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Microbiological quality of chicken wings damaged on the farm or in the processing plant

M.C. Malpass, A.P. Williams, D.L. Jones*, H.M. Omed

School of the Environment, Natural Resources and Geography, College of Natural Sciences, Bangor University, Gwynedd LL57 2UW, UK

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ABSTRACT

Selling of damaged chicken wings (those with bone protrusion) for human consumption is prohibited in the European Union on the grounds of possible risks to human health arising from microbial contamination. Standard food industry tests were used to assess different categories of chicken wings (undamaged, farm damaged and factory damaged; $n = 264$) for, coliforms, Enterobacteriaceae, total viable counts, *Pseudomonas* spp., *Staphylococcus aureus* and *Salmonella* spp. No significant differences in bacterial numbers existed among wings belonging to the three categories. Only low numbers of bacteria were found throughout, and 97% of all results would pass the standards of a leading UK retailer. These results were strengthened by a longitudinal survey of wing breakage, which showed almost all wing puncturing occurred during the de-feathering process, limiting the likelihood of microbial contamination. Combined, these results indicate there is no increased health risk from consumption of damaged, compared to undamaged, chicken wings. The existing imposed regulations may therefore be an unnecessary burden on the poultry industry.

1. Introduction

Damage to chicken wings (bone protrusion) represents a significant problem in the poultry industry as such wings are prohibited from passing though a production line. The whole of the damaged wing must therefore be manually trimmed from the carcass, preferably following evisceration to minimise the risk of contamination of exposed meat (Anon, 2007). At a typical large poultry slaughterhouse, processing approximately 40,000 broilers per day, the overall cost arising from damaged wings has been estimated at £65,000 per annum due to reduced productivity, loss of yield, and significant overheads arising from inspection and disposal costs (D. Broxton, personal communication).

Chicken wings can be visually categorised into the following three groups: normal or undamaged (N), farm damaged (FD) (damaged before reaching the processing plant, showing blood retention and/or bruising around the joint, usually protruding bones), and factory machine damaged (MD) (bone protruding through the skin but absence of blood around the joint or under the skin). This categorisation is based on the notion that blood retention arises due to damage occurring pre-slaughter (FD), whereas the lack of blood indicates that the carcass has already been bled before the damage occurs (MD). Most farm damage is thought to occur during the hand catching stage, and is highly dependent upon the technique of the catching team (Kettlewell and Turner, 1985). Machine damage is most likely to occur during the de-feathering process (as the kinetic energy used to remove the feathers is considerable) and not during the shackling process (Jones and Satterlee, 1997; Jones et al., 1998a,b).

Chicken skin is naturally contaminated with microbes from grazing and processing (Uyttendaele et al., 1997; Avens et al., 2002). It is hypothesized that if wings are damaged before reaching the processing plant (i.e. on-farm or during transport), there are greater opportunities for bacteria to enter the wing through the broken skin. Further, tissue contamination may also occur within the processing plant scald tank where there may be high levels of bacterial contamination (Georgnaras et al., 1996, 1998; Cason et al., 2000; Cansian et al., 2005). Therefore, it is implicitly believed that damaged wings will carry an unacceptably high microbiological load both on the exterior and inside of the meat. Indeed, selling damaged wings is prohibited in the EU on the grounds of potential microbial contamination (Anon, 2007). However, as the majority of MD wings are damaged in the plucking machine (i.e. after the scald tank), this would lessen the possibility of microorganisms entering the wing. We therefore hypothesised that the microbial load of FD wings would be greater than MD wings.

* Corresponding author. Tel.: +44 1248 382579; fax: +44 1248 354997.
E-mail address: d.jones@bangor.ac.uk (D.L. Jones).

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The first aim of this work was to undertake a longitudinal survey of broiler wings, following the same cohort of birds from catching through to post-evisceration to determine the point where maximum wing damage occurs. The second aim was to determine whether damaged wings possessed different microbial loads to undamaged wings and to ascertain whether damaged wings are justifiably deemed unfit for human consumption. The study included determining the numbers (or presence) of specific food-borne pathogens, indicators of faecal contamination, and bacteria associated with microbial spoilage or overall microbiological quality.

2. Materials and methods

2.1. Longitudinal surveys of wing damage

Studies were undertaken to determine the critical points at which damage to chicken wings occurs during the rearing to processing life cycle. These were undertaken on five farms supplying a large commercial chicken plant processing approximately 40,000 birds per day. All farms were independent of each other and were from different production sites to ensure heterogeneity in farms conditions. Tagged transport modules ($n = 5$; 706 birds in total) of caught broilers were manually checked for physical wing damage prior to the module being loaded onto transportation trucks (post-catching at farm). The same catching team was present for all of the sample modules, though they were not made aware as to the reasons for the module checking. Catching was conducted by hand, with multiple birds per catcher's hand. Transport distances from farm to plant ranged from 5 to 35 km. The same module was then checked in the factory lairage after transportation and unloading. Both of these checks were conducted by removing every bird from the module, feeling the wing joint for dislocation, and visually assessing it for blood and/or protruding bones. The numbers of birds per module, total numbers of pullets and the occurrence of leg damage were also recorded.

