



BC Centre for Disease Control
An agency of the Provincial Health Services Authority

Environmental Health Services

Food Issue

Notes from the Field

South African RTE dehydrated meats (biltong, chili bites, droëwors)

Request received from:	Multiple Health Authorities
Date of request:	September 10, 2019
Issue (brief description):	Evaluate food safety issues associated with raw ready-to-eat dehydrated meat products in multiple processing plants

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Summary of search information:

1. Internet sources: google scholar (author forward searching)
2. Consultation with Alberta Health Services and Public Health Ontario (OMAFRA – Ontario Ministry of Agriculture Food and Rural Affairs)

Background information:

Biltong, chili bites and droëwors are traditional South African ready-to-eat, salted, dried beef or game meats.¹ Biltong and chili bite style meats are cut into strips, salted and spiced with or without added vinegar, then hung and dried in the traditional method at ambient temperatures for up to two weeks. Moisture in these products can vary from 20 to 50% with water activity (A_w) ranging from 0.6 to 0.90.¹ The word 'biltong' originates from Dutch Afrikaan pioneers: 'bil' meaning round; similarly 'droëwors' translates to dry sausage. Droëwors are thin sausages that are made from comminuted (ground) beef or pork stuffed into casings that are dried quickly as described for biltong. Of public health concern is that these products are:

- Non-fermented, meaning there is no addition of starter culture to promote microbial competition. Lack of competition can potentially allow pathogens to grow;
- Raw with no kill (or cook) step in the traditional process; and
- Dried at temperatures favorable for microbial growth (in the range of 20°C to 30°C).

These products are frequently sold as ready-to-eat (RTE), shelf-stable or requiring refrigeration.

What are the risks associated with dehydrated meats such as biltong, chili bites and droëwors

Products made with raw meat that are dried without a cook step have been linked to previous illnesses and outbreaks. One review catalogues 19 outbreaks between 1949 and 2008 related to jerky and biltong.² Outbreaks associated with these products were categorized as falling into one of four broad groups: (1) enteric bacteria (*Salmonella* and *E. coli* O157:H7) in the majority of outbreaks; (2) *Trichinella* in pork and

wild animal products; (3) *Staphylococcus aureus* enterotoxin when products were slowly or improperly dehydrated; and 4) *Clostridium botulinum* in one venison jerky product.² One outbreak that occurred in London in 2008 involved antibiotic (penta) resistant *Salmonella*.³ Recent outbreaks linked to biltong and droëwors consumption involved five cases of haemolytic uremic syndrome in children under the age of five (the youngest case was eight months old) from South Africa.⁴ A survey of meats in South Africa found staphylococcal enterotoxin strains in traditionally prepared biltong,⁵ in Botswana mycotoxin producing fungal *Aspergillus* strains were also detected.⁶

In a study conducted in the U.S. inadequate log reduction of pathogens were noted during the traditional biltong and droëwors drying process.⁷ Raw beef strips (biltong) and ground beef (droëwors) were inoculated with *E. coli* O157:H7 and *Salmonella* and processed following traditional recipes (biltong: drying temperature between 20°C to 23°C at a relative humidity (R.H.) of >38% to 64% stored between 17 and 26 days; droëwors: same drying and R.H. stored for 12 to 21 days). The maximum reduction for *Salmonella* was between 3.1 and 4.2 log CFU/g, for *E. coli* O157:H7 was 2.8 to 4.4 log CFU/g.⁷

These findings were consistent with two other unpublished studies conducted at University of Guelph and Agriculture and Agri-Food Canada. The authors found drying conditions for biltong at three temperatures (15°C, 20°C and 25°C) after salting were all able to achieve a shelf-stability with water activities below 0.85⁸; however, the methods were not able to achieve a 5-log reduction of either *E. coli* O157:H7 or *Salmonella*.⁹ The authors noted that the methods did consistently achieve a ≥ 2 -log reduction of *E. coli* O157:H7 consistent with requirements for fermented meat policy.¹⁰

