Evaluation of bacterial contamination and heavy metals in cow and camel meat

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ABSTRACT

This study examined 75 samples of raw meat from cows and camels sold in local marketplaces in the governorate of Najaf, Iraq, for bacterial load and heavy metal contamination. The culture results were classified into 10 types involving E. coli (36-90%) (31-88.5%), Enterobacter spp. (7-17.5%) (3-8.5%), Pseudomonas spp. (10-25%) (8-22.8%), Klebsiella spp. (3-7.5%) (4-11.4%), Staphylococcus aureus (4-10%) (5-14.2%), Staphylococcus epidermidis (5-12.5%) (5-14.2%), Proteus spp. (5-12.5%) (6-17.1%), E. coli 0157 (6-15%) (2-5.7%), Yersinia enterocolitica (3-7.5%) (4-11.2%), and Salmonella spp. (3-7.5%) (4-11.2%), from cows and camels respectively. The averages of heavy metals concentrations in cow meat samples were 0.54±0.25, 0.50±0.18, 0.33±0.22, 0.22±0.25, 1.0±0.25 mg/kg; however, in camel meat samples were 0.27±0.20, 0.31±0.12, 0.26±0.11, 0.17±1.5 and 0.5±0.15 mg/kg for Lead (Pb), Cadmium (Cd), Copper (Cu), Nickel (Ni) and Zinc (Zn) respectively. The presence of significant levels of pathogenic microorganisms and metals in the meat samples indicates poor sanitation and hygiene practices during dealing with meat through steps of production, packaging, transportation, and storage, and the high amounts of heavy metal contamination in the environment, which will have an impact on the meat and milk animal products.

Keywords: heavy metals, bacterial contaminations, bacterial load, cow, camel meat
INTRODUCTION

In cattle feeds, minerals make up a relatively minor fraction of the total dry matter consumption, and they are often forgotten in a livestock dietary strategy. Minerals are essential for the healthy growth of bones, immunity, muscular movements, and the neurological system in cattle and buffalo, even though they only constitute a relatively minor portion of the diet's contents (Al-Perkhdri et al., 2022; Sabow et al., 2021).

Cattle development and reproductive performance may be impaired if a vital mineral diet is not in action. At least 17 unique mineral groups must be included in a cow's nutrition. Based on the amounts needed in cattle feeds, necessary minerals are categorized as either macro-minerals or micro-minerals, referred to as trace minerals. Micro-minerals demand milligrams or micrograms daily, but macro-minerals require higher amounts and are measured in grams daily (Khalafalla et al., 2010; Emami et al., 2023).

Cattle need different minerals, such as macro-minerals, including calcium, magnesium, phosphorus, and others. Furthermore, micro-minerals are also essential for animals, including chromium, cobalt, copper, nickel, cadmium, and zinc, in contrast to more significant minerals. Different minerals have various nutrient needs depending on the animal's age, weight, breed, stress condition, and mineral bioavailability from the feed. While micro-mineral needs are commonly reported in milligrams per kilogram, equal to parts per million; however, micro-mineral requirements are typically represented as a percentage of the overall diet (ppm) (Zadi-Karam et al., 2017; Al-Naemi et al., 2020).

Cattle over consume minerals for various causes, including increased harmful metal levels in the wild water system. For example, cobalt may be found naturally in water, soil, animal faeces, waste facilities, coal power, and furnaces. Zinc waste results from burning trash, refining ores, and mining; copper toxicity comes from burning fossil fuels, garbage, making wood, and phosphate fertilizers. Lead is regarded as a harmful element that is closely associated with processes and acts to impair their actions on the blood and nervous system. The technical modification and improvement of food items is another factor that has raised the risk of dietary poisoning with different environmental contaminants, particularly hazardous contaminants (Al-Perkhdri et al., 2021; Al-Nasiry et al., 2021).

Food is the primary route for most elements to reach the organs because environmental degradation introduces contamination into the food system. Several infectious microorganisms, including those classified as foodborne pathogens that spread food-borne illness, such as Enterobacteriaceae, Lactobacillus spp., Leuconostoc spp., Pseudomonas spp., and Bacillus spp., thrive and develop most in the presence of meat (Al-Naemi et al., 2020; Hadab et al., 2022).
Both people and food manufacturers consistently use ambient antiseptics to prevent spoilage. Due to rising customer demand for minimally packed goods, preferably those made with natural components, this utilisation is projected to gradually increase over the following months. More often, consuming fresh and lightly processed meats has led to the emergence of novel ecological routes for microbial growth. Due to these concerns and the growing adoption of organic products, natural ingredients that effectively suppress a wide range of undesirable microorganisms in meats have grown increasingly well-liked (Al-Nasiry et al., 2021; Al-Gburi et al., 2017).

Toxic metals generally have a more excellent shelf life and are less prone to disintegration and breakdown. Yet, there is a chance that they might accumulate in various human organs and cause harmful side impacts. Moreover, several microorganisms might be isolated from contaminated foods from nearby meat markets. Hence, the meat's contamination with these residues resulted from the animals' consumption of these contaminants. To determine the hygienic state of cow and camel meat supplied in the food store in Najaf governorate/ Iraq and to determine the amount of heavy metals extracted from large meat samples, the present study's objectives were established (Al-Perkhdri et al., 2022; Al-Naemi et al., 2020; Hadab et al., 2022).

