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(Received: June 1, 2013; Accepted: August 11, 2013)

Abstract—This is a retrospective study aimed to investigate the different pathological conditions reported in livers of slaughtered cattle and sheep leading to their total condemnation at Alkadroo abattoir (A.A.), North Khartoum. From the available records, data of four years period (2009-2012) were obtained and analyzed. Most of the slaughtered cattle were brought from Ethiopia and sheep from Elgadarief state in east Sudan. Both cattle and sheep suffered from Fasciola (FA), liver cirrhosis (LC), liver abscess (LA), calcification (LCa), hydrated cysts (HC), fatty change (FG) and ictrus (IC). The prevalence of FA, LC, LA, LCa, HC, FG and IC in cattle was 91%, 1.76%, 2.80%, 2.26%, 1.05%, 0.03% and 0.40% respectively, while in sheep it was 0.19%, 3.39%, 77.75%, 11.38%, 3.45%, 0.83% and 3.07% respectively. The incidence of FA and LC were significantly higher in cattle compared to sheep and that of LA and LCa, FG and IC were significantly higher in sheep compared to cattle. In cattle, FA prevalence was mostly higher during winter compared to summer and autumn. It is concluded that records from slaughterhouses are very important monitors for animals’ prevailing diseases and their control plan. Liver is one of the important organs found to be affected by different pathogens which are of much concern to human, public health authorities and economists.

Index Terms—: Abattoirs liver diseases cattle sheep

I. INTRODUCTION

Slaughterhouses are valuable sources for information about food borne and zoonotic diseases epidemiology, actual losses in meat production and the economical impacts for condemnations [1]. However, zoonotic threats prevention and control remains one of the major aspects in the developing countries [2].

Meat inspection at abattoirs, for hygienic quality, involves both ante and postmortem examination which include gross and microbiological investigation [3,4]. Liver is one of the most important organs as it is involved in many metabolic disorders and parasitic diseases [5]. It may harbor pathogens [6] which are dangerous for human consumption when passed with localized or mild infection. However, the most common liver lesions which are harmful to human health are fasciola (FA), liver abscess (LA) and hydrated cysts (HC) [7].

FA is one of the most important parasitic diseases of livestock in the tropical and subtropical areas [8] with an enormous economical impact on livestock production [9]. Moreover, FA is one of the food-borne zoonoses as many people worldwide are infected with FA [10,11]. Previous studies indicated the prevalence of FA in Sudan [12,13,14,15,16,17]. Ethiopia, [13] reported high prevalence of FA (30-90%). The prevailing climatic - ecological conditions favor the existence of the intermediate snail hosts of both F. hepatica and F. gigantica [18]. Both trematodes are reported to be the common liver flukes of Ethiopian cattle and sheep [19].

Humans are incidental hosts for FA and it is considered now as zoonosis of major global importance by the World Health Organization [20]. Raising infected sheep and cattle and eating and drinking contaminated food and water increased the incidence of FA in human in the last 50 years [21]. However, as an endemic and epidemiological health problem [22,23,21] human FA could be underestimated because of its similarity to hepatobiliary diseases and those with symptoms of eosinophilia and abdominal pain should be examined for FA infestation [23].

Generally liver abscesses (LAs) are caused by bacterial infection brought by blood from several sources mainly the portal vein [24,25]. Furthermore, diet became one of the important factors, as feeding more carbohydrates during sheep fattening results in rumenitis [26]. Liver abscess ends in calcified centers (LCa) due to caseous necrosis surrounded by polymorph-nuclear neutrophils and some mono nuclear cells [27]. However, liver fatty changes (FG) develop when liver, in response to acute infections, tends to isolate and neutralize pathogens to prevent their further entry and minimizes tissue damage [28]. Liver ictrus (IC) and congestion (CON) are sequel for liver damage and reflect liver failure in bilirubin and internal blood passage [29], these changes in liver tissue result in liver cirrhosis (LC).
Hydatiosis (HC) is one of the most parasitic zoonoses caused by the larval stage of *Echinococcus granulosus* (*E.granulosus*) and man is one of the intermediate hosts, where dogs are the definite hosts [8,30]. The prevalence of HC became one of the public health problems and economical loss due to condemnation of the edible organs infected by HC [31]. Several studies reported the prevalence of hydatidosis in Sudanese [32,33,34] and Ethiopian [35,36] cattle and sheep. In human, the diagnosis of HC prevalence needs modern diagnostic facilities, however, high incidence of HC in Maasia population were reported in Tanzania [37] which was attributed to the large population of stray dogs and improper disposal of abattoir organs.

