Testing of Surface Spoilage Bacteria in Meats by Application of Woolcool® Packaging

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Abstract: Woolcool® is an eco–friendly type of packaging, made of 100% pure sheep's wool, hygienically sealed in recyclable food–grade wrap. Due to its complex physical and chemical composition, wool can also help control humidity and reduce condensation. Given these properties, the potential of wool to be used as packaging liners for the transport of meat is of interest. The present study assessed the microbiological quality of meat packaged and stored at room temperature for 40 h in conventional EPS (expanded polystyrene) boxes and cardboard boxes lined with Woolcool® using standard, approved culturing techniques. It also sampled empty boxes stored under the same conditions. The findings suggest that the product may have potential market value as packaging liners for transporting meat, and possibly other food products. Further research is needed to allow better generalisation to real-world conditions, and understanding of how these packaging liners could maintain food quality on a larger scale. [Lahmer R. L, Curling S, Williams A P A, Jones D L. **Forests.** *J Am Sci* 2014;
[Nikzad S, Baradaran-Ghahfarokhi M, Nasri P. **Dose-response modeling using MTT assay: a short review**. *Life Sci J* 2021;18(6):48-51] (ISSN:1097-8135). http://www.lifesciencesite.com. 7. doi:10.7537/marslsj180621.07.

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1. Introduction

Meat spoilage is caused by biological deterioration of a product, which is potentially hazardous to health (Anon, 2012; Haque et al., 2008) and considered unacceptable by the consumer due to defects such as off–flavours, off-odour, sour taste, discoloration and slime formation (Nychas et al., 2008; Maltin et al., 2003, Ouattara et al., 2000). Poor operational techniques during the slaughter of animals and the subsequent stages of processing and storage of the meat may lead to elevated microbial counts and hence reduce shelf life and quality (Dave and Ghaly, 2011; FAO, 2007). Packaging is important in maintaining the quality and safety of meat and the type of packaging can influence the microbial flora of meat (Olaoye and Ntuen, 2011). It can also affect the relative humidity of the meat environment, with lower humidity associated with lower microbial counts.

Central to the above factors is the control of temperature; with meat needing to be stored at refrigeration temperatures (typically 1-4°C) to restrict microbial growth. Packaging that can maintain such temperatures during transportation aids in the delay of spoilage micro–organisms (Renerre and Labadie, 1993, Dillon and Board, 1991).

Wool is often used as an insulator in the construction industry due to its complex physical and chemical composition, which helps control humidity and reduce condensation (Woolcool® Packaging Company, 2012). Woolcool® packaging, made of 100% pure sheep's wool, hygienically sealed in recyclable food-grade wrap, may therefore have potential as a packaging liner for the transport of meat (Fig. 1).

Figure 1. Woolcool® packaging liners for boxes[1]

2. Objective

This study was conducted to investigate whether raw meat stored in boxes with lined or unlined Woolcool®, is of different microbiological quality to meat transported in conventional expanded polystyrene (EPS) boxes.

3. Material and methods

3.1. Sample collection

Three cardboard boxes were prepared: one containing lined Woolcool® (WC), one unlined

Woolcool® (WCUN) and one EPS. A 10 kg variety of fresh meat products (beef, pork, lamb joints) were packed into each box (Figure 1), and left unrefrigerated for 72 hours. The boxes were then opened, and swabs taken from the top, middle and bottom surface of each box and from the condensed liquid found on the surface of meat packs. Samples were also taken from the lamb shoulder joint from each box. They were then analysed for microbiological contamination as described below.

Figure 1. Sample boxes with meat (left-right: Woolcool® lined, Woolcool® unlined, expanded polystyrene)

3.2. Microbiological characterization

The following media were used to assay bacteria counts on meat and box surfaces: Plate Count Agar (Oxoid, product no CM0463) for total viable counts (TVC), Malt Extra Agar (Oxoid, product no LP0039) for fungi and Brilliance *E. coli*/coliform agar (Oxoid, product no CM0956) for *E. coli* and coliforms; as described in Lahmer et al. (2012). The swabs were inoculated into 10 ml of ¼-strength Ringer solution (Oxoid, product no. BR002), which was then subject to a ten–fold serial dilution series. A 25 g sub-sample was aseptically removed from the lamb shoulder joint, and mixed with 225 ml of Ringer solutions in a Seward 400 stomacher machine (Seward Ltd., Worthing, UK) at 230 rev min^{-1} for 30 s (Malpass et al., 2010). One ml of the homogenate was then plated following the serial dilution described previously. Plates were incubated for 48 h at 37°C for TVC, 18-24 h at 37°C for *E. coli* and for 3-4 days at 25°C for fungi. Colonies were counted manually.

4. Results

4.1. Sensory qualities

After 72 hours of storage in EPS or Woolcool® packed boxes, the sensory quality of each lamb shoulder joint was compared qualitatively (subjectively), using sensory attributes such as colour and smell. No difference was detected between meat kept in the two Woolcool® boxes (lined and unlined), but meat in the EPS boxes showed some signs of the early stages of spoilage, presumably due to the breakdown of fat, protein and carbohydrates.

4.2. Microbiological characterization

The results of the microbiological analysis based on the measures of TVC, *E. coli*, other coliforms and fungi are presented in Table 1 and Figure 2.

