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Microbiological Quality of Selected Meat Products from the Canterbury Region of New Zealand

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Abstract

The microbial level (CFU/g) of retail refrigerated raw diced chicken; roasted shredded chicken and salami were assessed in Christchurch, South Island New Zealand. Samples were purchased on a 4-weeks basis. Total aerobic plate count for raw diced chicken, roasted chicken and salami ranged from 103-106, 103-104 and 103-105 CFU/g respectively. And the level of yeasts and moulds counted in raw meat were 102-105 CFU/g, 101-103 CFU/g for cooked chicken and 102-104 CFU/g for salami samples. Staphylococcus aureus was not detected in any samples. Listeria monogecytogenes was detected in raw diced chicken samples purchased from retail outlets D and F. This study warrants further investigation to understand the extent of food safety risks associated with these foods and food products.

Key words: Meat products, microbiological quality, foodborne pathogens, food safety

Introduction

Today's consumers are looking for foods that are healthier, more nutritious, longer lasting and more convenient to prepare. Providing safe food is the responsibility of many individuals and groups including retailers. Meat is a major food in its own right and as well as an important ingredient in many food products. The abundance of nutrients in meat promotes bacterial growth making it highly perishable (Subratty and Gurib, 2003). There are many food-borne pathogens in the environmental which may contaminate food. The consumption of contaminated food may cause disease. Biological hazards that cause foodborne illness include microorganisms such as bacteria, viruses, fungi, toxins and parasites. Bacteria are able to cause foodborne disease by infection or intoxication. Ingestion of pathogenic bacteria such as Salmonella and Listeria monocytogenes may result in foodborne infection or consumption of food containing toxin (poison) produced by Staphylococcus aureus may result in foodborne intoxication (Vaclavik and Christian, 2008).

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Poultry meat can be contaminated with a variety of microorganisms but Salmonella spp. remains the organism of greatest global concern in this respect (Mead, 2004). When poultry meat is stored aerobically under chill conditions, spoilage can still occur due to various organisms and yeasts. Microbiological testing of raw meat purchased at the retail level may provide information on consumer exposure to pathogens present in raw meat just prior to the food handling and preparation stages as well as potential cross-contamination risk in the domestic situation.

Processed meat products have also been identified as high risk, with the pathogens of concern including pathogenic E. coli, Salmonella and L. monocytogenes. There have been a large number of recalls of processed meats due to L. monocytogenes, and a significant number of foodborne illness outbreaks (NSW Food Authority, 2009). L. monocytogenes must be considered a risk for most retail and catering packs and ready-to-eat (RTE) food. Special considerations are required for high risk consumers such as immune-compromised patients. Quesenberry et al. (2009) noted that 83% of illnesses and deaths from L. monocytogenes arose from deli meat consumption is attributable to deli meat sliced at retail facilities. This is thought to be caused by greater worker handling and the storage of the product by the retailer e.g., slicing meats on a common slicing machine, hand wrapping deli meat packages for consumers and also likely the use of too high

storage and display temperatures. The remainder is from prepackaged deli meat. The opening of packages with the risk of recontamination and subsequent growth of *L. monocytogenes* also causes concern. Of concern also is the intermediate storage at retail or catering premises where the low volume of sales of large packaged product in small operations may delay using up opened packages quickly with increasing risk of product contamination (Dufour, 2011). Foods, that require considerable handling during preparation at slightly elevated temperatures and after preparation, are frequently involved in staphylococcal food poisoning (FDA, 1997).

The samples in this study were microbiologically tested for Total aerobic count, *E. coli*, *Salmonella* spp., *L. monocytogenes*, Staphylococci spp. and Yeasts and moulds. Though a small number of samples were tested in this study, it does provide important information on the status of microbiological safety of selected meat products retailed in Canterbury region of the South Island of New Zealand. This study warrants the need of an extensive study to fully understand the food safety issues that can be associated with the meat and meat products sold by different retailers in the South Island of New Zealand.

Materials and Methods

Sampling plan. Samples of diced skinless and boneless raw chicken were collected from Retailer A and B for four weeks. Also, samples of classical roasted and shredded chicken were collected from only Retailer A for four weeks. Sliced Italian salami was collected weekly for four weeks from Retailer A except in week 2 when Danish salami was substituted when the Italian type was not available. Sliced Beef salami was collected weekly for four weeks from Retailer B.

Additionally, during week 3 an extra four diced raw chicken samples were randomly collected from Retailers C, D, E and F (diced chicken tenderloins purchased from F). All samples were about 250g by weight and purchased before the ‘‘sell-by’’ date.

