A Review of the Milk Supply Chain

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Food Standards Agency

Glanbia plc

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Irish Medicines Board

Millward Brown IMS

National Milk Agency

Radiological Protection Institute of Ireland

Contents

Abbreviations

ADI	Acceptable daily intake
AFBI	Agri-Food and Biosciences Institute
BMI	Body mass index
CDSC	Communicable Disease Surveillance Centre
CVD	Cardiovascular disease
DAFF	Department of Agriculture, Fisheries and Food
DARD	Department of Agriculture Food and Rural Development
DASH	Dietary Approaches to Stop Hypertension
EFSA	European Food Safety Authority
EMEA	European Agency for the Evaluation of Medicinal Products
FBO	Food business operator
FSA	Food Standards Agency
FSAI	Food Safety Authority of Ireland
GB	Great Britain
HPSC	Health Protection Surveillance Centre
HTST	High temperature short time
IID	Infectious intestinal disease
IMB	Irish Medicines Board
IOI	island of Ireland
LRNI	Lower reference nutrient intake
MAP	Mycobacterium avium paratuberculosis
MRL	Maximum residue level
NDNS	National Diet and Nutrition Survey
NI	Northern Ireland
NSIFCS	North South Ireland Food Consumption Survey
NSS	National Surveillance Scheme

OBF	Officially brucellosis free
OTF	Officially tuberculosis free
PBM	Peak bone mass
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzo-para-dioxin
PCDF	Polychlorinated dibenzo-furan
QAB	Quality Assurance Branch
RNI	Recommended nutrient intake
ROI	Republic of Ireland
SCC	Somatic cell count
TB	Tuberculosis
TBC	Total bacterial count
UHT	Ultra high temperature
VMP	Veterinary medicinal product
VTEC	Verocytotoxigenic *Escherichia coli*

Figures

List of Tables

Executive Summary

In 2005 ***safe*food** initiated a programme which involves two comprehensive food chain screening exercises per year over a three year period. Each review profiles a specific food category, identifies and describes the relevant food safety and nutritional issues pertaining to it at various stages along the food chain, and identifies opportunities to communicate the human health benefits to, and influence the behaviour of, the various stakeholders. The primary focus of these reviews is food safety and nutrition issues; however, other concerns identified by the consumer not directly related to food safety are discussed, for example, labelling, quality assurance schemes and training.

In economic terms, the milk industry is one of the most important sectors of agriculture on the island of Ireland (IOI). In 2006, the milk sector in the Republic of Ireland (ROI) was valued at €1,323 (£882) million, while the total dairy sector accounted for 38 percent of agricultural output. In the same year the milk sector in Northern Ireland (NI) was worth £327 (€491) million and represented 31 percent of agricultural output.

In 2006, 1,902 million litres of milk were produced in NI and 5,083 million litres were produced in ROI. Fourteen percent of total milk supplies in NI were used in the production of 'liquid milk' while the corresponding figure in ROI was ten percent.

Despite being ranked eighth amongst EU Member States in terms of total milk production. ROI is, nevertheless, becoming increasingly dependent on imports of milk, with NI the sole supplier. In 2006 total milk imports for liquid milk consumption from NI amounted to 104 million litres.

Liquid milk comprises 58 percent and 47 percent of the retail dairy market in NI and ROI, respectively. Based on 2006 figures the markets were valued at £155.1 (€235.8) million in NI and €446.4 (£293.62) in ROI. 'Own label' milk now dominates sales in NI; while in ROI 47 percent of sales remain under processors' brands.

In order to ascertain consumer attitudes and behaviour to milk and dairy products ***safe*food** conducted both quantitative and qualitative research. Ninety two percent of consumers interviewed (n=814) during quantitative research consumed milk and dairy products. Of these, 33 percent consumed low fat or skimmed milk on all occasions with 12 percent of participants consuming these milks regularly. When asked about their concerns regarding milk, the issues consumers were most concerned about included shelf life, the presence of antibiotics and hormones, tuberculosis, and country of origin. Best before dates, country of origin and brand names were amongst those indicators used to reassure consumers.

According to consumers the benefits of milk and dairy products rested on their nutritional value including calcium and their established benefits on bone formation and development, but the consumption of milk arose as a habit from childhood.

Of those who did not consume milk the main reasons cited were dislike of taste and texture, with some respondents indicating that they avoided milk due to allergies.

Six focus groups were held with consumers in Belfast, Dublin, Kilkenny and Portadown to further explore some of the areas raised in the quantitative research. An underlining theme running throughout all discussions was that consumers were well aware of the benefits of milk for infants and young children; however, particularly amongst women, the perceived requirement for milk dropped off as they entered the teen and adult years and hence consumption decreased. Men were more inclined than women to continue drinking milk into adulthood.

There was a strong perception that whole fat milk was a 'fattening' food and many consumed semi-skimmed (low fat)/skimmed (fat-free) milk as a healthier alternative. Teenage girls also considered milk to be higher in fat than other dairy products. While they currently drank milk, they acknowledged that they would be less likely to do so in the future and did not see any benefit in continuing to do so. This is a concern given the fact that 42 percent of teenage girls in ROI have inadequate calcium intakes, according to the findings from the National Teen's Survey.

There were few, if any, concerns about the safety of milk. Unpasteurised milk was not considered safe and most consumers stated that they would not drink it. A perceived lengthening of the shelf-life of products was referred to and some concern was expressed that this may be as a result of the addition of additives/preservatives. There was limited understanding of the purported link between milk consumption and allergies.

Milk and milk products are a key food group in the healthy eating guidelines on IOI highlighting their importance in the diet. In ROI the dietary guidelines, in the form of the food pyramid, advise three portions of dairy a day for the general population and five for teenagers and pregnant or breastfeeding women. In the UK approximately one sixth of the 'eat well' plate is dedicated to milk and dairy products equating to three portions per day.

