International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 23s, 2025
https://www.theaspd.com/ijes.php

Histological And Physicochemical Evaluation Of Sheep Organs And Meat Infected With Hydatid Cysts In Kerbala City

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Abstract:
A histological and physicochemical study was conducted to evaluate the effects of hydatid cyst infection on sheep meat and organs. Ten carcasses were collected from a slaughterhouse in Kerbala, and samples from the liver, lungs, mesentery, and muscle were examined. Meat quality parameters including pH, moisture content, protein content, ash content, and water activity (aw) were measured, and histological changes were observed to assess the impact of infection. A total of ten hydatid cysts were collected from various infected organs, with the liver being the most commonly affected (5/10), followed by the lungs (3/10) and mesentery (2/10). Single cysts were identified in five cases (three in the liver, one in the lung, and one in the mesentery), while multiple cysts were observed in the remaining five cases (two in the liver, two in the lungs, and one in the mesentery). Histological examination revealed degeneration and inflammatory changes in infected tissues, and significant alterations in meat parameters were detected when compared with healthy controls. These findings indicate that hydatid cyst infection can significantly affect both the histological structure and quality characteristics of sheep meat.
Keywords: *Hydatid cyst, Sheep meat, Liver, Lung, Mesentery, Histology, Meat quality.*

INTRODUCTION:

Hydatid illness, another name for echinococcosis, is a communicable illness that causes a significant continuous incidence of life years adjusted for disabilities (DALYs) worldwide (1). All nations in the Middle East and the western Mediterranean area are endemic for echinococcosis (2). The disease known as the infection is caused by the larval phase of the worm *E. granulosus*, species belongs to the phylum the genera Platy. Intermediate hosts, such as domestic animals like sheep and goats (called pastoral hydatidosis) especially wild animals like moose, the reindeer, and caribou (called sylvan hydatidosis), can contract the infection.

Inadvertent ingesting water or food that is tainted through the parasite's egg can expose individuals to an *E. granulosus* illness. The waste products of afflicted animals contain these eggs. This parasite's anomalous intermediary hosts were people. The organ known as the liver is where hydatid cysts most frequently form in people, occurring in fifty percent to ninety-three of instances (3). The juvenile worm stage, which is the mature version of *E. granulosus*, lives in the digestive tract of dogs. Intestinal tapeworm's eggs discharge larvae enter the intestines once they are eaten by intermediary hosts, including people, rats, antelope, cattle, and various other animals. The resulting embryos are then put into circulation through the portal. Although some of the fertilized embryos are trapped within the liver, the remainder pass through that organ and spread to other organs, and eventually develop as cysts of hydatid tissue (4). The organ responsible for liver function was impacted in 70% to 75% of cases with echinococcosis with cysts (CE), whereas the respiratory tract were impacted in between ten and twenty percent of cases. Nonetheless, cysts of hydatid tissue can form in every bodily organ (5). The mature worm has three to four proglottids and is small, averaging 3 to 6 mm in length and 0.5 mm in width. With differences in the physical characteristics of mature organisms, the capacity to infect particular hosts, and the severity of sickness, it is clear that While CE may appear in all organs and tissues of humans and other intermediate host animals, the liver generally accounts for the bulk of infections, with the respiratory tract coming in second (6). *E. granulosus*, *E. vogeli*, *E. oligarthrus*, *E. shiquicus*, and *E. felidis* are the six types species Echinococcus tapeworms that have been identified. Two species of significant medical importance are Echinococcosis (CE) produced by *E. granulosus* and AE caused by *E. multilocularis*. (AE) (7).

MATERIALS AND METHODS:

Sampling area

This study was conducted during the period from October 2024 to May 2025 in order to investigate the molecular and histopathological characterization of hydatid cysts. Ten cysts were selected and collected from sheep (*Ovis aries*) slaughtered at different local abattoirs in the holy city of Karbala (Figure 2-1), which were visited weekly for data and sample collection.

