Literature Review on the Microbiological Hazards Associated with Biltong and Similar Dried Meats

Dean Burfoot & Linda Everis
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Biltong

- Introduction
- Types of product
- Processes
- Equipment
- Microbiological issues
- Outbreaks and recalls
- Existing Guidance
- Conclusions

Biltong - Products

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Biltong – uncooked, "marinated", air dried product

Key distinguishing features – strips of meat, acid, salt, low temperature drying

Biltong - Products

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Jerky– marinated, heated, air dried product

Key distinguishing features – pieces of "meat", "cooking", high temperature drying, and possibly further heating

Other products – charqui (S. America), pemmican (N. America), pastirma (Middle East), tasajo (Cuba), nikku (Canada), sou gan (China)

Biltong - Process

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Biltong (typical in literature)

Marinate - 18 to 24 h in acid/salt/spice mix at 4ºC

Dry - 35ºC, 30% rh , 3 m/s for 6 days

Final conditions

a_w = 0.36 to 0.96 (mostly 0.7 to 0.75)

MC = 3.6 to 52% (mostly 20 to 30%)

pH = 5.6 to 5.9 (mostly 5.8)

Biltong - Process

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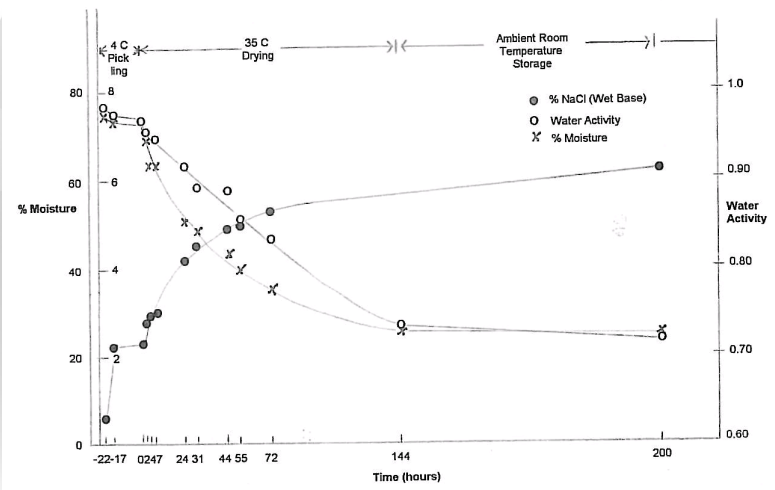
Biltong (Taylor, 1976)



Biltong - Process

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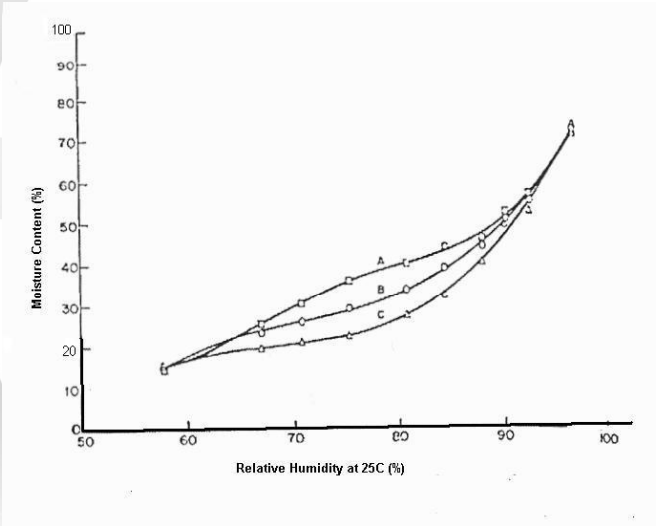
Biltong (van der Riet, 1976)