The North South Ireland Food Consumption Survey indicates that average consumption of whole milk amongst adults was 150g/d and of semi-skimmed milk, 88g/d. Women on the island consumed approximately 210g/d while men consumed 280g/d. However, women consumed more semi-skimmed, skimmed and flavoured milk than men (95g/d versus 80g/d); and less whole milk than men (110g versus 195g/d). The National Children's Survey in ROI indicated that amongst 5 to 12 year olds the consumption of whole milk was 238g/d and semi-skimmed and skimmed 28g/d. These intake data are in line with current market data; however, the latter data indicate that, in spite of a slight increase in consumption in recent years, there has been an overall decline in per capita consumption of milk in ROI and indeed in the EU. Beverage consumer trends show increased favour towards water, juices and soft drinks.

Contrary to popular belief, milk containing 3.9 percent fat is not classified as a high fat or high saturated fat food according to the Codex Alimentarius criteria. The availability of semi-skimmed and skimmed milks on the market in which 50 percent and 99 percent of fat, respectively, have been removed, offers the consumer choice.

Milk is an important source of calcium in the diet. The evidence underpinning the role of milk and calcium in the maintenance of bone health is compelling, although it has been established that calcium is only one of the many factors, including vitamin D and physical activity, that influence bone health.

While reports on the health effects of milk and dairy products have in the past mostly focused on bone health, it is now recognised that milk and dairy foods have broader benefits on health.

There is increasing evidence of a role for milk and dairy products in the diet for cardiovascular health. One of the key mechanisms through which milk and other dairy products are thought to protect against cardiovascular disease is by lowering blood pressure. This has been demonstrated by studies such as 'Dietary Approaches to Stop Hypertension (DASH)', which have shown that the inclusion of milk and other dairy foods in the diet can double the hypotensive effect observed with fruits and vegetables alone.

Milk consumption has been shown by meta-analyses to have a probable protective effect in colorectal cancer but there is limited and inconsistent evidence for breast cancer and prostate cancer.

More recently several cross sectional studies have indicated a beneficial effect of including milk and dairy products in the diet in the control of body weight. While the evidence is mounting the conclusions are still tentative as prospective and intervention trials have yielded inconsistent data.

Allergy to cows' milk is the most common food allergy in childhood and affects two to seven percent of babies under one year of age. Cows' milk allergy is more likely to develop in children from families with atopic (allergic) disease; however, the prognosis of childhood allergy is good with up to 90 percent of cases resolving by age three. Milk intolerance and lactose intolerance are often confused as was confirmed in the research/focus groups conducted on behalf of ***safe*food**. The former is an immune system dysfunction, whereas lactose intolerance is due to the deficiency in the enzyme lactase and is more common in adults.

In addition to being a nutritious food for humans, milk provides an excellent growth medium for micro-organisms. The naturally present organisms cause spoilage of the milk such as souring but some are pathogenic and can cause foodborne illness. The adoption of pasteurisation by the milk industry and cattle disease eradication programmes for TB and brucellosis from the 1950s to the 1980s have meant that milkborne disease is no longer a common source of human infection.

There have been no significant outbreaks of milkborne illness on IOI in recent years. Consumption of pasteurised milk ranked very low as a disease risk food group, representing two percent of all outbreaks of foodborne origin reported in England and Wales from 1992 to 2000. Nevertheless, of those who became ill there was a higher proportion of children and a comparatively higher case fatality related to mortality due to VTEC (verocytotoxigenic *Escherichia coli*) infection. As well as VTEC 0157, *Salmonella* and *Campylobacter* are the most frequently detected pathogens in milk-related outbreaks within the EU.

Pasteurisation is the single most significant step in the control of foodborne illness through the consumption of milk. Nevertheless improper handling of milk post-pasteurisation can result in its recontamination. The consumption of raw (unpasteurised) milk still occurs, particularly amongst farm families. In one qualitative study conducted in ROI in 1998, farmers stated that unpasteurised milk could be considered risk free and safe to drink on the basis of routine tests and in general tasted better than pasteurised milk.

Milk can act as a carrier matrix for chemical residues and contaminants. Monitoring programmes in ROI and NI routinely test for all chemical residues such as dioxins, furans and dioxin-like PCBs, as well as veterinary residues and growth hormones. In the years 2004 and 2005 one percent of samples tested (n=200) proved positive for veterinary residues in ROI, while in NI in 2003 one sample of 174 tested positive for alfatoxin M1. In this latter case samples in a follow-up investigation did not exceed the action level.

This review has collated and considered the information available - academic, regulatory, public health - on the safety and health implications of milk. The following conclusions are drawn, which may provide the basis for action by ***safe*****food** and other agencies on the island, as well as for stakeholders, public health professionals and consumers.

Conclusions

Primary producers and processors

- *Good hygiene during milking can reduce exposure to environmental micro-organisms reducing the pathogenic load in raw milk and the risk of animal diseases such as mastitis. Dairy farmers are obliged by regulations to employ good agriculture, hygiene and animal husbandry practices at farm level.*

- *Milk processors are also obliged to employ good manufacturing and hygiene practices.*

Distributors and transporters

- *Distributors and transporters should ensure that milk and milk products under their control are handled and stored correctly.*

- *It is essential, and indeed a legal requirement, that the chill chain is maintained throughout the food chain.*

Retailers and caterers

- *As the front line of the food industry, retailers and caterers have a legal onus of responsibility to their customers in ensuring the safety of the food that they present.*
- *Worker hygiene and hygienic practices are legal requirements and are central to the prevention of cross-contamination.*
- *HACCP is at the core of good food safety practice.*
- *The chill chain should be maintained at all stages along the food chain, including delivery to food premises.*
- *Caterers should offer a variety of milk products where possible, including whole and semi-skimmed/skimmed milks to promote choice for those who wish to avail of a lower fat option.*