Figure 1. Map of Karbala province showing the areas of the study

Hydatid cysts

The cysts were isolated from various organs, specifically the liver, lungs, and mesentery, with details on single and multiple cyst distributions as summarized in Table 1. The samples included three single cysts and two multiple cysts from the liver, one single cyst and two multiple cysts from the lungs, and one single cyst and one multiple cyst from the mesentery. The sheep under 5 years old from both sexes suffering from kerbala city abattoir and Al-Hussenyia sheep farmers in Kerbala, were sourced from.

Table 2- 1. The distribution of the 10 cyst samples by organ and cyst type

Sample Number	Organ	Type of Cyst
1	Liver	Single Cyst
2	Lung	Multiple Cysts
3	Mesentery	Multiple Cysts
4	Liver	Multiple Cysts
5	Liver	Single Cyst
6	Liver	Multiple Cysts
7	Lung	Single Cyst
8	Mesentery	Single Cyst
9	Lung	Multiple Cysts
10	Liver	Single Cyst

Determination of Meat parameters

Sheep organs including liver, lung, mesenteric tissue, and muscle samples were collected from slaughtered animals that were naturally infected with hydatid cysts. Ten organs were obtained and prepared for laboratory

analysis, while corresponding control samples were taken from healthy animals free from visible cysts. The samples were transported under aseptic conditions and stored at refrigerated temperature until examination. The pH of the meat was determined using a calibrated pH meter, while the moisture content was measured by oven-drying to a constant weight. The protein content was estimated using the Kjeldahl method, and the ash content was determined by incineration in a muffle furnace at high temperature. Water activity (aw) was assessed using a water activity meter. All measurements were carried out in triplicate, and the obtained values were compared between infected and control groups to evaluate the effect of hydatid cyst infection on meat quality parameters.

Histopathological Examination

All samples from the liver and lungs, each containing hydatid cysts, were selected for histological analysis. The specimens were thoroughly washed with 0.9% normal saline to remove blood and debris, ensuring clean samples for subsequent processing. Routine histological procedures were followed, with serial sections prepared from the cranial, middle, and caudal regions of these organs. This approach ensured a comprehensive assessment of tissue morphology and pathological changes, such as inflammation and fibrosis, associated with hydatid cyst infection.

RESULTS

Distribution of hydatid cyst among organs of sheep

In our study, a total of 10 hydatid cyst samples were collected from various infected organs, including the liver, lungs, and mesentery. The liver was the most commonly affected organ, accounting for 5 out of 10 cases, followed by the lungs (3/10) and mesentery (2/10). Single cysts were observed in 5 cases (3 in the liver, 1 in the lung, and 1 in the mesentery), while multiple cysts were identified in the remaining 5 cases (2 in the liver, 2 in the lungs, and 1 in the mesentery).

