Can Bovine Tuberculosis Hide in the Beef and Game Meat We Eat?

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INTRODUCTION - Bovine tuberculosis
• Infectious disease, closely related to human tuberculosis, which affects livestock, wildlife and humans
• Chronic progressive disease
• Cattle:
  – Occurs in all provinces of SA (herd prevalence: SA: < 0.2%), Mozambique, Zambia, Tanzania etc.
  – Zimbabwe, Botswana?
• Wildlife
  – Very broad host spectrum
  – Confirmed in 14 animal species in GKNPC, HiP (incl. buffalo, kudu, warthog, etc.)
  – Recent spread to Gonarezhou confirmed
  
Eradication: mission impossible?

INTRODUCTION – Zoonotic tuberculosis
• Low - moderate susceptibility in immunocompetent individuals
• Increased risk for young children, elderly and immunocomprised individuals, esp. under prolonged exposure
• Significance at present?
  – EU: 60 cases per year
  – Latin America: 7000 new cases per year
  – Mexico: 13.8% (of TB patients)
  – Africa: prevalence???
    • Nigeria: 5%
    • Tanzania: 18 – 30%
    • South Africa: unknown
    • WHO estimate: 10% of sputum samples may be positive

INTRODUCTION – Zoonotic tuberculosis (2)
• Neglected zoonotic disease (WHO)
• Spillover of *M. tuberculosis* to cattle?
• Transmission via close contact with infected animals, infected raw milk & dairy products
What about edible tissues?

- Carcass meat
- Organ tissues
- Risk ultimately depends on secondary processing
  - cooking
  - drying (biltong)

Objectives

**Study 1**
- To determine the survival of *M. bovis* in uninfected, spiked organ and muscle tissue samples from cattle subjected to standard secondary meat processing protocols (cooking and drying)

**Study 2**
- To determine the survival of *M. bovis* in organ and muscle tissues of naturally infected buffalo and kudu under standard secondary meat processing protocols

**Game meat**

Game industry has developed into a fully-fledged supplier of meat to local and international markets

- Increasing demand for game meat as an important protein source for a growing population.
- Harvesting on small scale (hunters) or larger scale operations
- Secondary processing and preserving of red meat: by cooking or drying (biltong)

**MATERIALS AND METHODS – Tissue samples**

**Study 1**
Bovine tissues collected from 8 carcasses (uninfected) at the abattoir (total: 48 samples):
- Muscle, kidney, liver, heart, lung and lymph nodes (Lnn mandibulares and parotideus)

**Study 2**
Muscle, kidney, liver, heart, lung and lymph nodes (Lnn mandibulares and parotideus) collected from the carcasses of 7 buffalo and 7 greater kudu with tuberculous lesions
Total: 84 samples
MATERIALS AND METHODS

• Spiking of tissue samples with *M. bovis* (study 1)
  
  Dose: $8 \times 10^7$ injected into each tissue sample (multiple sites)

MATERIALS AND METHODS - Processing of tissue samples (study 1 & study 2)

Cooking
  
  2 time periods: a) 10 minutes  
  b) 20 minutes

Drying (biltong making)
A hurdle effect of preservation (salt, pH and drying) was reached by:

• Cutting of meat strips from the diaphragm (20 g each),  
• Curing (12–18 hours) thereof in a standard mixture of salt, sugar (optional), vinegar and spices (only as a flavouring)  
• Drying in a biohazard cabinet (class II)

Mycobacterial culture: according to standard procedures

RESULTS

• Spiked tissues:
  – Drying (biltong): no isolation of *M. bovis*  
  – Cooking: Lung samples: no isolation of *M. bovis*  
    • Muscle, lymph nodes, liver, kidney, heart: overall isolation of *M. bovis* from 2.9% of culture slants  
    – no statistically significant difference between 10 and 20 min cooking time

• Naturally infected tissues:
  – Drying: no isolation of *M. bovis*  
  – Cooking: no isolation of *M. bovis*

BUT
Isolation of high numbers of non-tuberculous mycobacteria (NTM) from 4/7 buffalo and 1/7 kudu

Isolation of NTM from organ tissues of wildlife

<table>
<thead>
<tr>
<th>Tissue and treatment type</th>
<th>Buffalo</th>
<th>Kudu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung (n=7); t = 10 min</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(n=7); t = 20 min</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Muscle (n=7); t = 10 min</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(n=7); t = 20 min</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lymph node (n=7); t = 10 min</td>
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<td>0</td>
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<tr>
<td>(n=7); t = 20 min</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Liver (n=7); t = 10 min</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>(n=7); t = 20 min</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Kidney (n=7); t = 10 min</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(n=7); t = 20 min</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Heart (n=7); t = 10 min</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>(n=7); t = 20 min</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

Density and consistency of the tissue influences survival of microorganisms
Meaning what?

• NTM are abundant in the environment and mostly non-pathogenic to humans and animals
• Cause interference in immune response to BCG vaccine & cross-reactivity in TB diagnosis
• Some NTM species are recognised opportunistic pathogens (mycobacterioses)
• An increasing number of NTM have been identified as cause of complicating infections in immuno-compromised patients (M. avium, M. fortuitum, M. kansasii etc.)

CONCLUSION

• The zoonotic threat from M. bovis through consumption of cooked meat or biltong (low water content) from infected cattle, buffalo and kudu is minimal/negligible
• However, the detection of NTM in 4/7 buffalo (multiple organs) and 1/7 kudu raises concern as they were resistant to both the cooking and drying (pH, salt, dehydration) processes
• Significance for human health unknown – warrants further investigation (distribution, speciation)
• Take home message?

Never be too careful about food safety!
Biltong

- Strips of meat (beef or game) preserved by drying under the influence of salt, vinegar and spices
- Typically dried in the cold air (rural settings), cardboard or wooden boxes (urban) or climate-controlled dry rooms (commercial).
- Exported to Australia, New Zealand, USA (FDA approved)