Consumers
Healthy eating

Toddlers and Young Children

- *Milk is an important source of calcium in the diet of young children.*
- *Cows' milk should not be introduced before the age of 12 months but can be used to soften foods from six months onwards.*
- *Whole milk should be given until two years of age, after which semi-skimmed or low fat may be introduced.*
- *Skimmed or fat free milk should not be given to children younger than five years of age.*
- *Milk consumption by toddlers should ideally be part of a varied and balanced diet encompassing all food groups. Excessive consumption of milk can result in the displacement of other important foods in the diet, such as meat and fruits and vegetables and, in particular, compromise iron status.*

Primary School Aged Children

- *Parents and guardians should encourage their children to consume milk and dairy products from an early age thereby facilitating patterns of healthy eating.*
- *A wide range of milk and dairy products should be included in children's diets to support peak bone mass attainment.*
- *Milk and water are preferred options to soft drinks.*
- *Flavoured milks offer an option for children who do not like the flavour of plain milk; however, due to their higher sugar content, these should be consumed with meals for dental health.*

Teenagers

- *During the teenage years the consumption of milk and dairy products declines, particularly among girls. This appears to be related to the perception that milk and dairy products are fattening. Milk is not high in fat content, however, for those who consume a lot of milk, low fat options which retain the nutritional benefits of whole milk, should be considered.*

Adults

- *Semi-skimmed (low fat) and skimmed (fat free) milks are widely available as alternatives and provide a lower fat option if consumers are concerned about their fat intake. These milks have lower energy values but maintain the nutritional properties of full fat milk.*
- *Milk can be consumed as a drink but also at mealtimes, for example with cereal, or as an ingredient in puddings.*

Health Professionals

- *The importance of milk and dairy products in the diet should be promoted, especially amongst teenage girls.*
- *The continued consumption of milk and associated benefits in doing so should be promoted to young women.*
- *The broader health benefits of milk in the context of dairy products as a food group should be promoted. Dairy is no longer just about calcium and bone formation and development; it plays a role in the lowering of blood pressure; it has a protective effect against certain cancers such as colorectal cancer; and has a potential role in the control of body weight.*
- *Data showing adult consumption patterns indicate that the promotion of milk and dairy products in the context of mealtimes and with cereals or puddings is relevant for consumers. The adult data also indicates scope for increasing the consumption of milk as a drink.*
- *The establishment of milk and other dairy products as a normal part of the diet from an early age should be promoted to parents and guardians.*
- *The perception that milk is a high fat food is the main barrier to consumption, especially among teenage girls and young women. This perception needs to be addressed, as milk per se is not a high fat food.*

Food hygiene

- *Consumers should check the 'use by' date on unopened cartons/bottles of milk at the point of purchase. Cartons/bottles should also be checked to ensure that they have not been tampered with.*
- *Growth of pathogenic bacteria can occur if the cold chain is not maintained during transport of foodstuffs to the home. Raw meat should be packed in separate bags or containers away from other foods, particularly ready-to-eat foods such as milk and dairy products, to avoid potential cross-contamination. The use of insulated bags or freezer bags is recommended during transportation. Milk and other chilled and frozen food should be transported home as quickly as possible and put it in the fridge or freezer straightaway.*
- *Milk should be stored at refrigeration temperatures of 5°C or less, ideally in an opaque container to avoid the production of off-flavours.*
- *Milk should be returned to the fridge as quickly as possible after pouring out the required amount.*
- *Anyone who drinks unpasteurised milk is at the potential risk of being exposed to a number of food poisoning bacteria. Those at most risk include young children, the elderly, pregnant women or those whose immunity is low. The safest option is to drink milk that has been pasteurised. Farming families are strongly advised to either buy pasteurised milk for home consumption or to pasteurise their own milk with a reliable home pasteuriser.*

1. Introduction

1.1 Background

The purpose of this series of reviews is to provide consumers with the most relevant and pertinent information available to enable them to make informed choices with respect to the foods they eat. In doing so, the reviews set out to help consumers understand how the food safety system works; the efforts being taken by the regulators, producers, and industry, to reduce the inherent risks; and the prudent sensible steps that can be taken to address both perceived and potential risks. ***safe*food** will use the information gathered in the review to provide opportunities to promote good practice amongst all stakeholders along the food chain.

Reviews of the chicken, finfish, fruit and vegetable, and beef supply chains have already been undertaken in this series and are available to download at *www.safefood.eu*

1.2 Terms of reference

The general terms of reference for each review are to report on foods in light of their impact on human health and consumer concerns, and in particular to:

1. *Profile the food category, and identify and describe the issues relevant to human health at various points along the food chain.*
2. *Report on how the food safety system works across the entire food chain.*
3. *Identify opportunities to communicate the human health benefits and potential risks of this food category to the consumer.*
4. *Examine the various communication needs of all stakeholders to influence behaviour across the food chain.*
5. *Identify opportunities to highlight recommended best practices and develop communication programmes based on stakeholder needs.*

1.3 Scope

This document collates and considers the information available in the public domain (both regulatory and scientific) on the health and food safety implications of the milk supply chain. For the purposes of this review only non-fermented, liquid dairy products were considered.

On the basis of the evidence the review draws a number of conclusions for stakeholders in the milk supply chain, including producers, processors and distributors, as well as retailers, consumers and public health professionals.

While the primary purpose of these reviews is directly pertaining to food safety and nutrition issues, other relevant issues are discussed.

To support the technical information presented in this document, a summary document has been made available outlining the relevant points in a non-technical format.

1.4 Consumer focused review of milk

1.4.1 Introduction

Milk is the secreted fluid of the mammary glands of female mammals. Since the earliest times, mankind has used the milk of goats, sheep and cows as food. Today the term 'milk' is synonymous with cows' milk. The milk of other animals is spelled out, e.g. sheep milk or goat milk, when supplied commercially [1].

Milk can be divided into two categories, liquid milk and manufacturing milk. Liquid milk refers to milk used for direct human consumption or 'drinking milk', while manufacturing milk refers to milk used in the production of milk products such as cheese, yogurts and milk powders.

Council Regulation No. 2597/97, as amended, sets out the definitions for the various types of drinking milk (Table 6.1).