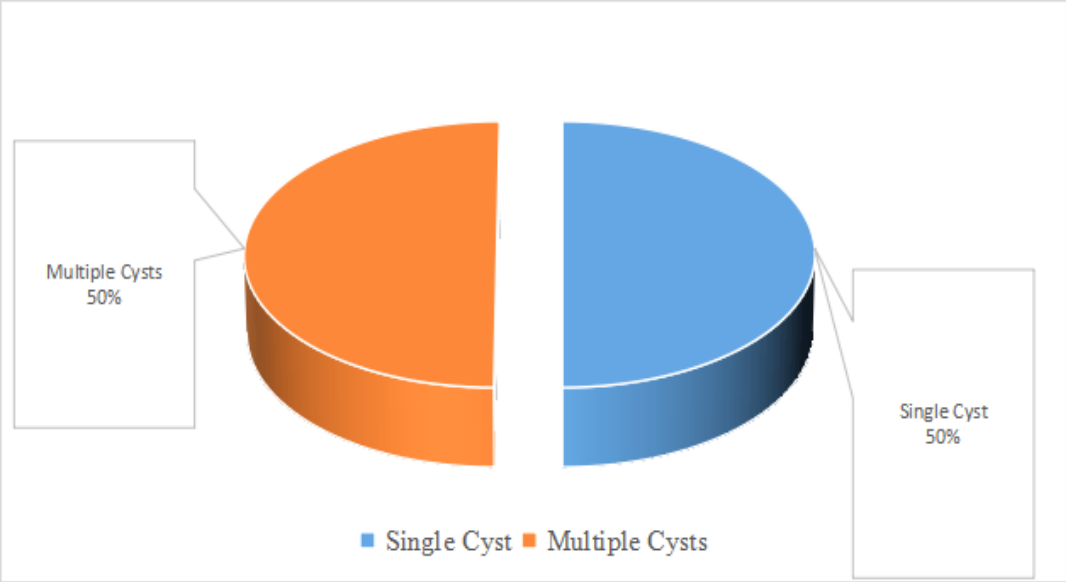

Figure (2):Distribution of hydatid cysts according to organ and cyst type

Histopathological examination of organs

Histopathological examination of lung tissue from infected subjects revealed significant acute and chronic inflammatory changes associated with hydatid cyst infection. A prominent finding was the extensive infiltration of neutrophils, indicative of an active innate immune response and ongoing inflammation. Additionally, marked peribronchial eosinophil accumulation was observed, a feature commonly linked to parasitic infections and allergic responses. Histopathological examination of tissues stained with hematoxylin and eosin (H&E) at 400x magnification revealed marked differences between the control and hydatid cyst-

affected groups, highlighting the pathological impact of E. granulosus infection. In the control group, liver sections displayed normal hepatic architecture. Hepatocytes were polygonal, organized in cord-like plates, with abundant eosinophilic cytoplasm and centrally located, round nuclei. Sinusoidal spaces between hepatocyte plates were well-defined, indicating healthy liver morphology with no signs of inflammation or structural disruption (Figure 3 A), In contrast, liver tissues from sheep infected with hydatid cysts exhibited significant pathological alterations. Extensive fibrosis was observed, characterized by dense collagen deposition surrounding the cyst wall. Chronic inflammatory cell infiltrates, including eosinophils and mononuclear cells, were prominent, reflecting a robust immune response to the parasite. Hepatocytes in affected areas were collapsed or degenerated, embedded within fibrotic tissue, indicating severe structural damage and loss of functional hepatic tissue (Figure 3 B), Lung tissue from the control group showed normal histological features, with numerous thin-walled alveolar sacs lined by Type I and Type II pneumocytes. The alveolar architecture was intact, with no evidence of inflammatory infiltration, edema, or wall thickening, consistent with healthy pulmonary tissue (Figure 3 C), on the other hamd, The histopathological findings underscore the severe impact of hydatid cyst infection on liver tissue, with fibrosis, inflammatory infiltration, and hepatocyte degeneration disrupting normal architecture. In contrast, the control group's liver, lung, and skeletal muscle tissues exhibited normal morphology, serving as a baseline for comparison. These observations align with previous findings in this study, where infected tissues showed extensive pathological changes, including fibrosis and necrosis, while control tissues remained unaffected. The results emphasize the destructive effects of E. granulosus on tissue structure and function, complementing the molecular and physicochemical data reported earlier.

The bronchial structures exhibited irregular luminal diameters and substantial thickening of the submucosal layer (Figure 3D), reflecting chronic inflammatory remodeling of the airways. Alveolar walls were thickened, with narrowed alveolar lumina, likely due to inflammatory edema and cellular proliferation. In affected regions, Type I pneumocytes showed degeneration necrosis, or detachment, resulting in denuded alveolar surfaces, In response to this injury, Type II pneumocytes displayed hyperplasia and squamous metaplasia, an adaptive change often associated with chronic inflammation or fibrosis. This was characterized by flattened epithelial cells and further thickening of the alveolar septa (Figure 3E) and Alveolar spaces were frequently filled with purulent exudate, consisting of dense fibrin, cellular debris, and neutrophilic infiltrates, suggestive of secondary bacterial pneumonia (Figure 3-8). This exudate occasionally extended into capillaries and microvasculature, potentially compromising gas exchang (Figure 3 F).