Biltong - Process

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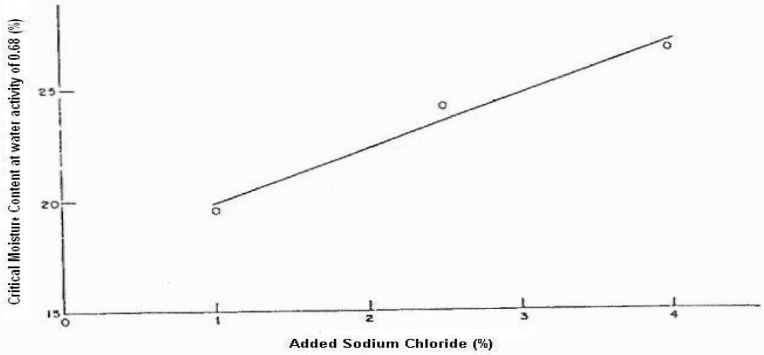
Biltong (van der Riet, 1976)



3.3 6.6 11.1

Salt content of product %

Biltong - Process

Jerky (USDA)

Marinate - 4ºC
Heat – To 71ºC or equivalent, moist heat or marinade
Dry – To a_w≤0.85 (60, 78, 82ºC in the literature)
Post-dry heat - 135ºC air for 10 min

Final conditions
a_w = ≤0.85
MPR ≤ 0.75 (MC ≤ 20% measured)
pH = 5.2 to 5.9

Biltong - Equipment

Dryers

Unheated ambient air in the UK is unsuitable

Forced convection, batch, tray/rack-style dryer is most suitable. Ovens may be used if not needed for other purposes

Dryer from biltong.com

Biltong - Microbiology

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Biltong – Surveys of Commercial Products

TVC	10^6 to 10^7 cfu/g
Enteros and coliforms	10^3 to 10^4 cfu/g
Yeasts	10^2 to 10^7 cfu/g
Moulds	to 10^5 cfu/g
Lactic acid bacteria	to 10^8 cfu/g
Staphylococci	10^4 to 10^8 cfu/g

Biltong - Microbiology

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Biltong – Broth studies

Naidoo & Lindsay, 2010

- Isolates from biltong :*L.monocytogenes, S.aureus*, *S.pasteuri*
- Plates/broths prepared at various salt concentrations, spice mixes, organic acids

Results showed that :

- *L.monocytogenes* grew at 15% salt, and *S.aureus* and *S.pasteuri* at 20%
- *L.monocytogenes* grew at 4°C, *S.aureus* and *S.pasteuri* didn't. None grew at 45°C
- Growth observed in presence of brown spirit vinegar and apple cider vinegar
- **These factors were not inhibitory as individual factors , but in combination , as a hurdle approach they are.**

Biltong - Microbiology

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Biltong – Pathogen Reduction during Processing

Organisms	Reduction
Salmonella	2 to 3 log
E.coli	2 to 3 log
L.monocytogenes	2 to 4.5 log
S.aureus	1 to 6 log

Acid dip then spice showed greater reduction than combined acid/spice mix (0.8 log) for *L.monocytogenes* but combined better for *S.aureus*

Reduction in pathogens increases as water activity is lowered

eg *S.aureus* shows no reduction at a_w=0.85 but 1 log reduction at a_w=0.6

Marination and drying are both important

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Biltong – Pathogen Survival

Pathogens can survive long periods

eg. *S. aureus* for 64 days

S. Dublin for 6 months

S. Newport for 24 months

Biltong - Microbiology

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- Raw meat dominant populations are *Pseudomonas* and *Achromobacter.*
- Dominant populations of biltong are *Bacillus* and *Staphylococci*
- Changes occur to *Micrococci* (21% on raw meat but 88% on dried meat).
- Samples with 2000ppm sorbate showed no growth at 6 weeks. Control samples showed growth at 1 week. Effectiveness dependent on pH (pH 3 98% undissociated pH 5 37%)
- Bacterial growth not inhibited by sorbate
- Mycotoxin producing moulds have been isolated from biltong

Biltong - Microbiology

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Biltong – Conclusions

Biltong contains high levels of microorganisms and may contain pathogens

Large reductions in microbial counts can be achieved through marination and drying