Table 1.1: Definition of drinking milk types

Category	Definition
Raw milk	Milk which has not been heated above 40°C or subjected to treatment which has an equivalent effect.
Whole milk (standardised)	Heat-treated milk standardised to a minimum 3.5% fat content. Member States may provide for an additional category of whole milk with a fat content of 4.0% or above.
Whole milk (non-standardised)	Heat-treated, non-standardised milk with a ('natural') fat content that has not been altered since the milking stage. However, the fat content may not be less than 3.5%.
Semi-skimmed milk	Heat-treated milk standardised to a fat content of between 1.5% and 1.8%.
Skimmed milk	Heat-treated milk standardised to a fat content of not more than 0.5% (previously 0.3%).

A number of other terms associated with milk are defined in Appendix A.

For consistency, the terms 'semi-skimmed' and 'skimmed' are used throughout the document although it is recognised that the terms 'low-fat' and 'fat free' are used as alternatives.

As well as a nutritionally valuable food, milk is an important food commodity on the island of Ireland (IOI).
The introduction of the pasteurisation of milk in the 1950s eliminated tuberculosis (TB), the major food safety risk, from this food. Nowadays, milk is considered to be a wholesome, safe and nutritious food.

1.4.2 Food safety risks in milk from a consumer perspective

1.4.2.1 Quantitative research

***safe*food** conducts bi-annual quantitative market research ('safetrak') during which consumers' attitudes and behaviour to particular foods and food preparation habits are determined.

Questions relating to milk and dairy products were included in two rounds of quantitative research, in January 2005 and January 2007. In January 2005 the questions relating to dairy centred mainly on consumers' food safety concerns, while in January 2007 consumers were questioned about their more general attitudes to milk and their awareness of the nutritional benefits/risks of consumption.

The research involved face-to-face interviews with participants on the island of Ireland (IOI); 819 participants were included in January 2005, 502 in the Republic of Ireland (ROI) and 317 in Northern Ireland (NI); while 814 participants were included in January 2007, 510 in ROI and 304 in NI. Samples in both rounds consisted of adults aged 15 to 74 and were representative of both jurisdictions.

When asked in January 2005 about their key concerns regarding dairy production, preparation and consumption the main (unprompted) concern of consumers on IOI was the best before date/shelf-life (Table 1.2).

Table 1.2: Key unprompted consumer concerns regarding milk and dairy products

Concern	%
Best before dates/shelf life	13
Antibiotics	7
Freshness	7
Country of origin	4
Additives/chemicals	3

When specifically asked what concerned them with respect to milk, consumers responded 'how long the shelf-life is' (Table 1.3).

Table 1.3: Key prompted consumer concerns regarding milk

Concern	%
'How long the shelf-life is'	72
'Getting food poisoning from milk'	61
'The presence of antibiotics in milk'	60
'The presence of growth hormones in milk'	60
'The presence of TB in milk'	60
'The origin of your dairy milk'	58

Shelf-life was again the issue that concerned consumers most when presented with a list of potential issues of concern with milk (Table 1.4).

Table 1.4: Issue of most concern to consumers regarding milk

Concern	%
'How long the shelf-life is'	22
'The presence of antibiotics in milk'	15
'The presence of TB in milk'	13
'The presence of growth hormones in milk'	9
'The origin of milk'	7

There were some differences in concerns between consumers in ROI and NI. Consumers in NI were more concerned about the length of the shelf-life of milk than consumers in ROI (30 percent and 19 percent, respectively); in ROI consumers were more concerned about the presence of antibiotics (18 percent and 7 percent, respectively), and the presence of TB (16 percent and 7 percent, respectively) than their NI counterparts.

The criteria that instilled confidence in the safety of the dairy supply chain in both NI and ROI were: use by dates (75 percent); country of origin (61 percent); quality assurance symbols (52 percent); brand names (51 percent); organic status (44 percent); and price (41 percent).

The results indicate a contradiction in concerns among consumers. While they utilised use by dates to ensure product safety, they were concerned about the perceived extension of the shelf-life of milk. The qualitative research shed further insight into this matter.

In January 2007, of the 814 respondents included in the second phase of quantitative research, 92 percent (n=749) consumed milk and dairy products. These consumers were asked why they ate dairy products and the top five unprompted responses were: 'because they are good for me' (44 percent); 'a good source of calcium' (30 percent); 'it's a habit' (16 percent); 'good for bone health' (15 percent); and 'something that I did as a child and have continued' (14 percent). Forty nine percent drank milk more than once a day and a further 29 percent drank milk just once a day. Three percent of this group (n=749) never drank milk, but consumed other dairy products such as cheese, yogurts, dairy spreads, etc.

Of those who consumed dairy products (n=749), including drinking milk, 92 percent never drank unpasteurised milk and 84 percent never consumed unpasteurised cheese.

Thirty three percent consumed low fat or semi-skimmed milk on all occasions, with a further 12 percent consuming it on a regular basis. Twenty one percent never drank low fat or semi-skimmed milk.

There are now a range of added value milks available on the market such as fortified milks, which have added vitamins, minerals and other nutrients, e.g. omega-3 fatty acids. Flavoured milks to which flavours such as strawberry, banana and chocolate have been added are also widely available. While these are growing in popularity, only 11 percent of respondents drank fortified milks regularly with 42 percent replying that they never consumed them. Similarly, only seven percent of respondents reported drinking flavoured milks on a regular basis, although these are targeted more at children.

Of those who did not consume milk and dairy products, taste was the main barrier (52 percent) followed by dislike of texture (21 percent) and allergies (21 percent).

1.4.2.2 Qualitative research

In March 2007, ***safefood*** commissioned qualitative research to elicit consumers' perceptions of the milk supply chain driven by the findings of the above quantitative research.