Table 1. Sampling plan and number of samples tested

Sample	No. of samples	Frequency	Retailers
Raw chicken	8	Weekly	2
Cooked chicken	4	Weekly	1
Salami*	8	Weekly	2
Raw chicken	4	Once	4

*Italian salami in week two it was not available so Danish salami was used

Microbiological analysis. 25 g of sample was weighed out cleanly in to the sterile plastic bag. 225 ml of 0.1% peptone water (Oxoid, CM0009) was added in to the sterile bag. The sample was homogenized for 2 min in Colworth Stomacher 400. From this homogenate, decimal serial dilutions (10^{-1}-10^{-6}) were made in the same sterile peptone water and used for microbiological analyses of the samples (Bell *et al.*, 2005). Samples were examined bacteriologically for Total Aerobic Counts (TAC), *Escherichia coli*, *Staphylococci* spp., yeasts and moulds, and the presence of *Listeria monocytogenes* and *Salmonella* spp.

Total Aerobic Counts (TAC) were determined by surface spreading of 0.1 ml of the sample homogenate, at selected dilutions, onto duplicate sterile plates of pre-poured and dried standard plate count agar (Difco, 213000; Merck, 1.05463), then the plates were incubated for 72 h at 42ºC.

Colonies number of *E. coli* were determined by surface spreading of 0.1 ml of the sample homogenate, at selected dilutions, onto duplicate sterile plates of pre-poured and dried MacConkey agar (Oxoid, CM0007), then the plates were incubated for 24 h at 37ºC. Colonies with a typical morphology of *E. coli* were red and non-mucoid on MacConkey agar.

Colonies number of *Staphylococci* spp. were determined by surface spreading of 0.1 ml of the sample homogenate, at selected dilutions, onto duplicate sterile plates of pre-poured and dried Baird-Parker agar (Fort Richard, 1005), then the plates were incubated for 48 h at 35ºC. Colonies with a typical morphology of *S. aureus* were grey-black shiny convex up to 3 mm (48 hours) narrow white entire margin surrounded by zone of clearing 2-5mm on Baird Parker agar. *S. epidermidis* colonies were not shiny black and seldom produce clearing. *S. saprophyticus* colonies were irregular and may produce clearing. Wide opaque zones may be produced in 24 hours.

L. monocytogenes were determined by surface spreading of 0.1 ml of the sample homogenate, at selected dilutions, onto duplicate sterile plates of pre-poured and dried *Listeria* selective agar (Oxoid, CM0856) with *Listeria* selective supplement (Oxoid, SR0140), then the plates were incubated for 48 h at 35ºC (Oxoid, *Listeria monocytogenes*). Colonies with a typical morphology of *L. monocytogenes* were brown colour with aesculin hydrolysis on *Listeria* selective agar. Pure *L. monocytogenes* culture was used as positive control to verify the colony morphology on agar plates.

Salmonella spp. were determined using streaking method (BAM, 2012). 0.1 ml of the sample homogenate was transferred to 10ml of Rappaport-Vassiliadis Soya peptone (RVS) broth and incubated at 42°C for 12 hours. A loopful (10µl) of the RVS culture was transferred to duplicated pre-poured and dried Xylose Lysine Desoxycholate (XLD) agar(Fort Richard, 1360) and Brilliant Green Agar-Modified (Fort Richard, 1020). The cultured was streaked to obtain single, well-isolated colonies. Both plates were incubated at 37°C for 24 hours. Colonies with a typical morphology of *Salmonella* spp. were red with a black centre on XLD agar; and pink, surrounded by bright red medium on BMG agar.

Yeast and moulds were determined by surface spreading of 0.1 ml of the sample homogenate, at selected dilutions, onto duplicate sterile plates of pre-poured and dried Yeast glucose agar made up by Yeast extract (BBL, 211929) and Analytical grade D-glucose anhydrous (LabServ, 930.500) with Chloramphenical (Sigma) this medium is superior to acidified potato dextrose agar for detection of yeasts and moulds, and these plates were incubated for 48 h at 28ºC (Beuchat, 1992).

Results and discussion

Results of microbiological quality for raw meats obtained (sampling week 3 of this study) from six retailers are shown in Table 2 and microbial counts data of meat products samples collected from retail outlets A and B are given in Table 3. Published guidelines (Colmegna *et al.,* 2009; Gilbert *et al.,* 2000) were used to interpret the microbiological quality of the raw and cooked meat products.