Table 1. Microbial counts of swabs taken from EPS boxes containing meat and Woolcool®-lined unlined boxes (WCUN, WC) containing meat. Following packaging, meat was stored at room temperature for 72 h prior to analysis. Samples were taken from the top (T), middle (M) and bottom (B) surfaces of boxes; from condensation (C) on meat products; and from a lamb shoulder joint within each box. 'n.d' refers to 'none detected'

Test	**EPS–packed + fresh meat products (CFU ml^{-1})**				
	T	**M**	**B**	**C**	**Meat**
Total viable counts	n.d	n.d	0.77	2.26	7.00
E. coli	n.d	n.d	n.d	n.d	5.64
Coliform	n.d	n.d	n.d	n.d	5.34
Fungi	n.d	n.d	n.d	n.d	6.53
Test	**EPS–packed + fresh meat products (CFU ml^{-1})**				
	T	**M**	**B**	**C**	**Meat**
Total viable counts	n.d	n.d	2.55	1.43	5.23
E. coli	n.d	n.d	1.33	n.d	2.39
Coliform	n.d	n.d	n.d	n.d	3.27
Fungi	n.d	n.d	n.d	n.d	4.88
Test	**WC–packed + fresh meat products(CFU ml^{-1})**				
	T	**M**	**B**	**C**	**Meat**
Total viable counts	n.d	n.d	1.69	0.97	6.00
E. coli	n.d	n.d	n.d	n.d	4.20
Coliform	n.d	n.d	n.d	n.d	4.85
Fungi	n.d	n.d	1.67	n.d	5.16

Swab samples taken from the middle and top were negative for the microbes tested in all box types (data not shown). Post-hoc analyses were run using Tukey HSD statistic, unless homogeneity of variance could not be assumed, in which case Games–Howell was used. For TVC, post-hoc analyses (Games-Howell) found significant differences between EPS and WCUN ($p < .001$), between EPS and WC ($p = .006$) and between WC and WCUN ($p = .014$). For *E. coli* (Tukey HSD), there was a significant difference between EPS and WC ($p = .003$), between EPS and WCUN ($p < .001$) and between WC and WCUN ($p = .001$). For coliforms, post-hoc analyses (Tukey HSD) found a significant difference between EPS and WCUN ($p < .001$) and between WC and WCUN ($p < .001$), but no significant difference between EPS and WC ($p = .069$). For fungi (Games-Howell) the EPS and WCUN comparison was significant ($p = .009$), as was EPS and WC, $p = .001$ but there was no significant difference between WC and WCUN, $p = .259$.

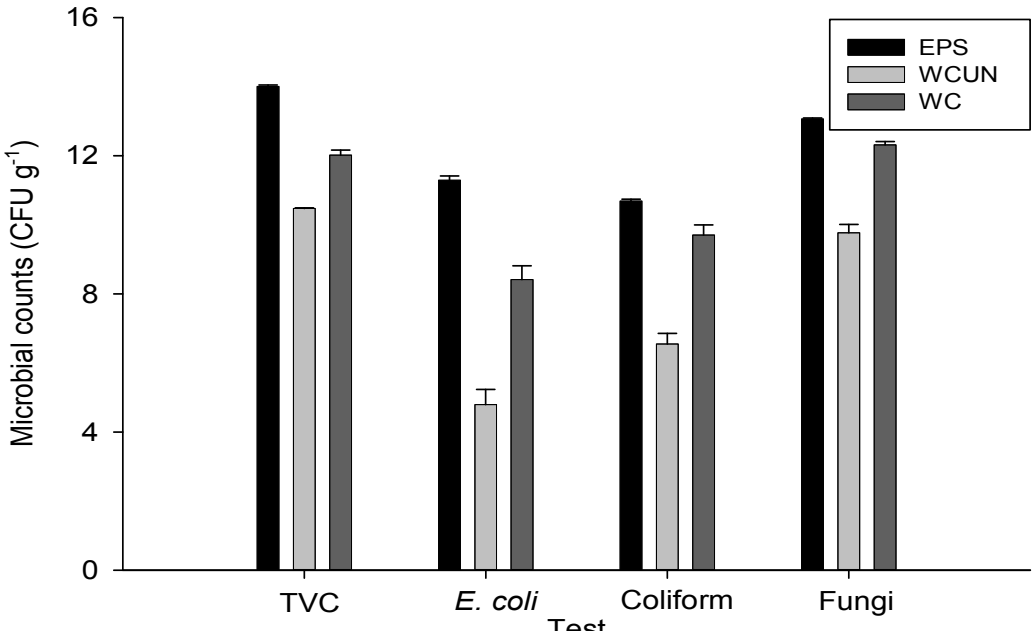

Figure 2. Microbial load analysis in meat (log $CFUg^{-1}$)

5. Discussion and conclusions

In the present study, a variety of meat was stored at room temperature for 72 h in either conventional EPS boxes or cardboard boxes lined or unlined with Woolcool®, before being assessed for microbiological quality. For all microbial measurements, EPS revealed the highest count, with this being significantly higher than WC and WCUN in many cases (with the exception of coliform). In general, WCUN revealed significantly lower counts than WC (except for measurements of fungi).

Although the best scientific methodology was practiced throughout, the study has several limitations. Firstly, the number of replicates was low, with each box type tested only once. Secondly, localised bacterial contamination of meat may result in considerable variation of bacteria count between samples. Therefore, directly comparing samples should be done with caution, although the meat types contained within all boxes were the same and the methods used were consistent throughout.

Although based on a limited sample set, these results suggest that Woolcool® may be superior to EPS in maintaining the microbiological quality of the meat. The findings support those of Lamher et al. (2012) and suggest that the product may have potential market value as packaging liners for transporting meat, and possibly other food products. It should be noted that the study was caried out under small scale laboratory conditions. Further research is needed to allow better generalisation to real-world conditions, and understanding of how these packaging liners could maintain food quality on a larger scale.

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