The broad core objectives were to:

- ***Assess the level of knowledge amongst the general public towards milk.***
- ***Assess attitudes towards milk consumption including motivations and barriers towards purchase/consumption.***
- ***Assess knowledge of the nutritional value and health benefits of milk.***
- ***Explore attitudes to associated contamination and microbiological risk of milk.***

Six discussion groups (eight participants per group) were held with milk consumers in ROI and NI. The groups were conducted in both urban (Dublin and Belfast) and rural (Kilkenny and Portadown) locations to provide a mix and allow for any regional variation. The groups were structured with a gender bias towards females with children in order to provide insight into their own attitudes and behaviours and those of their children and other family members. A group of young males and a mixed group of consumers in their mid to late twenties were also included to gain their perspectives on the issues.

One group with teenage girls (15 to 17 years) only was included to ascertain their views on milk and dairy products, as evidence suggests that this group is more inclined to reduce their intake of dairy products.

Table 1.5 outlines the make-up of the groups. All participants were milk consumers.

Table 1.5: Focus group matrix

Group	Gender	Life stage	Age	Social class	Location
1	Male	Single; working full time	20-24	BC1	Dublin
2	Female	Secondary school students	15-17	BC1	Kilkenny
3	Mixed	Single; working full time	25-29	BC1	Dublin
4	Female	Married with at least one child aged between 0-4 y and at least one aged between 5-12 y; homemaker working part-time	30-45	C1C2	Kilkenny
5	Female	Homemaker; married with children aged between 13-18 y (at least one daughter)	35-50	BC1	Belfast
6	Female	Married with children aged between 10-18 y (at least one daughter). Working full or part-time	35-50	C1C2	Portadown

Note: BC1 = middle and lower middle class
C1C2 = lower middle class and skilled working class.

Consumption: Patterns and influences
Drinking milk was first and foremost considered to be a habit instilled from early childhood. In almost all cases, participants had been given milk from a very young age and in turn gave it to their infants and children. Participants tended to stop or reduce the amount of milk they consumed as they grew older, and particularly as they entered the teenage years, and this laid down the pattern into adulthood. While mothers ensured that their children drank milk and they themselves had increased consumption while pregnant and breastfeeding, they did not see the need to drink it now as adults or as they grew older. This fall off in consumption was less prevalent amongst male participants.

While all participants consumed milk, it was infrequently consumed as a drink on its own per se, and more likely to be taken with food and drink items such as cereal, tea/coffee and omelettes. New products such as flavoured milks were popular with children but much less likely to be consumed by adults.

The school milk programme in ROI was spontaneously mentioned by mothers in the ROI groups and was viewed positively where their children were able to avail of it; however, the lack of such a scheme at post-primary level was considered a downside of the scheme, although mothers acknowledged little control over the eating habits of teenagers, particularly during the school day.

The majority of participants in the groups drank one of the different types of lower fat milks available on the market. There appeared to be a correlation between age and the consumption of lower fat milk, with a tendency to move to lower fat varieties as consumers got older.

When asked for their reasons for consuming lower fat varieties of milk, many reported that they felt full fat milk was ‘too creamy’ or ‘fattening’, others disliked the taste of full fat milk; however, the main overriding reason for low fat milk consumption was for perceived weight control reasons. While recognising that full fat milk contains only 3.5 percent fat, the point was made that this could be a significant daily intake of fat, if a lot of milk was being consumed. Lower fat milk was seen to have all the benefits of full fat milk, vitamins and minerals as well as taste, but without the additional fat.

In spite of the popularity of skimmed and semi-skimmed milk with adults, the importance of giving young children full fat milk was acknowledged. Nevertheless, the tendency was to move children to lower fat varieties after their formative years, some citing the current obesity epidemic as their reason.

Buying milk in bulk in the weekly shop was the main form of purchase and there was little pre-purchase consideration put into the process, with many going for the same type and brand out of habit. The quantities purchased depended on the size of the family. Families with children inevitably had to carry out a top up shop for milk throughout the week, while single participants tended to buy on an as-needed basis to avoid wastage. Milk deliveries via the traditional milkman were very much seen as a thing of the past and reasons from moving away from this service included poor service and hygiene concerns.

There were few differences in reported attitudes and behaviour amongst groups from NI and ROI, although participants in NI claimed to be more price conscious than their ROI counterparts and tended to shop around for milk and go for shop-own brands rather than proprietary brands.

Nutrition and health benefits

Milk and dairy products were considered to be healthier than red meats and ready meals such as pizza, but not as healthy as fruit and vegetables or fish and white meat such as chicken.

In general participants were knowledgeable about the dietary recommendations outlined in the Balance of Good Health[1] and the Food Pyramid and identified three portions of dairy a day as the target they should be trying to achieve. Nevertheless, portion size was an issue for some, stating that they were unsure of what exactly comprised a portion.

Participants spoke of their concerns regarding their cholesterol levels and many of the female participants had adjusted their diets, and their dairy intake (particularly cheese), to try and control their cholesterol intake. Milk was seen as less fattening than cheese or cream. Nevertheless, participants felt that milk, including low fat milk, would be placed above yogurt in terms of its fat content.

Weight and weight control issues featured strongly in discussions amongst the female groups, with many participants admitting that they had been on several different weight loss regimes. As part of these discussion dairy was a key element with some participants suggesting that dairy products contained more fats than other food groups. This issue also came across strongly when discussing the reasons for choosing low fat milks.

When asked about the health benefits of consuming milk, all participants were aware of milk as a source of calcium and the benefits of this mineral in bone and dental health. The groups considered calcium to be more important for infants and young children, with a reduced requirement for adults, hence the fall off in consumption with age.

While the issues of osteoporosis and brittle bones were raised, these were not considered to be of the same level of importance as cholesterol and heart disease.

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[1] Since the qualitative research took place, the Eatwell Plate has replaced the Balance of Good Health.

Barriers to consumption
Taste was the foremost reason cited for consumers not drinking milk. Those who disliked the taste of milk spoke in terms of the texture and flavour.