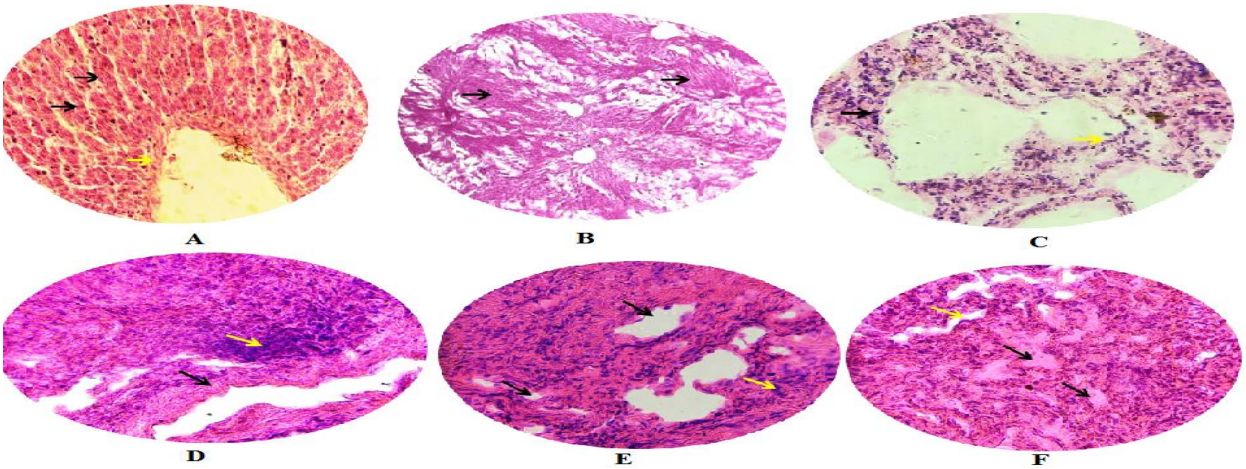

Figure 3: A: Liver tissue of the control group showing polygonal hepatocytes arranged in plates with abundant eosinophilic cytoplasm and centrally located nuclei (black arrow). H&E stain, 400x; B: Liver tissue infected with hydatid cyst showing extensive fibrosis, infiltration of chronic inflammatory cells, and degenerated hepatocytes within fibrotic areas (black arrows). H&E stain, 400x; C: Lung tissue of the

control group showing numerous, thin-walled alveoli lined by two types of pneumocytes, with intact alveolar structure. H&E stain, 400x; D: Histological section of a lung infected with hydatid cysts, showing a high concentration of eosinophils surrounding the pulmonary bronchiole (yellow arrow). The bronchiole displays an irregular diameter and marked thickening of the submucosal layer (black arrow). H&E staining, 400× magnification; E: Lung tissue infected with hydatid cysts, demonstrating extensive infiltration of inflammatory cells within the pulmonary parenchyma (yellow arrow). Alveolar structures exhibit narrowing (stenosis) of their diameter (black arrow). H&E staining, 400× magnification; F: Histological image of a hydatid-infected lung showing alveoli containing purulent exudate, indicative of purulent pneumonia or lung abscess formation (black arrow). H&E staining, 400× magnification

Comparison of tissue pH values between apparently healthy and infected sheep

In our study, to evaluate the effect of hydatid cyst infection on tissue acidity, pH values of various tissues from apparently healthy and infected sheep were compared using an independent t-test. The results revealed a statistically significant reduction in pH across multiple tissues in the infected group compared to healthy controls. Specifically, the mean pH of back muscle tissue in infected sheep (5.32 ± 1.14) was significantly lower than in healthy sheep (6.63 ± 0.632) ($p = 0.012$). Similarly, chest muscle tissue in the infected group showed a reduced pH (5.66 ± 0.93) compared to the healthy group (6.89 ± 0.852) ($p = 0.024$). The most pronounced difference was observed in thigh muscle tissue, where the pH dropped from 6.98 ± 0.132 in healthy sheep to 5.01 ± 0.834 in infected sheep ($p = 0.036$).