In Sudan, meat and liver examination in the slaughterhouses are of much concern as eating raw meat and liver (Marara and umfitfit) is one of the Sudanese traditions.

Therefore this study aimed to investigate the prevalence of different liver lesions, their zoonotic importance and economical impacts for slaughtered cattle and sheep at Alkadaro abattoir during the period from 2009-2012 where most of the cattle were brought from Ethiopia.

### II. MATERIALS AND METHODS

**Area of data collection:** This work was done at Alkadaroo Abattoir (AA) located at Khartoum North 15° 50’N ,32° 33’E at Oum Elgora Janoob area. Where animals brought from different areas are slaughtered. In this study cattle are mainly brought from western Ethiopia and sheep from northern Kordofan and Elgadarief in east Sudan.

**Data collection:** From the available records during the study period (January,2009-december,2012), data for the total number of slaughtered cattle and sheep and grossly detected liver lesions at AA were obtained and utilized.

**Condemned livers cost:** To calculate the cost of condemned livers, the whole cattle and sheep liver, weights (W.T) and prices were randomly obtained from 20 meat centers in Khartoum. The average W.T and prices were obtained for each and the price of total livers condemned was computed in terms of Sudanese pounds(SG) and American dollars($) .

**Statistical Analysis:** The data obtained were evaluated by two way analysis (ANOVA) using the statistical software SPSS [38], results obtained are presented as mean±SD.

### III. RESULTS AND DISCUSSION

Table 1 and 2 respectively, show the total number of slaughtered cattle and sheep at Al kadaroo Abattoir (AA) and the total number of different grossly detected liver affections throughout the study period. Compared to the total number of sheep slaughtered, the total number of affected and condemned livers was 1564(0.84%) this value was lower than that reported for cattle, 5793(9.29%). This result could be related to the high prevalence of fasciola (FA) infestation in cattle, 5272 (91%) amongst the other liver lesions (Table1). This high values reported for FA could be associated with the increased number of cattle brought from Ethiopia to AA according to the available records. Similar higher values for FA were reported in Ethiopia (90.7%) [39].

The mean values for FA prevalence throughout the study period were also higher compared to other liver lesions (Fig.1). This predominance of FA is accounted for by the high numbers of cattle brought from Ethiopia during the experimental period. Cattle owners changed their local markets due to the high prices of local cattle and taxes applied by the local authorities through their way from the local markets up to the slaughterhouses. This high prevalence of FA coincides with the findings of [40,41,18] in Ethiopian cattle. The level of FA reported in this study, showed an increasing trend with the maximum level in 2011 after which it declined (Fig.3). However, the observed decrease in FA prevalence during 2012 (Fig3) could be attributed to owners' attention and orientation about the Ethiopian cattle health and to their associated economical loss.
Table 1  
Number of slaughtered cattle and incidence of liver lesions.

