/358) prevalence was determined, figure 3; additionally, scarring processes were observed in 71% (253/358) of the animals, figure 4.

**Figure 2. Prevalence of pulmonary lesions**



**Figure 3. Presence of pleurisy lesions**



**Figure 4. Presence of scars in the lungs**

In the inspection of red viscera in swine livestock, it is frequent to find a high degree of pulmonary lesion, as was evidenced in the present study and is reported in studies carried out by authors such as Guzmán *et al* (2008) and Staaveren *et al* (2016). They reported 78,18% and 85% of apparent pulmonary tissue lesions respectively. In studies done by Merialdi *et al* (2012) and Meyns *et al* (2011) prevalence of 46,4% and 23,85% of macroscopic pulmonary lesions were observed respectively, this difference could be due to the size of the sample. The distribution of the lesions of the present study are shown on table 2.

**Table 2. Degrees of lesion of the totality of pulmonary lobes**

Lobe	Side	n	mean	D.E.	Var (n-1)	Var (n)	Min	Max	Median
Apical	Left	358	1,07	1,87	3,49	3,48	0,00	9,00	0,00
Cardiac	Left	358	2,01	2,29	5,22	5,21	0,00	9,00	1,00
Diaphragmatic	Left	358	1,25	2,32	5,40	5,38	0,00	15,0	0,00
Apical	Right	358	1,79	2,13	4,55	4,54	0,00	9,00	1,00
Cardiac	Right	358	2,10	2,26	5,09	5,07	0,00	9,00	2,00
diaphragmatic	Right	358	1,54	2,87	8,23	8,20	0,00	18,0	0,00
Accessory		358	0,97	1,87	3,51	3,50	0,00	9,00	0,00
Total		358	10,72	11,88	141,06	140,67	0,00	71,0	7,00

The findings showed a greater affectation of the right side of the lung, these results match the reported by Martín *et al* (2017), Guzmán *et al* (2008) and Steinmann *et al* (2014) who observed that the greatest degrees of macroscopic lesion were found on the apical, cardiac and diaphragmatic lobes of the right lung; although it is important to mention that in the study of Martín *et al* (2017) and in the study of Guzmán *et al* (2008) different percentage classification models were used. These findings could be explained



by what König *et al.* (2008) described, which is that the right lung is bigger than the left lung and this could favor the presentation of lesions of the right lung.

With regard to the observed lesions suggestive of pleurisy, it was found in 13% of the lungs evaluated, which is consistent with what was found by Fraile *et al* (2014) with a prevalence of 13.4% and similar to Alawneh *et al* (2018) who reported 22% of pleurisy; it should be noted that the latter work was done with a much larger sample (11,292 lungs).

In the present study, adhesions associated to pleurisy were not observed, this is consistent with the study of Staaveren *et al* (2016) who referenced a low frequency of pulmonary adhesions to the thoracic wall associated with pleurisy. Similarly, Andreasen *et al* (2000) affirms that it is common to find chronic pleural lesions in processing plants, because medical resolution of pleurisy can last three or more months; although in this study the evolution time of pleurisy was not determined, it is possible to presume that the result obtained may be due to the presence of chronic processes and not active infections.

On the other hand, the evaluation method proposed in this study has some limitations because the observations were made in very short times, due to the slaughter process being usually too quick, for this reason no incisional cuts were made, which would have allowed to check the depth of the injuries. Steinmann *et al.* (2014) considered that the limitations in this type of study could be directly related to its nature, which means that an observation or a two-dimensional photograph does not represent the pulmonary lesions with great exactitude as would a threedimensional evaluation. According to Hill *et al* (1992) and Davies *et al* (1995), the imprecision range between both methods results negligible due to the purpose to develop a pulmonary lesion scheme in the animal processing plants. Even though the proposed model in this study allowed to establish a simple and fast percentage rating of the

lesions, it is suggested to include lobe cuts in the methodology of future studies that may improve the observation of the different lesions, in addition to increasing the size of the sample and the spectrum of the evaluated farms and to try to evaluate the risk factors associated to these lesions in the productive systems.

#### 4. Conclusion

This study revealed that the right and left cardiac lobes were the most affected, presenting the highest prevalence of pulmonary lesion. Additionally, it was possible to establish that the pulmonary percentage evaluation method used in the processing plant could be considered a practical and effective tool when monitoring the sanitary state of animals to be slaughtered, facilitating the analysis and association of these macroscopic findings with the different production parameters that are associated with profitability on farms and that allow the producer to make informed decisions about health plans, biosecurity measures and management practices to be implemented or reinforced to mitigate the presence of pathogens. It could also complement studies that correlate clinical signs, histopathological, bacteriological and virological studies focused on a definitive diagnosis of the diseases of respiratory origin.

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