A report issued by a meat association provided technical guidance about water activity (a_w). Minimum a_w for food safety is defined at 0.85 or less for shelf stable foods. However, does not exclude the growth of molds on jerky.¹¹ The association recommends for food quality that meat products are dried to an a_w of 0.7 or lower or that some other control measure is implemented.¹¹ Additional controls include exclusion of oxygen using vacuum packaging, oxygen scavenger packets in the packaging, or adding potassium sorbate or some other inhibitor.¹¹

Previous guidance on biltong and jerky from British Columbia

A scan of previous food safety correspondence from BC to various health authorities on dried meat products consistently recommended three critical control points for RTE dried beef products: (1) a kill (cook) step; (2) proper cooling; and (3) achieving a low enough water activity (a_w) during dehydration to ensure shelf stability. Options for cooking times and temperatures that can now be found now on the Canadian Food Inspection Agency (CFIA) site described as Annex D (note: these were originally provided by the U.S. Department of Agriculture (USDA) under Annex H and were adopted by CFIA).¹² Cooling temperature advice provided was that following the cook step products must be cooled within six hours (from 60°C to 20°C within two hours and from 20°C to 4°C within four hours) as required by the Canadian food retail and food services code.¹³ Drying conditions must meet the requirements for shelf stable and dried meat products as outlined in previous CFIA guidance that is now housed under the *Safe Foods for Canadians Regulations* (described below). These include achieving a water activity (a_w) of 0.85 or less

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(regardless of pH), a pH of 4.6 or less (regardless of a_w), or have a combination of a_w of 0.90 or less and pH of 5.3 or less per archived CFIA guidance for fermented meat products.¹⁴

Previous guidance on biltong and jerky from Canada and the United States

The Canadian Food Inspection Agency has recently updated its guidance for the control of pathogens in dried products under the *Safe Foods for Canadians Regulations*, **“As dried beef products may pose a hazard associated with *E. coli* O157:H7, these products must be submitted to a heat treatment before the drying process.”**¹⁵

Dried beef products are expected to have control measures in place for *E. coli* O157:H7 that include cooking the product until it reaches an internal temperature of 71°C for 15 sec, or a validated process for achieving a 5 log₁₀ (5D) reduction of *E. coli* O157:H7 defined by optional cooking temperatures ranging from 62.8°C for 8 minutes to a minimum temperatures at 54.4°C for 121 minutes. Dried products are considered shelf-stable if the pH is <4.6 or A_w is <0.85.

In Ontario, provincially licensed meat plants are regulated by the Ministry of Agriculture, Food and Rural Affairs (OMAFRA). They provide guidance on meat products and have published an on-line set of meat plant guidelines.¹⁶ OMAFRA requires a cook step for dried meat products such as biltong, droëwors and other traditionally prepared dried raw meat products.¹⁷ They state in their document that “drying does not destroy microorganisms or their toxins, it slows down the growth of microorganisms. Meat that is dried, without being through a kill step first, may not be adequately processed to achieve the lethality necessary to produce a safe product.” Alternatives to a cook step in Ontario follow the controls established by the Canadian Food Inspection Agency to address hazards related to verotoxigenic *E. coli* and *Salmonella* in fermented sausages. Possible interventions include¹⁰:

- Cook step as described, or
- Process scientifically validated to achieve a 5D reduction of *E. coli*, or
- End product testing on each batch for *E. coli* O157:H7 and *Salmonella*, or
- Combination of HACCP and process scientifically validated to achieve a 2D reduction of *E. coli* O157:H7

In the United States, the Food Safety Inspection Service (FSIS) has a set of compliance guidelines for small meat and poultry establishments that produce RTE products (June 2017)¹⁸ and jerky (2014).¹⁹ They require all dehydrated meat products to undergo a cook step that achieves at least a 5-log (or greater) reduction of pathogens (*Salmonella* and shigatoxigenic *E. coli*) and requires humidity during the dehydration process.^{18,19} They note that *Salmonella* survives in vinegar based marinades and was most often found in pork products.^{18,19} A HACCP based approach is recommended that requires processors to identify hazards (9 CFR 417.2) and critical limits and critical control points (9 CFR 417.2(c)3).^{18,19} During the cook step controlled humidity is needed for pathogen reduction. The importance of humidity was realized after an outbreak of *Salmonella* in 2003. Jerky was dried in an 82°C dry oven to a very low a_w of 0.3.²⁰ However, 20% of the jerky was still positive for *Salmonella*. A wet-bulb thermometer measurement found the oven