Liver tissue from infected sheep also exhibited a significantly lower pH (5.64 ± 0.35) compared to healthy sheep (7.24 ± 0.351) ($p = 0.013$), suggesting notable tissue acidosis associated with the infection. In contrast, pH differences in lung and mesentery tissues were not statistically significant. The mean pH in the lungs of infected sheep (4.76 ± 0.51) was lower than in healthy sheep (6.83 ± 0.62), but this difference was not significant ($p = 0.24$). Similarly, mesenteric tissue pH showed no significant difference between infected (5.71 ± 0.462) and healthy sheep (6.74 ± 0.134) ($p = 0.48$). These results indicate that hydatid cyst infection significantly lowers pH in muscle and liver tissues, likely due to tissue damage, inflammation, and metabolic changes induced by the infection. The lack of significant pH changes in lung and mesentery tissues may reflect biological variability or less severe pathological involvement in these tissues

Table 3- 1. Comparison of mean pH levels in different tissues of apparently healthy and aydatid cyst-infected sheep using independent T-Test

Type of tissues PH	Apparently health Mean SD	Sheep infected **Mean SD**	T independent test P value
Meat Back	6.63± 0.632	5.32± 1.14	**0.012**
Meat Chest	6.89± 0.852	5.66± 0.93	**0.024**
Meat Tight	6.98± 0.132	5.01± 0.834	**0.036**
Liver	7.24 ± 0.351	5.64 ± 0.35	**0.013**
Lung	6.83 ± 0.62	4.76± 0.51	**0.24**
mesentery	6.74± 0.134	5.71± 0.462	**0.48**

Comparative analysis of moisture content in tissues of healthy and infected sheep

Table 3-2 showed the comparison of moisture content across various tissue types (back meat, chest meat, thigh meat, liver, lung, and mesentery) from apparently healthy and hydatid-infected sheep. Moisture content was determined by measuring the weight difference of tissue samples before and after drying.

Our results revealed a statistically significant increase in moisture content in all tissues from infected sheep compared to healthy controls ($P < 0.05$). The highest moisture levels were observed in the liver (26.8%) and back meat (26.7%) of infected sheep, while the lowest were recorded in the lung (18.3%) and chest meat (20.1%) of healthy sheep. These results suggest that hydatid infection may enhance the water retention capacity of affected tissues, likely due to pathological changes associated with the infection

Table ():Comparison of moisture content in different tissues between apparently healthy and hydatid cyst-infected sheep

Type of tissues	Apparently health			Infected sheep			P value
Moister	Initial Weight (g)	Final Weight (g)	Moisture Content (%)	Initial Weight (g)	Final Weight (g)	Moisture Content (%)	
Meat Back	50	35.5± 4.25	23.7± 3.65	50	38.5± 3.56	26.7± 3.67	0.013
Meat Chest	50	36.4± 3.87	20.1± 6.3	50	39.4± 6.87	23.1± 4.73	0.034
Meat Tight	50	35.8± 3.54	19.3±5.35	50	38.8± 3.74	22.3± 3.94	0.029
Liver	50	34.1± 2.87	23.8± 4.14	50	37.1± 5.28	26.8± 4.81	0.022
Lung	50	34.8± 4.65	18.3± 3.46	50	37.8± 3.72	21.3± 5.72	0.015
mesentery	50	35.2± 4.75	20.7± 3.52	50	38.2± 4.82	23.7± 3.92	0.041

Comparison of protein content in different tissues of apparently healthy and infected sheep

Table 3-3 presents a comparative analysis of biochemical parameters, including protein content, nitrogen content, and sample weight in various tissues (meat back, chest, thigh, liver, lung, and mesentery) between apparently healthy and infected sheep. The results indicate a significant difference in protein and nitrogen contents across all sampled tissues, as reflected by the p-values ($p < 0.05$). Notably, in all examined tissues, the infected samples showed a lower percentage of protein and nitrogen compared to the healthy counterparts. This reduction suggests possible metabolic alterations or tissue damage due to infection. The most pronounced decrease was observed in liver and mesentery tissues, where nitrogen and protein content dropped more substantially in the infected group. Our results support the hypothesis that infection may compromise the nutritional and biochemical integrity of sheep tissues