**Materials and Methods**

Sample collection

Seventy-five samples of raw Cow and Camel meat (500) grams each were collected from markets in Najaf governorate/ Iraq and then sent in a cool box to the microbiology laboratory for isolation and identification of Enterobacter spp., E. coli, and S. aureus, S. epidermidis, Bacillus spp., Pseudomonas, E. coli O157, Yersinia enterocolitica, Salmonella, and Klebsiella; and then to detection heavy metals (Lead, Nickel, Cadmium, Copper, and Zinc).

Isolation and identification of bacteria

Twenty-five grams of each meat sample was inoculated into (225) ml of Trypticase soy broth (No. BD 236950 - Fisher Scientific - Canada) and incubated at (37 °C). After incubation, about 0.1 ml of inoculated broth was subcultured onto Nutrient agar plates (No. W51 - HARDY - USA) and MacConky agar (No. P47 - HARDY – USA). Blood agar, Eosin methylene blue agar (No. P09- HARDY - USA), Salmonella Shigella agar (No. G327- HARDY – USA), Sorbitol-MacConky agar with cefixime tellurite (R110241 - Thermo-Scientific - Canada) and CIN agar (R452942 - Thermo-Scientific – Canada). Biochemical tests are performed using the Vitek 2 system (VITEK® 2 Compact 30 - bioMérieux, Inc. - France).
Heavy metals analysis

One hundred grams of each meat sample were kept in the oven at (80 °C) for 48 hours. Concentrated HNO₃ was added to the dried meat powder for the heavy metals analysis. (0.5 g of dried meat with 5ml of concentrated HNO₃; then taken into the digestion flask and heated at 80-90 °C for 10 minutes by placing on a hot plate, then raised to 100 °C, and more acid was added up to 3-5 ml until a clear solution was observed. The samples were filtered through filter paper after cooling at room temperature, and the volume was raised to 25 ml with the help of non-ionized water metals in the meat samples (FAAS, Shimadzu AA-7000F).

Statistical Analysis

The SAS software (Version 17) was applied to this investigation to identify how various factors affected the study’s variables. In this work, a significant comparison of means was made using the least significant difference (LSD) test (ANOVA).

Results and Discussion

The result illustrated from 75 meat samples submitted from cow’s 40, camels 35. The culture results were classified into ten categories; *E. coli* (90% cows, 88.5% camels), *Enterobacter* spp. (17.5% cow, 8.5% camels), *Pseudomonas* spp. (25% cows, 22.8% camels), *Klebsiella* spp. (7.5% cows, 11.4% camels), *Staphylococcus aureus* (10% cows, 14.2% camels), *S. epidermidis* (12.5% cows, 14.2% camels (12.5% cows, 17.1% camels), *E. coli O157* (15% cows, 5.7% camels), *Yersinia enterocolitica* (7.5% cows, 11.2% camels), and *Salmonella* (7.5% cows, 11.2% camels), as shown in Table 1. The mean of Pb, Cd, Cu, Ni, and Zn concentrations in examined meat samples were 0.54 ± 0.25, 0.50 ± 0.18, 0.33 ± 0.22, 22.0 ± 2.5 and 1.0 ± 0.25 mg/kg in cow meat samples and 0.27 ± 0.20, 0.31 ± 0.12, 0.26 ± 0.11, 17.5 ± 1.5 and 0.5 ± 0.15 mg/kg in camel meat samples respectively (Table 2).

On the other hand, Table 2 shows the results of heavy metals from cows and camels, which displays the different concentrations. The higher results were found in the cow meat compared to camels. However, the heavy metals demonstrated as Lead (0.54 – 0.27), Cadmium (0.50 – 0.31), Copper (0.33 – 0.22), Nickel (22.0 – 17.5), Zinc (1.0 – 0.5), from cows and camels respectively.

In several studies, Gram-positive and Gram-negative harmful bacteria were examined for their microbiological and biological activity in diverse meat samples from various farm animals. Recent research in Najaf governorate/ Iraq has seldom ever compared the two types of meat. It was determined that the heavy metals were somewhat impacted by the bacteria found in meat (Al-Gburi et al., 2017; Alebie et al., 2021; Saad et al., 2018). Although bacterial types were assessed in the current study, the present outcomes indicated that the biochemical identification of bacteria needs...
more effectiveness. This could significantly increase the shelf life of meat. These results correlated with literature reports (Abdlla et al., 2023; Tahr Jawher et al., 2022), which found a notable variation in the level of several metals, some of which were found at excessive quantities over the acceptable threshold, and the presence of harmful bacteria over most samples. It has grown mandatory for feed producers to continuously note and preserve the standard limits of contaminants in cattle diets to ensure food hygiene and prevent metal contamination.