Full fat milk was considered to be fattening and a source of cholesterol and thus consumption was restricted, either overall or in terms of the variety consumed. Most of the participants had switched to lower fat varieties in the belief that this would help to reduce their intake of fat and cholesterol; however, in spite of the belief that this was a healthier option, low fat milk was still seen to contain fat and some participants claimed to limit the amount added to tea and coffee in an effort to consume less fat.

A common theme running through all discussions was that participants readily drank milk as a habit during childhood and recognised benefits such as strengthening of teeth and bones. Women recognised the importance of dairy consumption when pregnant or breastfeeding; however, as adults, they perceived no extra benefits in consuming milk. Those who had stopped or reduced the amount of milk they drank now consumed more water in its place and suggested that this was more beneficial to them. Men were more inclined than women to continue drinking milk into adulthood.

When asked how the public could be encouraged to drink more milk suggestions included:

- *Creating more awareness in general about milk and in particular highlighting the nutritional benefits of milk for adults and older people.*
- *Having smaller bottles of milk available in convenience stores that would be easier to drink and also create less food waste.*

Concerns
There were few concerns about the safety of milk. Some of the participants referred to drinking unpasteurised milk as a child but would not do so now and would not permit their children to do so either.

One issue raised was the perceived increase in the shelf-life of milk. Some participants queried whether additives or preservatives were added to milk to prolong shelf-life. There was little recognition/perception of improvements in the handling and storage or the regulations governing the milk chill chain.

When asked about milk and dairy products in relation to allergies and intolerance, participants were not able to differentiate between the two conditions but discussed illnesses amongst family members which they associated with dairy and milk consumption. These included asthma, eczema, lactose intolerance and undefined illnesses attributed to the inability to digest milk.

The origin of milk was not considered to be an issue. Milk was assumed to come from the island and milk from IOI was classed as first class given IOI's identity as a renowned dairy producing region.

Teenage attitudes and behaviours
While all the teenagers consumed milk it was more likely to be in cereals and tea and coffee, rather than as drinking milk, and low fat options were usually chosen over full fat milk. At weekends or during school holidays some acknowledged that they would often skip having cereal at breakfast time, a potentially important contributor to their milk intake. Those who drank milk believed that they would be less likely to do so in coming years and there was no overt need to do so in any case.

The barriers to consumption were similar to those in the adult groups. Taste was a primary barrier, although the teenagers conceded that they would consider milkshakes or flavoured milks.

Teenagers were more negative about the health benefits of milk than adults, considering milk to be one of the most fattening products in the dairy group. While they knew of the benefits of milk in terms of calcium and vitamins they did not consider that these applied to themselves but rather to younger children. They considered the nutritional benefits of fruit and vegetables to be more important than those of milk. None of those in the group had any concern about their low level of milk and dairy intake.

1.5 In summary

This review collates and considers the information in the public domain on the food safety and nutritional aspects of the milk supply chain on the island of Ireland.

In order to frame the review, both quantitative and qualitative research was conducted to elicit consumer attitudes, perceptions and behaviours of this particular category. The quantitative research demonstrated that consumers were primarily concerned by the length of the shelf-life of milk. The primary reason cited for consuming milk was its beneficial effects on health and calcium content. The main barrier to consumption, however, was taste, with, to a lesser extent dislike of texture and allergies.

These facilitators and barriers to consumption were also observed in the qualitative research. Milk was perceived as an important component of the diet during childhood; however, consumption was reduced or even ceased as children grew older, with teenager girls and female adults citing that there were no benefits to them in maintaining their childhood consumption levels. Fat content was an issue for consumers and, while they generally accepted that milk might not be a high fat food, they nonetheless switched to lower fat options to decrease their overall fat intake.

2. *The Supply Chain*

2.1 Overview of milk sector on the island

The dairy industry is one of the most important sectors of agriculture on the island of Ireland (IOI).

In the Republic of Ireland (ROI) milk and dairy account for 38 percent of total agricultural output which is valued at €5.2 (£3.7) billion [2]. The dairy processing industry employs over 7,000 people and makes a significant contribution to sustaining rural communities [3]. In 2005, the average family farm income on specialist dairy farms in ROI was approximately €36,690 (£24,799) compared to just under €8,030 (£5,428) on cattle rearing farms [3]. Direct payments/ subsidies contributed a percentage of farm family income, a total of 48 percent and 130 percent, respectively, for dairying and cattle rearing in 2005 [3].

In 2006, the milk sector in ROI at farm gate was valued at €1,323 (£882) million [2], while in Northern Ireland (NI) it was valued at £328 (€491) million [5].

Milk supplies produced in ROI are characterised by a highly seasonal production pattern, based on grassland milk production and seasonal calving. Nearly six times more milk is produced in peak season than in the off-peak season. This is commonly referred to as the peak to trough ratio, which is the ratio of milk supplied during the peak month of production, as measured by milk deliveries (May in ROI), versus that supplied in the lowest month's production (January in ROI). The peak to trough ratio varies for liquid milk supplies (1.8) and manufacturing milk supplies (8.7) [6]. This seasonal production has two disadvantages; increased processor operating costs and restricted types of products that can be produced [7]. In 2006 in the seven month period of March to September, 79 percent of milk supplies were produced, with the remainder produced in the five months of October to February inclusive [6].

Milk supply in NI is considerably less seasonal than in ROI, with a peak to trough ratio of 1.5 [6]. The reason for this is largely historical as suppliers in NI were given incentives to provide a consistent supply throughout the year.

Table 2.1 provides an overview of key aspects of the milk sector on IOI in 2006.

Table 2.1: Overview of milk production on the island

	ROI	NI
Total supplies – m litres	5,083	1,902
Average butterfat %	3.75	3.97
Average protein %	3.3	3.2
Peak month/trough month ratio	5.7	1.5
No. of suppliers	22,042	3,761
Average supplies/ supplier - litres	231,000	506,000

Source: National Milk Agency, 2007 [6]

Milk produced on the island is fed to calves, used for on-farm consumption, or sold to processors. Processors can utilise milk for two purposes – liquid milk for domestic consumption or manufacturing milk for butter, milk powders, cream, cheese, whole milk powder, chocolate crumb and other products. The latter are sold on the domestic market, exported or sold into intervention.