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temperature was only 30°C.²⁰ Humidity must be measured, particularly in high-altitude areas where the relative humidity is low.²⁰ Humidity is a CCP for jerky. Recommendations from FSIS are to cook jerky to a minimum internal temperature of 63°C for meat products while introducing steam into the oven where a 90% humidity can be maintained for at least one hour (other options are also given).¹⁸ Other recommendations in the FSIS guidance include labelling that states 'keep refrigerated' for vacuum packaged products with $a_w > 0.85$ and ≤ 0.91 as the product is no longer shelf-stable in presence of oxygen; and post-processing sanitation to avoid cross-contamination with pathogens such as *Listeria* and *Salmonella*.¹⁸

Meat manufacturers in Alberta do not currently require a cook step for dehydrated biltong, chili bites or droëwors,²¹ however, this may change in the future. Alberta Health Services current recommendations are stringent for processing these products and include the following:²¹

- Process fresh meat only. Outer portion must be trimmed off before slicing (biltong, chili bites) or grinding (droëwors).
- Marinate in vinegar, spice mix and Cure agent (nitrite must be added to 100 to 200 ppm). Marinating to occur at 4°C or less.
- A pH of 5.3 or less must be achieved prior to drying (to control for *S. aureus* enterotoxin formation).
- Dry in a dedicated room, ideally at 4°C, although temperatures traditionally used for these products are often higher.
- Facilities should have a thermometer and humidity meter in the drying room. They should control for air flow and should record temperature and humidity parameters on log sheets. Log sheets should be kept for one year.
- After drying pH and a_w requirements must meet requirements for shelf stability if they are intended to be sold as RTE and shelf stable.
- Labels must indicate it is a raw product.

Recommendations from BCCDC:

Illnesses are amply documented in these products. Best practices for preparation of South African meats indicate that a cook step is required to ensure pathogen reduction that may occur from the meat or ingredients during the marinating step. This is consistent with current CFIA guidance. Recommendations from BCCDC are:

A. Critical Control Points

1. Processors are advised to incorporate a cook step after marinating that will provide a 5.0 log₁₀ reduction of *Salmonella* and *E. coli* O157:H7 in beef. Temperature logs should be kept to document the cooking time and temperature.
2. Humidity is a CCP in the cooking process. Humidity should be monitored to ensure adequate moisture will allow a full kill step. Humidity logs should be kept

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3. Cooling following the cook step must follow current advice to cool from 60°C to 20°C or to the drying temperature within two hours. Drying temperatures at or below 4°C are recommended, but are not a critical control with a cook step.
4. For shelf-stability, drying to a water activity (a_w) of 0.85 or less is required as a CCP. Further drying to a_w of 0.7 or less will prevent mold formation. Products that are not dried to a_w of 0.85 or less (regardless of pH), to a pH of 4.6 or less (regardless of a_w), or have a combination of a_w of 0.90 or less and pH of 5.3 or less must be stored refrigerated or frozen and appropriately labelled.
5. Cooling following the dehydration step is also a CCP when dehydration occurs at temperatures >4°C. Cooling must occur within six hours from 60°C to 20°C in two hours and 20°C to 4°C or less within four hours.

B. Safety and Quality Recommendations

1. Use fresh whole cuts of meat. Avoid trim. If using frozen meat, ensure thawing is done under refrigerated (<4°C) conditions.
2. When monitoring the temperature in strips of dehydrated meat, use the largest width strip (worst case scenario) for monitoring to ensure internal temperatures are reached.
3. To limit introduction of pathogens during the marinating step, use spices verified to not contain pathogens (e.g., *Salmonella*) that have a certificate of assurance or have been irradiated.

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