Identification of Species in Commercially Sold Game Meats using DNA Barcoding

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Identification of Species in Commercially Sold Game Meats Using DNA Barcoding

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Abstract

DNA Barcoding

Unknown species

Unknown barcode region

Buffalo identified

DNA barcoding is an organism identification system based on sequencing a universal specific genetic region (Hebert and others 2003). In animals, the gene coding for cytochrome c oxidase subunit 1 (COI) is used as the barcode. Similar to a Universal Product Code (UPC) present on grocery, the COI serves as a code to identify a species (Figure 1). To identify a species, the COI gene sequence is compared to a database to find the top-species match.

Food Fraud, A Global Concern

Food fraud, in the form of ingredient substitution and mislabeling, has been observed globally (Johnson 2014). Intentional substitution of meat species may be for economic gain or to avoid import restrictions for exotic meat. Although the reason behind substitution is important, it is equally imperative to understand if mislabeling is a factor in the continued decline of threatened or endangered species (Knauss and Morrissey 2009).

Game meats are animals and birds not included in the Meat and Poultry Act (FDA 2012) such as rabbit, bobcat, and venison. Due to differences in retail prices between game meats and livestock such as beef, there is high economic motivation for species substitution to occur (ERS 2014). Although mislabeling has occurred globally in the marketplace and negatively impacted conservation efforts (D’Amato and others 2013) there is a lack of information on mislabeling of game meats in the United States.

Introduction

DNA Barcoding

Unknown species

Universal Barcode region

Milk identified

DNA Barcoding

Figure 1. DNA Barcodes identify species similar to grocery barcodes identifying products.

Figure 2. Overview of methods utilized to identify the species of a game meat product

A total of 54 game meat products representing 22 game species were collected in this study from four online retail sources in the United States. Species identification was determined using methods shown in Figure 2. DNA extraction of -10 mg of tissue sample was completed with DNeasy Blood and Tissue Kit (Qiagen). The COI region of DNA was amplified with polymerase chain reaction (PCR) using a mammalian primer cocktail described by Ivanova (2012). The amplified COI was sent out for sequencing and the genetic code was queried in the Barcode of Life Database (BOLD) for species. Samples identified as potentially mislabeled were subjected to re-extraction and sequencing for confirmation.

Method Overview

Samples collected

Unknown species

Unknown product

Universal Product Code (UPC)

Milk identified

DNA extracted

Polymerase chain reaction (PCR)

DNA barcode sequenced

Species identified

Labeling status assessed

Figure 2. Overview of methods utilized to identify the species of a game meat product

Table 1. Products potentially mislabeled for economic gain

<table>
<thead>
<tr>
<th>Distributor</th>
<th>Sample ID</th>
<th>Product label</th>
<th>Retail price (USD)</th>
<th>Cut</th>
<th>Identified species</th>
<th>Retail price of identified species (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A18</td>
<td>Antelope</td>
<td>$41.78/kg</td>
<td>Sirloin steak</td>
<td>Bison (Bison bison c)</td>
<td>$55.16/kg</td>
</tr>
<tr>
<td></td>
<td>A12</td>
<td>Beef</td>
<td>$10.75/kg</td>
<td>Sirloin steak</td>
<td>Bison (Bison bison c)</td>
<td>$11.16/kg</td>
</tr>
<tr>
<td></td>
<td>A49</td>
<td>Beef</td>
<td>$75.55/kg</td>
<td>Rib eye steak</td>
<td>Domestic cattle (Bos</td>
<td>$15.12/kg</td>
</tr>
<tr>
<td></td>
<td>B17</td>
<td>Beef</td>
<td>$13.35/kg</td>
<td>Leg quarters</td>
<td>Red deer musk (Cervus</td>
<td>$3.71/kg</td>
</tr>
<tr>
<td>A</td>
<td>A41</td>
<td>Red deer</td>
<td>$61.73/kg</td>
<td>Loin chop</td>
<td>Alpaca (Lama pacos)</td>
<td>$44.07/kg</td>
</tr>
<tr>
<td></td>
<td>A28</td>
<td>Yak</td>
<td>$62.98/kg</td>
<td>Sliced steak</td>
<td>Domestic cattle (Bos</td>
<td>$16.46/kg</td>
</tr>
</tbody>
</table>

Products listed in this table indicate the retail price of the purchased product is higher than the retail price of the substituted identified species resulting in potential economic profit.

Table 2. Products potentially mislabeled due to mishandling

<table>
<thead>
<tr>
<th>Distributor</th>
<th>Sample ID</th>
<th>Product label</th>
<th>Retail price (USD)</th>
<th>Cut</th>
<th>Identified species</th>
<th>Retail price of identified species (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A10</td>
<td>Alligator</td>
<td>$17.66/kg</td>
<td>Tenderloin meat</td>
<td>Spectacled caiman (Caiman crocodilus)</td>
<td>$86.12/kg</td>
</tr>
<tr>
<td></td>
<td>A11</td>
<td>Alligator</td>
<td>$44.07/kg</td>
<td>Body and meat</td>
<td>Spectacled caiman (Caiman crocodilus)</td>
<td>$86.12/kg</td>
</tr>
<tr>
<td>B</td>
<td>A16</td>
<td>Black bear</td>
<td>$28.55/kg</td>
<td>Sirloin steak</td>
<td>American beaver (Castor</td>
<td>$11.06/kg</td>
</tr>
<tr>
<td></td>
<td>A53</td>
<td>Red deer</td>
<td>$61.73/kg</td>
<td>Loin chop</td>
<td>Llamas (Lama guanicoe)</td>
<td>$11.06/kg</td>
</tr>
</tbody>
</table>

Products listed in this table indicate the retail price of the purchased product is lower than the retail price of the substituted identified species resulting in potential mishandling.

Key Findings

- Overall, 10 out of 54 samples (18.5%) were determined to be potentially mislabeled (Tables 1 & 2).
- 60% of potentially mislabeled products were associated with economic incentives and may have been mishandled for profit (Table 1).
- Distributor B was most frequently associated with products potentially mislabeled for profit (Table 1).
- Samples A12 and A49 labeled as beef (Table 1) could potentially have been a result of hybridization between bison and cattle.

Key Findings (cont’d)

- Several products were found to have been substituted with a low-value species and were likely mislabeled for profit.
- Products that were substituted with a high-value species may have been mislabeled due to inadequate traceability systems and/or mishandling by the distributor or supplier.
- Brand products identified as cattle may have been mislabeled for profit or may have been a result of hybridization.

Significance of Findings

The results of this study suggest that existing policies may require some amendment to identify and deter fraudulent practices, as the identification of mandatory requirements for game meats and verification of species labeling. Additional market research on game meat labeling within the United States is recommended in order to delineate trends and determine appropriate steps to improve control of this specialty food group.

References


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