Table () Comparison of moisture, protein, and nitrogen content in different tissues of apparently healthy and infected sheep

Type of tissues Moister	**Infected sheep**			**Apparently health**			**P value**
	Weight of Sample (g)	Nitrogen Content (%)	Protein Content (%)	Weight of Sample (g)	Nitrogen Content (%)	Protein Content (%)	
Meat Back	1	2.8± 0.098	19.34± 0.028	1	20.307	3.0576± 0.093	**0.021**
Meat Chest	1	1.04± 0.013	19.4± 0.0104	1	20.37	1.092± 0.028	**0.025**
Meat Tight	1	3.1± 0.045	19.5± 0.031	1	20.475	3.3852± 0.011	**0.017**
Liver	1	2.2± 0.062	14.67± 0.022	1	15.4035	2.4024± 0.052	**0.038**
Lung	1	3.1 ± 0.013	20.63 0.031	1	21.6615	3.45± 0.063	**0.019**
mesentery	1	2.09± 0.041	14.56 ± 0.0209	1	15.288	2.184± 0.052	**0.026**

Ash content comparison in different tissues of apparently healthy and infected sheep

The ash content of tissue samples collected from apparently healthy and infected sheep were compared across six different tissue types: back meat, chest meat, thigh meat, liver, lung, and mesentery. As shown in Table 3-4, there was a significant decrease in the initial sample weight (as an indicator of moisture content) in all infected tissues compared to the corresponding tissues in healthy sheep. The differences were statistically significant, with P values ranging from 0.011 to 0.047.

In back meat, the initial weight dropped from 14.19 ± 0.75 g in healthy sheep to 11 ± 0.78 g in infected samples (P = 0.014). Similarly, the thigh meat samples showed a significant reduction from 11.61 ± 1.28 g to 9 ± 1.34 g (P = 0.047). The liver and lung samples exhibited weight reductions from 10.32 ± 0.99 g and 15.48 ± 1.36 g to 8 ± 1.04 g and 12 ± 1.43 g respectively (P < 0.05 for both).

Table ():Ash content comparison in different tissues of apparently healthy and infected sheep

Type of tissues Moister		Apparently health			Infected sheep		P value
	Ash Content (%)	Initial Weight of Sample (g)	Weight of Ash (g)	Ash Content (%)	Initial Weight of Sample (g)	Weight of Ash (g)	
Meat Back	1	14.19± 0.747592	0.131±0.0128	1	11 ±0.782	0.11± 0.013	0.014
Meat Chest	1	16.77± 0.13384	0.124±0.0536	1	13 ±0.14	0.13± 0.056	0.011
Meat Tight	1	11.61± 1.28104	0.15±0.060	1	9 ±1.34	0.09± 0.063	0.047
Liver	1	10.32± 0.99424	0.115±0.0133	1	8 ±1.04	0.08± 0.014	0.026
Lung	1	15.48± 1.36708	0.167±0.06	1	12 ±1.43	0.12± 0.063	0.038
mesentery	1	14.19± 0.747592	0.133 ±0.012	1	8 ±0.953	0.08± 0.067	0.018

Although ash content percentages remained constant across the tissues (1%), the actual weight of ash extracted was slightly lower in the infected tissues, suggesting a general reduction in both organic and inorganic content due to infection. The most marked decline was observed in the mesentery, where the weight dropped from 14.19 ± 0.75 g in healthy sheep to 8 ± 0.95 g in infected ones (P = 0.018). Overall, these findings suggest that infection significantly affects the water content and mass of various tissues, potentially due to metabolic or structural alterations caused by parasitic cysts

Effect of hydatid cyst infection on sheep meat texture

The evaluation of sheep meat texture revealed considerable variations in tenderness among the samples. According to the results showed in Figure 7, the highest proportion of samples (46%) were classified as less tender, indicating a significant firmness in the meat which could be associated with pathological changes following hydatid cyst infection, such as increased fibrosis or inflammatory reactions in the muscle tissue. In contrast, 35% of the samples demonstrated acceptable tenderness, reflecting relatively normal muscle

structure without severe alterations. Only 19% of the samples showed moderate tenderness, suggesting an intermediate degree of tissue modification. The observed predominance of less tender meat might reflect the impact of parasitic infection on the connective tissue, leading to increased collagen cross-linking or muscle degeneration.