Each module was separated and processed separately on the production line, using markers and a 50 shackle gap for clear identification. These broilers were then followed through the slaughter and processing line, with surveys of damaged wing incidence being conducted after the neck cutter, plucking machine and post-evisceration. Surveys were conducted using mechanical counters to ensure accuracy (one each for pre- and post-mortem damage).

2.2. Microbiological quality of wings

Samples were collected at various times from September 2006 through to November 2008 at the same large commercial chicken plant where the longitudinal study was undertaken. Wings were collected randomly post-carcass evisceration (prior to entering the air-chiller section) to give the maximum opportunity for cross-contamination from the scald tank (Geornaras et al., 1996, 1998; Cason et al., 2000; Cansian et al., 2005), plucking machine (Berrang and Dickens, 2000; Rasschaert et al., 2006), and evisceration (Corrier et al., 1999). This represents the same point at which poultry inspection assistants (PIA) remove all damaged wings. After collection, the wings were placed inside sterile plastic bags, placed on ice in a cool box and taken to the laboratory for analysis within 1 h of collection. At each independent sampling event, triplicate samples of undamaged, farm damaged, and factory damaged wings were taken for analysis.

2.3. Microbiological food quality standards

All the methods employed were based upon food industry microbiological quality standards, specifically those detailed in the Marks and Spencer Microbiology Methods Manual (Anon, 2004), which are based on Campden and Chorleywood Food Research Association accredited methods (Campden BRI, Chipping Campden, UK). It was decided to base the wing testing on Marks and Spencer's (M&S) stringent Food Quality Standards (Table 1) as these are widely regarded to be amongst the highest within the UK food industry (D. Broxton, personal communication). Depending on its microbiological status, raw chicken can be categorised into one of three classifications within the standards; namely, 'acceptable', 'borderline', or 'unacceptable'. Chicken categorised both in the 'acceptable' and 'borderline' classification are regarded of sufficiently high microbiological quality to be deemed fit for human consumption.

2.4. Enumeration of bacteria

Unless otherwise stated, all assay ingredients were sourced from Oxoid Ltd. (Basingstoke, UK). For the five bacterial counts tests, the sample preparation was as follows: Briefly, a composite (10 g) sample containing skin, muscle, cartilage, bone fragments and any traces of feather left on the wing after plucking were aseptically recovered from each wing ($n = 264$; 88 from each category) using sterile scissors. The sample was firstly cut from the muscle around the humerus and then continued around the joint to the muscle adjoining the radius and ulna. This method ensured the joint was thoroughly opened and that the surrounding meat (therefore the areas most likely to be contaminated) was included in the sample. Maximum Recovery Diluent (90 ml; MRD) was then added to the sample before stomaching in a Seward 400 circulator machine (Seward Ltd., Worthing, UK) at 230 rev min^{-1} for 30 s (Anon, 2004). Serial dilutions were then prepared from the stomached sample for the following analysis, with all solutions plated in triplicate.

For coliform bacteria and Enterobacteriaceae counts, 1 ml of prepared samples was pipetted into sterile petri-dishes before being overlaid with molten Violet Red Bile Agar and Violet Red Bile Glucose Agar, respectively; then mixed by agitation (Oxoid, 2009). Total viable counts (TVC) were determined via placing 0.5 ml aliquots of serially diluted samples into sterile petri-dishes then overlaying with molten standard plate count. Once set, all plates were subsequently incubated at 37 °C before enumeration of characteristic colonies after 24 h (Oxoid, 2009). To determine numbers of *Pseudomonas* spp., 0.5 ml aliquots of serially diluted samples were pipetted onto solidified *Pseudomonas* agar

Table 1
Marks & Spencer microbiological Food Quality Standards for raw chicken (numbers are measured in $\log_{10}$ CFU g^{-1} sample).

Test	Agar used	Acceptable no.	Borderline no.	Unacceptable no.
Coliforms	VRBA	<2	2–4	>4
Enterobacteriaceae	VRBGA	<4	4–7	>7
Total viable counts	Standard plate count agar	<5	5–7	>7
Pseudomonas spp.	*Pseudomonas* agar with CFC supplement	<4	4–6	>6
S. aureus	Baird-Parker Medium	<2	2–3	>3
Salmonella spp.	XLD and BGA	Absent in 25 g	Absent in 25 g	Present in 25 g