A review of the dairy industry in ROI was conducted in 2003. The report set out three key overall strategies for the future, namely: increasing industry competitiveness and cost efficiency via major consolidation and rationalisation at producer and processor level; increasing the proportion of higher added value products in the dairy product mix versus commodity-type products; and emphasising actions to underpin food safety and quality in the dairy sector [8].

2.2 Milk producer numbers

There has been a continual reduction in the number of producers involved in milk production on IOI since the introduction of the quota regime in 1984 [8].

There were 3,761 dairy farms in NI in 2006, a decrease of 45 percent on 1996 figures [9]. Despite having a significantly smaller number of producers, however, NI producers have on average twice the quota of their ROI counterparts. This is primarily because producers in NI can purchase additional milk quotas from other parts of the UK. The average quota held by producers in NI is 433,884 litres (447 tonnes) [9].

There were 22,042 active milk producers registered in ROI in 2006, a 68 percent decrease on 1984 figures [6]. ROI nevertheless still has a relatively large number of small producers, with only a small number of farmers holding large quotas [6]. While the number of producers in ROI has decreased significantly, however, the average quantity of milk deliveries by producers has increased. The average delivery by milk producers has risen from 76,000 litres in 1984 to 231,000 litres in 2006 [6, 8]. The average quota held by farmers in ROI was 238,000 litres in 2006 [2].

2.3 Dairy herd numbers

There were 296,000 dairy cows in NI in 2006, an increase of over five percent on 1996, despite an overall decrease of 20 percent in the UK for this period [9]. The average herd size has also increased in NI, from 47 in 1996 to 71 in 2006 [9] (Personal Communication Department of Agriculture and Rural Development (DARD), August 2007).

UK average milk yields increased by 23 percent from 1996 figures to 6,815 litres per cow in 2006 [9].
Figures specific to NI are unavailable.

There were 1.1 million dairy cows in ROI in 2006 [2]. The average number of cows per farm in ROI was 50, while average milk yield per cow was 4,720kg per annum [2].

2.4 Production figures

2.4.1 Northern Ireland

Domestic milk supplies in NI amounted to 1.9 million litres in 2006, an increase of over 40 percent on 2003 figures [10].

Average annual milk supplies per supplier in NI in 2006 were 506,000 litres [6].

In 2006, 14 percent of annual milk supplies in NI were utilised for processing for liquid consumption [6].

See Table 2.2 for further information on NI milk output.

Table 2.2: Milk output in NI

	2001	2002	2003	2004	2005	2006 (provisional)
Annual average number of dairy cows ('000 head)	295.5	296.7	291.1	290.1	292	294.7
Average gross yield per cow (to nearest ten litres per annum) [a]	6,210	6,120	6,260	6,230	6,540	6,590
Total output of milk for human consumption (million litres) of which:	1,799	1,780	1,786	1,788	1,870	1,903
Sales off farms	1,793	1,774	1,781	1,784	1,866	1,899
Used in farm households	6	6	5	4	4	4
Average producer price (pence per litre)						
Gross price [b]	18.95	18.95	18.46	18.67	18.31	17.14
Net price [c]	18.40	18.40	18.00	18.25	17.88	16.74
Market value (£m)	342.3	292.8	331.2	334.9	343.3	327.2
Other receipts (£m)[d]	9.2	-	-	13.6	-	-
Value of output (£m)[b]	351.5	292.8	331.2	348.5	343.5[e]	327.2[e]

Notes: (a) Comprising sales off farms, milk consumed in farm households and milk fed to other livestock
(b) After deduction of superlevy but not marketing expenses (transport costs)
(c) After deduction of marketing expenses (transport costs) but not superlevy
(d) Comprising Milk Agrimoney Compensation, Dairy Premium Scheme and Additional Dairy Premium
(e) Figure is not directly comparable with previous years because of direct payments following decoupling.
Source: Department of Agriculture and Rural Development, 2005 [5]

2.4.2 Republic of Ireland

In 2006, domestic milk supplies (to creameries and pasteurisers) in ROI were 5,083 million litres [6].

The average quantity of milk supplied by all milk producers in 2005/6 was 231,000 litres [6].

Table 2.3: Milk output and disposal on ROI[a] (whole milk only)

Million litres	2006
Manner of disposal	
Milk sold off farms	5,079
Milk used in farm households[b]	35
Imported milk intake	566
Total milk output	5,680
Of which:	
Used for liquid consumption	503
Used in the manufacture of:	
Butter	3,099
Cheese	1,294
Cream[c]	241
Whole milk powder	256
Chocolate crumb	126
Miscellaneous products	867

Notes: (a) Milk output and disposal will not reconcile due to different processes in the production of milk based products
(b) Including milk used for the production of farm butter, cream and cheese and milk given as payment in kind to agricultural employees
(c) Includes milk used for the manufacture of cream by creameries and pasteurisers
Source: Department of Agriculture, Fisheries and Food, 2007 [4]

Ninety percent of domestic supplies was used in the manufacture of dairy products, mainly for export, while ten percent was processed for liquid consumption [6].

Milk supplies from domestic milk producers comprised 82 percent of the domestic liquid milk market with imports accounting for the remainder [6].

In the milk year 2005/06 the average producer price for liquid milk was 30.63c (20.42p) per litre [6].

2.4.3 Production in a European and global context

ROI ranked eighth in terms of EU-25[2] milk production which comprised 142 million tonnes in 2006. Germany was the largest producer (20%), followed by France (18%), UK (11%), Italy (8%), Netherlands (8%), Poland (7%), Spain (4%), ROI (4%), Denmark (3%) and others (17%) [11].