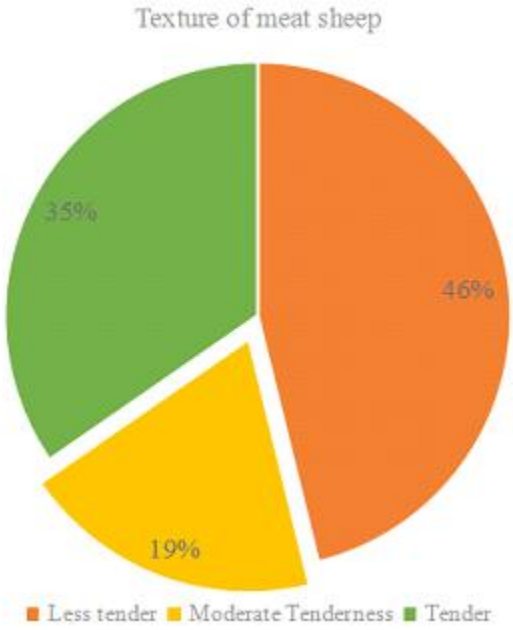

Figure (4): Distribution of meat texture characteristics in sheep infected with hydatid cyst

This study comprehensively investigated the impact of Echinococcus granulosus infection on the physicochemical properties (pH, moisture content, water activity, protein content, and ash content) and textural characteristics of various sheep tissues, including back meat, chest meat, thigh meat, liver, lung, and mesentery. The results indicated valuable insights into the pathological and biochemical alterations induced by hydatid cyst infection, contributing to the understanding of cystic echinococcosis (CE) in small ruminants.

DISCUSSION:

Our study observed a significant reduction in pH across back muscle (5.32 ± 1.14 vs. 6.63 ± 0.632, P = 0.012), chest muscle (5.66 ± 0.93 vs. 6.89 ± 0.852, P = 0.024), thigh muscle (5.01 ± 0.834 vs. 6.98 ± 0.132, P = 0.036), and liver (5.64 ± 0.35 vs. 7.24 ± 0.351, P = 0.013) in infected sheep compared to healthy controls. However, pH differences in lung (4.76 ± 0.51 vs. 6.83 ± 0.62, P = 0.24) and mesentery (5.71 ± 0.462 vs. 6.74 ± 0.134, P = 0.48) were not statistically significant. These findings suggest that hydatid cyst infection induces tissue acidosis, likely due to inflammatory processes, tissue damage, and metabolic shifts.

The observed pH reduction in muscle and liver tissues aligns with studies on parasitic infections affecting tissue biochemistry. For instance, Al-Bermani and Al-Dabhawi (2022) reported lower pH in the liver and muscle tissues of CE-infected sheep, attributing it to increased lactic acid production from inflammatory cell metabolism and tissue hypoxia caused by cyst-induced pressure. Similarly, Beigh et al. (2017) noted a significant pH decrease in infected sheep livers, linking it to hepatocellular damage and metabolic stress. The lack of significant pH changes in lung and mesentery tissues in our study may reflect less severe pathological involvement or higher biological variability, as suggested by Almogren et al. (2021) reports.