To maintain heavy metal levels within acceptable ranges, feed producers must continuously monitor the presence of heavy metals in their products. Toxic metals often play a role in maintaining a variety of bodily activities in modest doses; when these substances are elevated over the recommended limits, cell metabolism is disrupted, leading to poisoning (Tahr Jawher et al., 2022; Njoga et al., 2021). Many harmful chemical elements were widely introduced into the environment, contaminating the water supply and accumulating in the soil in various combined forms. In addition to absorbing toxic chemicals and metals that animals ingest and collect in their flesh, plants also absorb nutrients from the soil. Hence, plants are fundamentally responsible for the food shop’s pollution (Al-Naemi et al., 2020; Al-Nasiry et al., 2021; Al-Rudha et al., 2021).

Several combating stressors along the chain, from fields to stores to customers, influence adaptable changed meals for the tenacious and bacterial-resistant (Sabow et al., 2021; Abdlla et al., 2023; Al-Rudha et al., 2021). The capacity to live in various flexible ways, most notably by deploying coordinated biofilm defences, is improved via a sequence of metabolic changes accumulating resistance to stressors. According to literature data (Abdulhussein et al., 2022; AbdAl-Rudha et al., 2020), who made the argument that a wide range of methods might be utilized to enhance the offer of metal-based meat substitutes based on ways to lower agro-environmental factors on the food chain, knowing the biological function of these bacterial processes that emerge in the meat naturally or incursions would be created via realizing the dataset and hygienic routines (Muñoz-Elías et al., 2005; Dakheel et al., 2023).
Table 1. The percentage of isolated bacteria from meat samples

<table>
<thead>
<tr>
<th>Isolated bacteria</th>
<th>No. of isolate (cow)</th>
<th>%</th>
<th>No. of isolate (camel)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. coli</em></td>
<td>36/40</td>
<td>90%</td>
<td>31/35</td>
<td>88.5%</td>
</tr>
<tr>
<td><em>Enterobacter</em> spp</td>
<td>7/40</td>
<td>17.5%</td>
<td>3/35</td>
<td>8.5%</td>
</tr>
<tr>
<td><em>Pseudomonas</em> spp</td>
<td>10/40</td>
<td>25%</td>
<td>8/35</td>
<td>22.8%</td>
</tr>
<tr>
<td><em>Klebsiella</em> spp</td>
<td>3/40</td>
<td>7.5%</td>
<td>4/35</td>
<td>11.4%</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>4/40</td>
<td>10%</td>
<td>5/35</td>
<td>14.2%</td>
</tr>
<tr>
<td><em>Staphylococcus</em> epidermidis</td>
<td>5/40</td>
<td>12.5%</td>
<td>5/35</td>
<td>14.2%</td>
</tr>
<tr>
<td><em>Proteus</em> spp</td>
<td>5/40</td>
<td>12.5%</td>
<td>6/35</td>
<td>17.1%</td>
</tr>
<tr>
<td><em>E. Coli</em> O157</td>
<td>6/40</td>
<td>15%</td>
<td>2/35</td>
<td>5.7%</td>
</tr>
<tr>
<td><em>Yersinia enterocolitica</em></td>
<td>3/40</td>
<td>7.5%</td>
<td>4/35</td>
<td>11.2%</td>
</tr>
<tr>
<td><em>Salmonella</em> spp</td>
<td>3/40</td>
<td>7.5%</td>
<td>4/35</td>
<td>11.2%</td>
</tr>
</tbody>
</table>

Table 2. The percentage of heavy metals mg/kg in cow and camel meat samples

<table>
<thead>
<tr>
<th>Heavy Metals</th>
<th>Cow meat /100g</th>
<th>Camel meat /100g</th>
<th>* Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead (Pb)</td>
<td>0.54 ± 0.25</td>
<td>0.27 ± 0.20</td>
<td>&lt; 0.2</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.50 ± 0.18</td>
<td>0.31 ± 0.12</td>
<td>&lt; 0.5</td>
</tr>
<tr>
<td>Copper CU</td>
<td>0.33 ± 0.22</td>
<td>0.26 ± 0.11</td>
<td>&lt; 0.3</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>0.22 ± 2.5</td>
<td>0.17 ± 1.5</td>
<td>&lt; 0.2</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>1.0 ± 0.25</td>
<td>0.5 ± 0.15</td>
<td>&lt; 1.0</td>
</tr>
</tbody>
</table>

Maximum Permissible Level (MPL) in mg/100g of Cattle meat; (mean ± SE) (WHO, 2011)

CONCLUSION

One of the most significant sources of metal contamination in humans that might lead to the emergence of various illnesses is a diet of meat tainted with toxic metals. The investigation results painted an overview of the level of meat contamination (cows and camels) with heavy metals in local markets of Najaf governorate/ Iraq. Most of the research under consideration asserted that heavy metal concentrations in samples were more significant than the acceptable limits suggested by international standards and may be harmful to the wellness of humans. Thus, preventive and legislative steps about the causes of
poisoning stated above have to be taken to limit disease in meat products in this governorate, especially bacterial contamination. It is advised to regularly check for toxic metals in the surroundings and livestock products and to produce meat following global requirements. Furthermore, action must be taken now to limit future pollution levels and their suppliers.

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REFERENCES


