CAMPYLOBACTER

THE ORGANISM/TOXIN

This organism causes the most commonly reported gastrointestinal disease in New Zealand. The two species *Campylobacter jejuni* and *C. coli* are most often associated with disease. Grows best in reduced oxygen atmospheres and only at temperatures exceeding room temperature.

GROWTH AND ITS CONTROL

Growth:

Temperature: Optimum 42°C, range 30.5 to 45°C. Is comparatively slow growing (fastest generation time approximately 1 hour) even under optimum conditions.

pH: Optimum 6.5 to 7.5, range 4.9 to 9.

Atmosphere: Normally requires reduced levels of oxygen – optimum growth at 3-5% oxygen and 2-10% carbon dioxide. Can be adapted to aerobic growth, although the significance of this in transmission of the disease is unclear.

Water activity: Optimum growth is at a_w = 0.997 (≡0.5% NaCl), minimum $a_w \geq 0.987$ (≡2.0% NaCl)

Survival:

Temperature: Survival in food is better under refrigeration than at room temperature, up to 15 times as long at 2°C than at 20°C. Can survive up to an hour on hands and moist surfaces. Numbers decline slowly at normal freezing temperatures after an initial reduction. Freezing therefore does not instantly inactivate the organism in food.

Atmosphere: Survives well in modified atmosphere and vacuum packaging. Usually survives poorly at atmospheric oxygen concentrations.

Viable but Non-Culturable (VNC) Cells: Under adverse conditions *Campylobacter* is said to undergo a transition to a "VNC" state. The ability for *Campylobacter* to produce VNC cells is becoming widely accepted.

Inactivation (CCPs and Hurdles):

Temperature: Rapidly inactivated by heating at 55°C and above.

D_{50} = 1-6.3 min. D_{55} = 0.6-2.3 min. D time at 60°C = 0.2-0.3 min.

pH: Growth inhibited in foods at less than pH 4.9 and above pH 9. Rapid death in foods at pH <4.0 especially at above refrigeration temperatures.

Water activity: Thought to be sensitive to drying but under certain refrigeration conditions can remain viable for several weeks.

Preservatives: Sensitive to NaCl concentrations above 1%, and death occurs slowly at 2% (D time is 5-10 hours). Ascorbic acid and several spices inhibit growth.

Sanitisers/Disinfectants: (These products must be used as advised by the manufacturer).

Sensitive to sanitisers, e.g. chlorine, used in the food industry. Equally or more sensitive than *E. coli* to water disinfection processes (monochloroamine, free chlorine).

(N.B. The absence of a sanitiser/disinfectant from this section does not necessarily imply that it is ineffective).

Radiation: Sensitive to γ irradiation. An estimated 6 D reduction would result from exposure to 2 kGy, 10 D would result from 2.5 kGy. A 2-3 kGy dose is sufficient to decontaminate meat. D values reported are 0.18 kGy in refrigerated product, 0.24 kGy in frozen product.

More sensitive to ultraviolet radiation than *E. coli* and commercial UV water treatment units producing 30 mWs/cm^2 are considered adequate.

THE ILLNESS

Incubation: 1 to 10 days (usually between 2 and 5 days) following ingestion of the bacteria.

Symptoms: Typically muscle pain, headache and fever (known as the "febrile prodrome") followed by watery or bloody diarrhoea, abdominal pain and nausea. Symptoms may last 1 day to 1 week or longer (usually 5 days). Excretion of the organism in stools occurs on average for 2 to 3 weeks and is mostly self-limiting. Hospitalisation has been reported in 13% of cases. The attack rate is around 45%.

Condition: Campylobacteriosis. *Campylobacter* colonises the gut and damages the intestine. The exact mechanisms of this remain unclear.

Toxins: Toxins are not produced in foods.

At Risk Groups: Can affect any age group but most often isolated from infants (< 1 year) and young (twenties) adults. Incidence higher in males (up to 45 years of age).

Long Term Effects: Infection may occasionally be followed by arthritis (e.g. Reiter's syndrome) or Guillain-Barré Syndrome (GBS). 1% of cases suffer reactive arthritis 7-10 days after onset. 0.1% of cases develop GBS 1-3 weeks after infection, and of these 15% recover completely, 3-8% die and the rest recover with varying degrees of impairment. A number of other less common non-enteric diseases can occur. Invasion of the bloodstream may occur in 1.5 per 100,000 cases, especially in the elderly. US data suggests a case-fatality rate of around 3 per 100,000 outbreak associated illnesses.