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of slaughtered cattle</th>
<th>Facioliasis</th>
<th>Cirrhosis</th>
<th>Abscess</th>
<th>Calcification</th>
<th>Haydated cyst</th>
<th>Fatty changes</th>
<th>Ictrus</th>
<th>Congestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>14451</td>
<td>1242</td>
<td>16</td>
<td>9</td>
<td>53</td>
<td>17</td>
<td>0</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>2010</td>
<td>14245</td>
<td>1387</td>
<td>21</td>
<td>22</td>
<td>24</td>
<td>12</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>18435</td>
<td>1841</td>
<td>24</td>
<td>64</td>
<td>18</td>
<td>10</td>
<td>0</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>2012</td>
<td>15202</td>
<td>802</td>
<td>41</td>
<td>67</td>
<td>36</td>
<td>22</td>
<td>2</td>
<td>7</td>
<td>20</td>
</tr>
</tbody>
</table>

Total number of affected livers: 5793.

Table 2  
Number of slaughtered sheep and incidence of liver lesions.

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of slaughtered sheep</th>
<th>Facioliasis</th>
<th>Cirrhosis</th>
<th>Abscess</th>
<th>Calcification</th>
<th>Haydated cyst</th>
<th>Fatty changes</th>
<th>Ictrus</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>67058</td>
<td>0</td>
<td>10</td>
<td>196</td>
<td>28</td>
<td>15</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>2010</td>
<td>48655</td>
<td>0</td>
<td>15</td>
<td>230</td>
<td>42</td>
<td>11</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>2011</td>
<td>35374</td>
<td>0</td>
<td>14</td>
<td>222</td>
<td>39</td>
<td>17</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>2012</td>
<td>34897</td>
<td>3</td>
<td>13</td>
<td>568</td>
<td>69</td>
<td>11</td>
<td>0</td>
<td>23</td>
</tr>
</tbody>
</table>

Total number of affected livers: 1564.

Table 3  
Liver lesions incidence in cattle and sheep/2009-2012 (mean±SD).

<table>
<thead>
<tr>
<th>Species</th>
<th>Facioliasis</th>
<th>Cirrhosis</th>
<th>Abscess</th>
<th>Calcification</th>
<th>Haydated cyst</th>
<th>Fatty changes</th>
<th>Ictrus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>1318±428.30</td>
<td>25.5±10.84</td>
<td>40.5±29.38</td>
<td>32.75±15.43</td>
<td>15.25±5.38</td>
<td>0.5±1.00</td>
<td>5.75±1.89</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.75±1.5</td>
<td>13±2.16</td>
<td>304±176.60</td>
<td>44.5±17.41</td>
<td>13.5±3.00</td>
<td>3.25±2.5</td>
<td>12±7.34</td>
</tr>
</tbody>
</table>

Means values within the same column bearing different superscripts are statistically different.
In sheep, liver abscess (LA) represented 77.75% out of other liver lesions reported (Table2) and the higher mean values throughout the study period compared to the other liver lesions (Fig.2), while in cattle it was represented by 2.80% only. This high value of LA reported in sheep could be accounted for by feeding sheep rations high in grains for fattening purposes. In grain overload, lactic acidosis and rumenitis occur leading to erosion of ruminal epithelium which allows bacterial growth [42]. Similarly, high prevalence of LA were reported in fattened sheep [43] and in cattle as a result of chronic rumenitis [44]. However, Tadepalli et al.[45] indicated that liver abscess originates from a necrobacillary rumenitis caused by *fusobacterium necrophorum*, a normal ruminal microflora, which invades the hepatic portal vein. This study had the higher values compared to previous studies in sheep LA [46,47,48]. Compared to the previous years, and to the number of sheep slaughtered in 2012 the prevalence of LA was higher and this was closely associated with the number of infected sheep (Table2).

Compared to values reported in sheep, cattle had a significantly higher prevalence of FA (p<0.001)(Table3). This response is closely related to the high prevalence of FA reported in cattle (Table1). Similar high values of FA in cattle were reported in Malaysia (88.7%) [49], Tanzania, (87%) [50] and Nigeria [51].