Raw meat. Results of microbiological quality for raw meats sampled in week 3 and obtained from six retailers were shown in Table 2. From Table 2 it can be seen that the total aerobic counts were relatively high for raw diced chicken purchased from different shops, however, all results were within specification. When comparing the microbial counts for raw meats purchased from six retailers, results revealed that retailer E had the highest bacteria counts for total aerobic counts, E. coli and Staphylococcus spp. with no L. monocytogenes detected. Meats collected from E were pre-packed and plastic film covered and refrigerated, a relatively high microbial reading may be due to contact of processing plant and operator during manufacturing. Overall, the microbial status of raw meat collected from retailer A were good as comparing to the results obtained from other stores. The average TAC and E. coli, and yeasts and moulds were 10 times lower than bacteria counts of raw meat collected from retailer B. Products collected from A were packed in plastic film covered package and kept refrigerated, while in retailer B, all pre-diced raw meats were chill air refrigerated and kept under a big plastic film, and when weighing is required, operator needed to open the plastic film and then re-cover it back. This process would cause exposure of meat products to oxygen and increase the potential of contamination from environment and operator. *L. monogecytoges* strain were detected in raw diced chicken samples purchased from retail outlets D and F. Operator in F showed improper handling practice during weighing and cutting. At the time of purchasing raw chicken samples, operator was in the middle of handling other raw meat products using hands without gloves on. When weighing raw chicken samples, the operator used hands without washing or putting on gloves, this inadequate manner would be the reason that raw meat samples had a high TAC counts and *L. monocytogenes*. Pure cultures of *L. monocytogenes* were used to confirm the detection in the samples.

Meat products obtained from retailer E showed a relatively high *E. coli* reading (4 x 10^4 CFU/g) compared with meats collected from other stores. Products were packed with plastic film and kept refrigerated. However, this presumptively identified *E. coli* required confirmation.

No *S. aureus* were detected in raw diced chicken purchased from any of the retailers. This indicated that there was possible no products were post-contaminated with *S. aureus* from the environment and worker during handling of products at each retail outlet.

Raw chicken samples collected from retailer A and B both showed negative results for *Salmonella* spp (Table 3). This indicated that no samples were contaminated with Salmonella spp. during slaughtering and dicing operations.

Cooked chicken. The microbial number for TAC, *E. coli*, *Staphylococcus* spp. yeasts and moulds for cooked shredded chicken samples were predictably lower compared to raw chicken samples (Table 3). In week 1, samples had a presumptive E. coli reading of 1 x 10^3 which was ten times higher than the limit for RTE foods. These presumptively identified E. coli required further confirmation in further study.

In the experiment, Staphylococcus spp. were detected for cooked chicken samples, however, again, no S. aureus colonies were observed throughout the experiment period. International Commission on Microbiological Specifications for Foods (ICMSF, 2001) suggests the contamination of RTE foods with coagulase-positive staphylococci (e.g. S. aureus) is largely as a result of human contact. At each time of purchasing samples, the researcher observed that workers followed good food handling practices. Each personnel were observed wearing gloves and using plastic bag to weigh samples instead of using other equipment such as tongs to minimize the incidence of contamination.o L. monocytogenes was detected in cooked chicken samples, which indicated that the cooking processing was adequately and no sample was contaminated during handling. The detection of L. monocytogenes in foods which have been prepared specifically for 'at risk' population groups such as the elderly, immune-compromised and infants should be considered as potentially hazardous. Salmonella is considered as the primary source of contaminant to processed meat products. In this experiment, no Salmonella spp. were detected for cooked chicken samples. This could indicate that operators used good handling practices during shredding or weighing.

Fermented Italian salami. The average TAC counts of salami purchased from A were higher than samples from B during 3 weeks sampling. E. coli counts were only detected during week 1 which was 4 x 10^3 CFU/g, and no *E. coli* bacteria were detected in the samples in the following weeks. Furthermore, both samples collected from two retailers showed *Salmonella* negative. A reason for these low microbial counts might be that both types of salami

contain preservatives, and thus may prevent bacteria growth on products. There was no *L. monocytogenes* detected for the samples purchased from two retailers in the four weeks of study.

From the results it can be seen that Staphylococci spp. were detected in samples purchased from A, while Staphylococci spp. were not detected in samples from B during four weeks of sampling. And no *S. aureus* were detected in two types of fermented salami purchased from retail outlets A and B.

The level of yeasts and moulds were acceptable for both salami collected from two retailers. In the manufacture of fermented meat products yeasts and moulds are used in order to achieve meat fermentation. And the heavy growth of molds on the surface of Italian salami helps in their preservation by inhibiting the activities of food-poisoning and food spoilage bacteria and may also enhance their flavour development. Therefore, a slightly higher number of yeast and moulds may be observed in fermented meat products than other products. However, in this experiment, the number of yeasts and moulds present in fermented meat salami were reasonable comparing to cooked chicken product and raw meat.