Dose: Consumption of 800 cells causes infection on approximately 50% of occasions, but the proportion

of people becoming sick is not as high. Dose response information for numbers less than this is not available. Modelling has indicated an "optimum" dose for becoming ill is 1,000-10,000 cells.

NZ Incidence: 320 cases/100,000 in 1998, 224.8 in 1999. There is a distinct seasonal trend, with most cases occurring in Spring and Summer. Since records were kept the overall trend is that of increasing annual rates.

Treatment: Usually none, but fluids may be given. Some cases warrant treatment with antibiotics. Erythromycin is the drug of choice, although resistant strains are emerging.

SOURCES

Human: *Campylobacter* is not one of the organisms normally found in the human intestine. Faecal-oral person-to-person transmission (in some cases by asymptomatic carriers) has been reported.

Animal: Commonly found at high numbers in the guts of ruminant animals. Some non-ruminant animals (e.g. dogs and cats) are infected with the organism and may, or may not, show signs of disease. Flies have been implicated as vectors. Birds are considered to be a primary reservoir.

Food: Raw poultry is frequently contaminated (55-60% of samples in New Zealand); cooked chicken is rarely contaminated (0.07%-NZ data). Raw milk, offal, red meat, mushrooms, garlic butter, salads and shellfish have all yielded *Campylobacter*. However pathogenic species were not detected in New Zealand commercially harvested shellfish.

Environment: Excreta from infected animals may contaminate soil or water. Environmental survival is conventionally considered to be poor but newer information suggests it may be better than currently acknowledged. For example *Campylobacter* has been detected in dry beach sand. Survival in cold water is good, but reduced at temperatures above 10^{o}C. Recreational water (i.e. river water) in New Zealand has been shown to be contaminated by *Campylobacter* present at low concentrations. *Campylobacter* is present in water and sediments more frequently and at higher numbers in the winter months. Environmental survival appears to be the opposite to human cases, i.e. survival is poorer in the warmer months.

Transmission Routes: The importance of undercooked chicken as a source of a proportion of cases of campylobacteriosis recognised, but the relative importance of other routes, e.g. other foods, recreational water, occupational exposure is unknown.

OUTBREAKS AND INCIDENTS

Outbreaks: Most cases of disease are sporadic and outbreaks relatively rare. Because the organism is unlikely to grow in foods unless they are severely temperature abused, most outbreaks are caused by cross contamination or inadequate cooking. Correct refrigeration serves to aid the survival of the organism. In general contaminated milk (usually unpasteurised) and water are considered to be responsible for most outbreaks. However, any food that may become contaminated can act as a vehicle.

New Zealand:

Liver Pâté: 12 cases. Control point failure: inadequate cooking of chicken livers.

Water: 19 cases. Control measure failure: breakdown in chlorination of town supply.

Water: 67 cases. Control point failure; unsafe drinking water supply.

Overseas:

Garlic butter: 30 cases, 4 hospitalised. Control measure failure: inadequate heat treatment.

Milk: 23 cases, 0 hospitalised. Control measure failure: milk unpasteurised.

Tuna salad: 79 cases, 39 cases in infirmary. Control measure failure: cross contamination.

Cucumber: 78 cases. Control measure failure: cross contamination.

Water: 257 cases. Control measure failure: unchlorinated water.

Stir fried chicken: 12 cases, 1 hospitalisation. Control measure failure: inadequate heat treatment.

Epidemiology: A major New Zealand study identified recent consumption of raw or undercooked chicken, and eating chicken in restaurants to be associated with disease and there was also an association with recent overseas travel, rainwater as a source of water at home, consumption of raw dairy products and contact with puppies and cattle, particularly calves.

Associations identified overseas include; occupational exposure to raw meat, having a household pet with diarrhoea, ingesting untreated water from lakes, rivers and streams, travel abroad, consumption of poultry liver, consumption of poultry, consumption of sausages at a barbecue, and eating poultry that was brought into the house raw.

ADEQUATE PROCESSING GUIDELINES

N.B. These guidelines have been derived from published information. Industry is advised to ensure that processing steps they are using are adequate to meet their particular food safety objectives.

Cook meats to:	**Internal temperature reached**	**Time**
Minced meats (beef, veal, lamb, pork) + pork cuts	71°C	15 sec
Minced poultry	74°C	″
Meat cuts (beef, veal, lamb), fish, seafood	63°C	″
Poultry, breast	77°C	″
Poultry, whole	82°C	″
Reheat cooked foods to	74°C	Instantaneous
Reduce pH of food to ≤ 4.9		
Avoid cross contamination from raw foods to cooked foods		
Avoid direct handling of cooked ready-to-eat foods		

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