Furthermore, liver cirrhosis (LC) was also significantly higher(p<0.05) in cattle compared to sheep(Table3) this could be associated with the damage of liver cells induced by liver fluke migration and increases of connective or fibrous tissue. It was indicated that LC is concomitant to liver parenchymal damage and atrophy in response to FA infestation [53]. Similar findings were reported [50,7]. Although the incidence of hydatosis (HC) was higher in cattle compared to sheep, but it did not attain the significance level.

Compared to cattle, the prevalence of LA was significantly (p<0.001) higher in sheep (Table3). This finding could be related to the infection that may occur to sheep in early ages. Fetcher [6] reported that, in lambs LA can be caused by septicaemia or an extension of umbilical vein infection. Moreover, the occurrence of LA was reported to be in all breeds, sexes and ages of sheep [43]. However, management practices and nutrition differences may play a great role.

Liver calcification LCa (Table3) was significantly (p<0.05) higher in sheep compared to cattle. This could be associated with the high prevalence of LA. Similar findings were reported by Swai and Ulicky [50]. Furthermore, the significantly higher values (p<0.05) reported for liver fatty change (FG) in sheep compared to cattle could be associated with the amount of concentrates fed and the reaction of the immune system. During rumenitis, the rumen produces endotoxines [53] these endotoxins are removed from circulation by activated lipoproteins which are removed by liver [54] resulting in high amount of fat trapped in liver tissues [55]. Similar results for liver FG were reported in sheep [7].

Icterus(IC) was significantly higher (p<0.05) in sheep than that reported in cattle(Table3). This is associated with the obstruction of bile ducts. As a result of LA and FG and swelling of damaged liver cells, bile canaliculi are obstructed leading to intra hepatic obstruction and accumulation of unconjugated bilirubin [52].

The prevalence of FA showed seasonal pattern during the experimental period. It was higher during winter in 2009, 2010 and 2012 compared to summer and autumn (Fig4). The seasonal pattern reported in the prevalence of FA (Fig4) could be related to the time when cattle were brought to AA and the variation in the climate-ecological conditions in western half of Ethiopia mainly the rain fall [56,57] the abundance of snail and cattle/ water contact [58]. The different living stages of FA require optimum temperature (above 10°C) and humidity to develop and the moist environment is rather than the dry [5]. The increased incidence of FA reported in this study during winter coincides with the period following the wet season of rain fall peak (June-September) [57] of rich pastures which may be contaminated with snails and cattle harboring the infection for 10-12 weeks[59] until winter season. However, the high values reported for FA during summer (Fig4) compared to the other respective months is explained by seasonal migration of cattle during the dry season (November-February) followed by a short rain period from March to April [57] in search for pools and damp pastures which are contaminated with snails. Similar seasonal pattern in FA occurrence were reported [60,61,50].

In this study, the overall estimated losses in cattle W.T due to FA and all different lesions were 18452 and 20275.5 Kg respectively. However, in sheep, the overall estimated losses in liver W.T were 1301 and 1600 Kg due to liver abscesses and all different lesions respectively. The respective losses, as a result of liver condemnation, in cash was 1,164,969 SG and valued at 194,161.5 $ for both cattle and sheep. Similar results reported huge economical losses due to liver affection and condemnation [62, 63].

IV. CONCLUSIONS

1- Slaughterhouses are safe guards for human health and can be pools for zoonoses dissemination with the lack of condemned organs follow up and incineration.

2- The prevalence of fasciolaisis and other liver lesions in cattle and sheep needs more joint work with medical and public health researchers in human zoonosis in and out slaughterhouses.

3- Public health extension awareness about the risks of eating raw livers and meat and dealing with infected and pet animals are highly required.
4- The local authorities regulations should support animals’ owners and encourage meat industry.

ACKNOWLEDGEMENTS

The author would like to thank Dr.Hatim, M.A. General Director of Alkadroo Abattoir, Dr.Huda A.M and Dr.Ahmed K. for their unlimited help for availing the required data of this work.

REFERENCES


