Food Safety AUTHORITY OF IRELAND

MICROBIAL FACTSHEET SERIES

ISSUE NO. 1 | SEPTEMBER 2011

Cronobacter spp. (*Enterobacter sakazakii*)

1. What are *Cronobacter* spp. (*Enterobacter sakazakii*)?

In 2007, *E. sakazakii* was reclassified as *Cronobacter* spp. The new genus is composed of 6 species: *Cronobacter sakazakii*; *C. turicensis*; *C. malonaticus*; *C. muytjensii* and *C. dublinensis*. A sixth species was indicated as genomospecies I, however, it includes only 2 representative strains at the present time. *Cronobacter* spp. are synonymous with *E. sakazakii* and thus this nomenclature is used throughout this factsheet.

Cronobacter spp. have been implicated in outbreaks causing meningitis and enteritis, especially in infants.

2. Sources of *Cronobacter* spp.

The natural habitat is not well understood; however, they have been isolated from a diverse range of environments, e.g. processing plants, domestic environments, and foods, e.g. powdered infant formula, fermented bread, cheese.

3. *Cronobacter* spp. and Powdered Infant Formula

Powdered infant formula (PIF) has been implicated as the vehicle of infection in a number of neonatal infections. PIF is not a sterile product (as it is not possible to manufacture sterile powdered infant formula using current technology) and therefore may occasionally contain pathogens. PIF undergoes a pasteurisation step during its manufacturing process and although *Cronobacter* spp. do not survive pasteurisation, recontamination may occur during subsequent handling and filling, i.e. via:

1) Raw materials and in particular the heat sensitive nutrients, e.g. vitamins, minerals etc., added after pasteurisation
2) The processing environment, i.e. equipment and processing lines

Although *Cronobacter* spp. cannot grow in PIF, they can survive for a long period of time and therefore, pose a potential risk after rehydration if the product is temperature abused.

Cronobacter spp. *(Enterobacter sakazakii)*

Food Safety AUTHORITY OF IRELAND

4. Growth and Survival of *Cronobacter* spp.

PARAMETER	RANGE	OPTIMUM
Temperature for growth	6 – 45°C	37 – 43°C
Generation time* at 22°C	37 – 44 minutes	
D-value† at 60°C (*Cronobacter* spp. strain isolated from PIF)	3.52 – 3.58	

* The generation time is the time necessary to double a given bacterial population.

† D-value is the time in minutes at a given temperature to achieve a 90% reduction in the number of viable cells.

5. The Main Groups at Risk

Cronobacter spp. can cause illness in all age groups; however, the following groups have been identified based on international risk assessment (FAO/WHO, 2006):

Vulnerable group	All infants (defined as persons less than 12 months of age)
Most vulnerable group	All infants less than two months of age and all immunocompromised infants irrespective of age

6. The Infective Dose

The infective dose, i.e. the number of bacterial cells necessary to induce illness, is unknown.

7. Illnesses caused by *Cronobacter* spp.

It has been associated with neonatal meningitis, necrotising enterocolitis (NEC), bacteraemia and necrotising meningoencephalitis. Complications include neurological disorders. Mortality rates have been reported to range from 20% to as high as 50% or more.

Bowen and Braden (2006) studied 46 cases of invasive *Cronobacter* spp. infection to investigate the risk factors relating to ingestion of this pathogen in infants (the 46 cases occurred in USA, England, Denmark, Netherlands, Portugal, Iceland, Israel, Belgium and France). Twelve infants had bacteremia, 33 had meningitis and 1 had a urinary tract infection. Infants with either meningitis or bacteremia fell into 2 distinct groups:

PARAMETER	SYMPTOMS	
	Meningitis only	**Bacteremia only**
Median gestational ages	37 weeks	27.8 weeks
Median birth weights	2,454g	850g
Median age at infection onset	6 days	35 days

Those with meningitis had greater gestational age ($p=0.02$), birth weight ($p=0.002$) and developed infection at a younger age ($p<0.001$) than infants with isolated bacteremia. This may be explained by differences in time of exposure to *Cronobacter* spp. rather than differences in susceptibility.

Cronobacter spp. *(Enterobacter sakazakii)*

Food Safety AUTHORITY OF IRELAND

8. Legislation

All food business operators have a legal responsibility to produce safe food (Regulation 178/2002)[1]. The safety of foodstuffs is ensured by a preventative approach, i.e. the implementation of a food safety management system based on the principles of Hazard Analysis and Critical Control Point (HACCP). This system enables hazards to be identified and controlled before they threaten the safety of food. All food business operators, with the exception of primary producers, are legally obliged to put in place, implement and maintain a permanent procedure or procedures based on HACCP principles (Article 5 of Regulation 852/2004)[2]. Furthermore, all food business operators, including primary producers, are legally obliged to implement good hygiene practice (GHP). Regulation 852/2004 lays down hygiene requirements for all foodstuffs; while Regulation 853/2004[3] lays down more specific hygiene requirements for foods of animal origin.

Regulation 2073/2005[4] lays down microbiological criteria for various combinations of food commodities and microorganisms, their toxins or metabolites. It requires food business operators to take measures, as part of their procedures based on GHP and HACCP principles, to ensure compliance with the relevant microbiological criteria. Food business operators should test against these criteria, as appropriate, when validating and verifying the correct functioning of these procedures.