Table 2. Microbial counts (CFU/g) for raw chicken samples collected from six retailers

Retailers Microbial counts	Retailer A (average)	Retailer B (average)	Retailer C	Retailer D	Retailer E	Retailer F
TAC	2.7×10^3	1.9×10^5	4.5×10^4	1.9×10^5	5.7×10^5	2.5×10^5
E. coli	8.8×10^2	5.3×10^3	3.5×10^2	ND	4×10^4	2×10^2
Staphylococci spp.	3.1×10^3	6.1×10^3	1.2×10^4	3.9×10^4	8.6×10^4	3.5×10^3
Yeasts & moulds	3.2×10^2	1.3×10^3	7.5×10^3	2.9×10^3	2.3×10^3	5×10^2
L. monocytogenes	ND	ND	ND	3×10^2	ND	2×10^3
Salmonella spp.	ND	ND	ND	ND	ND	ND

Table 3. Microbial counts (CFU/g) data for three samples collected from two retailers

Type of microbial counts		Raw chicken				Salami				Cooked chicken			
	Retailer	Wk 1	Wk 2	Wk 3	Wk 4	Wk 1	Wk 2	Wk 3	Wk 4	Wk 1	Wk 2	Wk 3	Wk 4
TAC	A	--	3.7×10^3	2.8×10^4	1.6×10^3	--	2.5×10^4	8.7×10^3	1.5×10^3	--	--	5.1×10^3	7.9×10^3
	B	--	4.3×10^4	5.2×10^5	9.2×10^3	--	1.8×10^4	4.2×10^4	5.3×10^3	--	--	--	--
E. coli	A	2×10^3	1×10^2	5.5×10^2	ND	4×10^3	ND	ND	ND	1×10^3	ND	ND	ND
	B	1.5×10^4	1×10^3	ND	15	ND	ND	ND	ND	--	--	--	--
Staphylococci spp.	A	4×10^3	1.5×10^3	6.2×10^3	6×10^2	1.9×10^3	3.8×10^3	2.3×10^3	4.5×10^2	ND	ND	5.5×10^2	2.5×10^2
	B	4.5×10^3	1.4×10^4	5.3×10^3	6.5×10^2	ND	ND	ND	ND	--	--	--	--
Yeasts & moulds	A	5.8×10^2	1×10^2	4.3×10^2	1.8×10^2	6.8×10^3	1×10^2	2.5×10^2	2.2×10^2	2×10^2	10	1×10^2	5.5×10^2
	B	6.7×10^3	4.4×10^3	3.6×10^4	2.9×10^3	2×10^2	2.9×10^2	8.3×10^3	35	--	--	--	--
L. monocytogenes	A	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	B	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
Salmonella spp.	A	ND	--	--	--	ND	--	--	--	ND	--	--	--
	B	ND	--	--	--	ND	--	--	--	--	--	--	--

Conclusions

In this study, three types of meat products were microbiologically assessed on a four-week basis. Overall results were acceptable for the samples obtained from the retail outlets sampled from the Canterbury region. S. aureus and Salmonella tests were negative for all samples during the study period. The TAC of raw chicken samples was relatively higher than TAC detected from cooked RTE chicken samples. Retailer E had the highest bacteria counts for TAC, *E. coli* and *Staphylococcus* spp. with no *L. monocytogenes* detected and this may be due to contamination from processing plant and operator handling during manufacturing. In this experiment, *E. coli* bacteria were tested. *E. coli* is a normal non-pathogenic and useful inhabitant of the bowel. There are a minority of enterovirulent strains within the species (e.g. Enterohaemorrhagic *E. coli* (EHEC)) that cause illness ranging from travelers' diarrhoea through to a destructive and, not uncommonly, fatal illness.

EHEC produce potent toxins known as Shiga toxins which are toxic to cultured Vero cells and other toxic factors. In addition, presumptively identified bacteria as E. coli in this study require further biochemical identification. And in the future, more study can be conducted on the enterovirulent strains of E. coli. In addition, presumptive *L. monogecytogenes* was detected in raw diced chicken samples purchased from retail outlets D and F. Present studies showed that sliced meats in particular tend to have high contamination rate with *L. monocytogenes*, although actual numbers of organisms are quite low. And the long shelf life associated with these products (~ 6 weeks) can allow growth of the organism to occur. And it is advised that susceptible person such as pregnant women, should avoid to consume pre-packaged sliced meats. A report showed that during 2004-2008 there have been 33 recalls from RTE processed meats, mostly due to contamination with *L. monocytogenes* (NWS Food Authority, 2009).

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