Organisms can survive for long periods

Correct processing reduces pathogen survival

Biltong - Microbiology

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Jerky – Surveys

Just 2 surveys carried out on commercial samples

Levine et al. (2001)
Salmonella in 0.3% of samples
Listeria in 0.5% of samples

Velasco-Ramos (2009)
No *Salmonella* or *Listeria*

Neither survey detected *E.coli* O157 or *S.aureus*

Biltong - Microbiology

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Jerky – Marination

Marination can increase the lethality of the drying process

Greater reduction of *Salmonella*, *L.monocytogenes* and *E.coli* O157 observed when product has been marinated

No survival of *E.coli* O157 or *Salmonella* observed in marinated samples dried at 80ºC

Biltong - Microbiology

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Jerky – Heating and Drying

•Heating raw meat to 71.1ºC prior to drying achieved > 5-log reduction of *Salmonella* and *E.coli* O157 and >4-log reduction of *L.monocytogenes*

•Further drying at 60ºC led to no survival of those organisms

•Survival was observed in product that was not heated before drying (Harrison, 1999)

•Many studies found that a high drying temperature achieves greater microbial reductions

•Air at 135ºC for 10 min used post-drying increased microbial reductions by 3-log for *Salmonella* and *E.coli* O157

Biltong - Microbiology

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Jerky

USDA (2007) guidance on jerky processing:

For beef, at least 6.5-log reduction of *Salmonella* is required
For poultry a 7.0-log reduction is required

Temperature/times for heating are recommended
If deviations from these recommendations, then process needs to be validated

Industry also applies same criteria to *E.coli* O157 and USDA has zero tolerance for *L.monocytogenes*

Biltong - Microbiology

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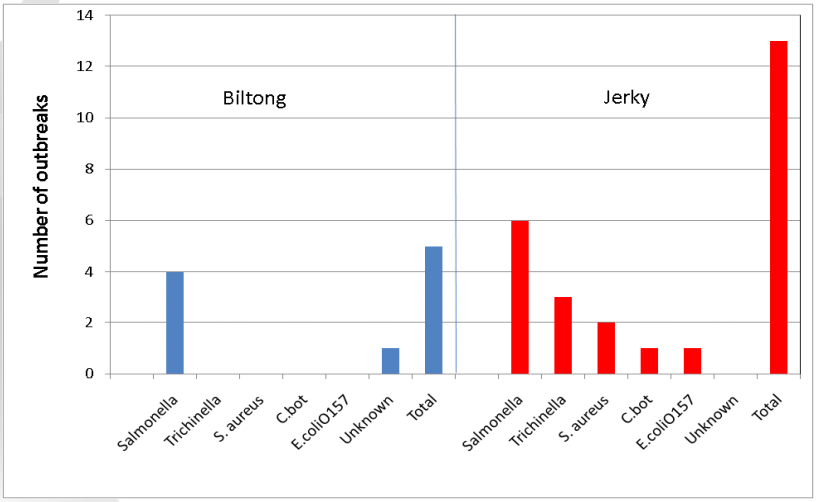
Outbreaks - Biltong and Jerky



Biltong - Guidance

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No specific guidance is available on biltong. Eight guidance documents available on jerky. Key points are:

1. Use, correctly store, and handle only good quality materials from good sources.
2. Thaw and marinate at chill temperatures (<4°)
3. Carry out procedures hygienically to avoid cross-contamination.
4. Define and record treatments (ingredients, temperature, time, humidity) and weight loss
5. Provide guidance on storage for the consumer

Biltong - Conclusions

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1. No legal definition exists for biltong. Prescriptive (USDA) definition exists for jerky.
2. Manufacture of biltong relies on marination and correct drying.
3. Forced air drying is recommended.
4. For biltong, TVC → 10^7 cfu/g; yeasts → 10^7 cfu/g; LAB → 10^8 cfu/g; *Staphylococcus* → 10^8 cfu/g; moulds → 10^5 cfu/g.
5. Pathogens occasionally found on commercial products.

Biltong - Conclusions

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6. Pathogen reductions have been reported: *Salmonella* and *E.coli* (3-log), *L.monocytogenes* (4.5-log), and *S.aureus* (6-log).
7. Microorganism counts reduce during storage.
8. Guidance may be needed to assist small manufacturers.
9. Guidance on producing fermented meats may be required.