The pronounced pH reduction in thigh muscle (from 6.98 to 5.01) is particularly notable and may indicate severe metabolic disruption or localized ischemia, as described by Hidalgo et al. (2021) findings. These findings underscore the organ-specific impact of CE on tissue pH, with implications for meat quality and microbial susceptibility, as lower pH can enhance bacterial growth, as noted by Lawrie and Ledward (2006).
Our results demonstrated a statistically significant increase in moisture content across all tissues in infected sheep ($P < 0.05$), with the highest levels in the liver (26.8%) and back meat (26.7%) of infected sheep, compared to the lowest in the lung (18.3%) and chest meat (20.1%) of healthy sheep. This increased water retention is likely due to inflammatory edema and tissue damage, as cysts disrupt normal tissue architecture and promote fluid accumulation
These findings are consistent with Almogren et al. (2021), who reported elevated moisture content in CE-infected sheep tissues, particularly the liver, due to inflammatory exudates and fibrotic changes. Similarly, Beigh et al. (2017) observed increased hydration in infected livers, attributing it to cyst-induced pressure and vascular leakage. The higher moisture content in our infected samples may also reflect altered membrane permeability and cellular damage, as noted by Lawrie and Ledward (2006) reports.
The significant moisture increase in the liver and back meat suggests that these tissues are particularly susceptible to CE-induced pathological changes, possibly due to their high vascularity and exposure to larval antigens. The lower moisture content in healthy lung and chest meat aligns with their typically lower baseline hydration, as reported by Honikel (2010).
Our study found a significant reduction in protein and nitrogen content across all tissues in infected sheep ($P < 0.05$), with the most pronounced decreases in the liver and mesentery. This suggests that E. granulosus infection compromises the nutritional integrity of tissues, likely due to protein catabolism, cellular damage, and inflammatory processes.
These findings are supported by Al-Shabbani (2014), who reported decreased protein content in CE-infected sheep livers, attributing it to hepatocellular necrosis and metabolic stress. Similarly, Beigh et al. (2017) noted reduced nitrogen content in infected muscle tissues, linking it to muscle fiber degeneration and inflammatory cell infiltration. The significant protein loss in the liver and mesentery in our study may reflect the severe histopathological changes observed, such as fibrosis and necrosis, which disrupt normal protein synthesis and storage, as described by Almogren et al. (2021). This reduction has implications for meat quality, as lower protein content can affect nutritional value and texture, as discussed by Lawrie and Ledward (2006).
The ash content analysis revealed a significant reduction in the initial sample weight of infected tissues ($P = 0.011–0.047$), with notable decreases in back meat (11 ± 0.78 g vs. 14.19 ± 0.75 g), thigh meat (9 ± 1.34 g vs. 11.61 ± 1.28 g), liver (8 ± 1.04 g vs. 10.32 ± 0.99 g), lung (12 ± 1.43 g vs. 15.48 ± 1.36 g), and mesentery (8 ± 0.95 g vs. 14.19 ± 0.75 g). Although ash content percentages remained constant (1%), the lower ash weight in infected tissues suggests a reduction in both organic and inorganic components, likely due to tissue degradation and fluid accumulation.
These results align with Almogren et al. (2021) reports. The significant weight reduction in the mesentery is particularly striking and may reflect severe tissue disruption, as mesenteric cysts are less common but can cause extensive localized damage, as noted by Kumar et al. (2012). The consistent ash content percentage despite reduced tissue weight suggests that the mineral composition remains proportional, but the overall tissue mass is compromised, as supported by Honikel (2010) researchs, The texture analysis revealed that 46% of infected sheep meat samples were classified as less tender, 35% as acceptably tender, and 19% as moderately tender, suggesting that hydatid cyst infection significantly affects meat texture, likely due to increased fibrosis and inflammatory changes. The predominance of less tender meat aligns with Beigh et al. (2017) reportes. Similarly, Lawrie and Ledward (2006) noted that parasitic infections can increase connective tissue content, reducing meat tenderness.
The observed texture changes may be linked to the histopathological findings of fibrosis and inflammatory cell infiltration in our muscle tissues, as well as the reduced protein content, which can weaken muscle

structure, as described by Al-Shabbani (2014). These alterations have significant implications for meat quality, affecting consumer acceptability and economic value, as discussed by Honikel (2010).

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