The Regulation differentiates microbiological criteria into:

1) **Process hygiene criteria:** These criteria indicate if the production process is operating in a hygienic manner. These criteria apply during or at the end of the manufacturing process. There is no process hygiene criterion set for *Cronobacter* spp.
2) **Food safety criteria:** These criteria define the acceptability of a foodstuff in terms of its microbiological safety. They are applicable to foodstuffs placed on the market during their shelf-life. The Regulation lays down a food safety criterion for *Cronobacter* spp. (*E. sakazakii*) in dried infant formulae and dried dietary foods for special medical purposes intended for infant below 6 months of age.

Regarding environmental monitoring, the Regulation also requires food business operators manufacturing dried infant formula or dried dietary foods for special medical purposes intended for infants below 6 months which pose a *Cronobacter* spp. (*E. sakazakii*) risk, to monitor the processing areas and equipment for *Enterobacteriaceae* as part of their sampling plan.

Please note: Food business operators should be aware of their obligations in these and other pieces of legislation. It is the responsibility of the food business operator to keep up-to-date with all amendments to legislation. For further information on the legislation, please consult the Food Safety Authority of Ireland (FSAI) website: http://www.fsai.ie/legislation/food_legislation.html.

[1] Regulation (EC) No 178/2002 of The European Parliament and of The Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety

[2] Regulation (EC) No 852/2004 of The European Parliament and of The Council of 29 April 2004 on the hygiene of foodstuffs

[3] Regulation (EC) No 853/2004 of The European Parliament and of The Council of 29 April 2004 laying down specific hygiene rules for food of animal origin

[4] Commission Regulation (EC) No 2073/2005 of 15 November 2005 on Microbiological Criteria for Foodstuffs

Cronobacter spp. *(Enterobacter sakazakii)*

Food Safety AUTHORITY OF IRELAND

9. Control Strategies

Control strategies are essential during the manufacture of PIF. These include:

- Monitoring the microbiological quality of the raw materials (in particular ingredients not undergoing heat treatment prior to mixing)
- Reducing the level of *Enterobacteriaceae* in the production environment. Strategies include good manufacturing practices (GMP), GHP and the implementation of an environmental monitoring programme
- Implementation of a food safety management system based on the principles of HACCP. Testing against microbiological criteria as appropriate, when validating and verifying the correct functioning of their HACCP based procedures and other hygiene control measures

Control strategies are required not only during manufacture but also during the rehydration, use and handling of PIF as *Cronobacter* spp. (if present) can pose a potential risk after rehydration (particularly if the rehydrated product is temperature abused). In addition, extrinsic contamination can occur from the preparation environment or from contaminated utensils, e.g. spoons, bottles etc, used for preparing or feeding PIF.

Guidelines on the preparation, use and handling of PIF in care settings and in the home have been published by the World Health Organization (WHO, 2007). In Ireland, information relevant to the development of guidance material for the safe feeding of reconstituted powdered infant formula has been published by the FSAI (2007) and guidelines for consumers are available from *safe*food.

Cronobacter spp. *(Enterobacter sakazakii)*

Food Safety AUTHORITY OF IRELAND

References/Further Reading

Bowen A.B., Braden C.R. (2006) Invasive *Enterobacter sakazakii* disease in infants. *Emerg. Infect. Dis.* August Publication
http://www.cdc.gov/ncidod/EID/vol12no08/05-1509.htm

Codex Alimentarius (1972) Codex standard for infant formula. Codex standard 72-1981
http://www.codexalimentarius.net/web/standard_list.jsp

European Food Safety Authority (EFSA) (2004) Opinion adopted by the BIOHAZ Panel related to the microbiological risks in infant formulae and follow-on formulae. *EFSA Journal* 113, 1-35
http://www.efsa.europa.eu/en/science/biohaz/biohaz_opinions/691.html

Food and Agricultural Organization of the United Nations (FAO) and the World Health Organization (WHO) (2004) *Enterobacter sakazakii* and other micro-organisms in powdered infant formula. Microbiological Risk Assessment Series 6
http://www.fao.org/docrep/007/y5502e/y5502e00.htm

Food and Agricultural Organization of the United Nations (FAO)/World Health Organization (WHO) (2006) *Enterobacter sakazakii* and *Salmonella* in powdered infant formula: Meeting report. Microbiological Risk Assessment Series 10
http://www.fao.org/ag/agn/agns/jemra_riskassessment_enterobacter_en.asp

Food and Agricultural Organization of the United Nations (FAO)/World Health Organization (WHO) (2008) *Enterobacter sakazakii* (*Cronobacter* spp.) in powdered follow-up formulae: Meeting report. Microbiological Risk Assessment Series 15
http://www.fao.org/ag/agn/agns/jemra_riskassessment_enterobacter_en.asp

Food Safety Authority of Ireland (FSAI) (2007) Guidance Note No. 22. Information relevant to the development of guidance material for the safe feeding of reconstituted powdered infant formula
http://www.fsai.ie/resources_and_publications/guidance_notes.html

***safe*food (2009)** Leaflet 'How to prepare your baby's bottle feed'
http://www.safefood.eu/Global/Publications/Consumer%20information/PIF%20leaflet.pdf?epslanguage=en

World Health Organization (2007) Guidelines for the safe preparation and handling of powdered infant formula
http://www.who.int/foodsafety/publications/micro/pif2007/en/index.html