The volume of cows' milk produced globally was 541 million tonnes in 2006. The largest producer was the EU-25 (25%), followed by North America (15%), South America (8%), Asia (China, India, Korea and Japan) (15%), Oceania (4%), East Europe (Common Wealth of Independent States) (9%), and others (24%) [11].

2.5 The milk processing industry

2.5.1 Northern Ireland

Drinking milk and liquid milk products are produced on 13 sites in NI (Personal Communication, DARD, August 2007).

There are two processors with annual milk supplies in excess of 80 million litres per year. The remainder process between 20 to 30 million litres per year (two processors); 10 to 20 million litres per year (two processors); one to ten million litres per year (three processors); and less than one million litres per year (two processors) (Personal Communication, DARD, August 2007).

2.5.2 Republic of Ireland

The fragmented nature of the milk industry in ROI is illustrated by the number of processors operating in this jurisdiction. Six companies process 80 percent of the milk pool compared to one in Denmark, one in New Zealand and two in the Netherlands [8].

Fifteen processors of milk for liquid consumption, with twenty one heat treatment plants, were registered with the National Milk Agency[3] in ROI in 2006. There were 32 heat treatment plants in 1995. This reflects the increasing consolidation of the industry. Two processors operating plants for the processing of milk for liquid consumption (including UHT, or 'Ultra high temperature' milk), import all their milk supplies for processing for liquid consumption from outside ROI and are not registered with the National Milk Agency [6].

Average annual milk supplies processed per plant during 2006 were 26 million litres [6]. The industry structure is nonetheless highly concentrated. The two largest processors with purchases of 349 million litres operated seven plants, while the 13 other processors registered with the Agency operated 13 plants [6].

Two processors with annual milk supplies in excess of 60 million litres account for 68 percent of all producers and 71 percent of supplies [6]. Three processors with annual supplies between 20 million and 60 million litres accounted for 16 percent of producers and 16 percent of supplies [6]. Ten processors with annual milk supplies for processing for liquid consumption of less than 20 million litres accounted for 16 percent of producers and 13 percent of supplies [6].

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[2] EU-25 Member States include the original EU-15 Member States - Belgium, France, Italy, Luxembourg, Netherlands, Denmark, Ireland, UK, Germany, Spain, Portugal, Austria, Finland, Sweden, Greece; plus the ten new Member States which were accessed in 2004 - Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Malta, Poland, Slovakia, Slovenia.

[3] The National Milk Agency was established by the Oireachtas to regulate the supply of milk for liquid consumption throughout ROI in accordance with the provisions of the Milk (Regulation of Supply) Act, 1994.

2.6 Milk imports and exports

2.6.1 Imports

2.6.1.1 Republic of Ireland

NI is the sole supplier of imported milk to the ROI market. Total milk imports from NI by processors and pasteurisers in bulk and in packaged form amounted to 612 million litres in 2006, the highest milk import volumes on record [6]. This represented 11 percent of annual domestic milk supplies and 30 percent of NI's annual milk supplies. Imports for processing into manufactured dairy products represented 90 percent of these imports, while bulk milk imports for processing for liquid consumption represented ten percent.

Total milk imports for liquid milk consumption amounted to 104 million litres. Bulk milk imports for processing for liquid consumption represented 56 percent of these imports (58 million litres), while the remainder were packaged liquid milk imports [6].

Milk imports for liquid consumption, both bulk and packaged, accounted for 18 percent of the domestic fresh liquid milk market [6].

See Table 2.4 for further information.

Table 2.4: ROI milk imports for liquid consumption (millions of litres)

	2006	2004	2002	2000	1998	1996
Consumption	568	556	563	553	543	536
Bulk Imports	58	(55)	(42)	(43)	(45)	0
Packaged Imports	46	(38)	(26)	(23)	-	-
Total Imports	104	(93)	(68)	(66)	(45)	0
Consumption from Domestic Supplies	464	463	495	487	498	536
Imports as % Consumption	18	17	12	12	9	0
Domestic Supplies as % Consumption	82	83	88	88	91	100

Source: CSO/NMA in National Milk Agency, 2007 [6]

Imports of packaged liquid milk from NI, mainly for discount retailers, represented 44 percent of imports for liquid consumption at 46 million litres [6].

Since 1996 the market share of domestic supplies for the liquid milk market has fallen from 100 percent to 82 percent, while the market share of imports has grown to 18 percent.

2.6.1.2 Northern Ireland
37.5 million litres of raw milk were imported into NI in 2006, of which 11.72 million litres comprised whole milk, with the remainder comprising skim milk [10]. The origin of these imports is not available, nor is the destination. Figures for packaged milk imports are not available.

2.6.2 Exports
Approximately €2 billion in dairy products was exported from ROI during 2006 [4]. Due to the nature of the liquid milk industry, milk produced on the island remains within the island. There are cross-border movements of liquid milk as discussed in the previous section.

Exports of skim milk, whole milk and cream from processors in ROI to NI amounted to 42 million litres in 2006 [6].

In NI in 2006, 595 million litres, or 31 percent of the annual milk supply, was exported as raw milk. Over 95 percent of these raw milk exports were to ROI [6].

2.7 *Retail milk sales*

2.7.1 Introduction
Milk comprises 58 percent and 47 percent of the dairy market in NI and ROI, respectively [12].

The retail milk market in NI was valued at £155.1 (€235.8) million in 2006 compared with £125.9 (€209.9) million in 2001. The retail market size of milk in ROI has fallen slightly from €457.2 (£274.4) million in 2001 to €446.4 (£293.62) million in 2006 [12]. This is essentially due to price and currency differences rather than sales growth, as milk is believed to have 100 percent penetration in IOI households [12].

The market share of domestic milk supplies in the fresh milk market was 82% as imported milk supplies, both bulk and packaged, increased their share to 18% in 2006 [6].

2.7.2 Distribution channels
In 2006 retailers, particularly the larger multiples, continued to grow in importance as distribution channels for liquid milk. The three major multiples (Tesco, Dunnes and Supervalu) control almost 70 percent of the market [6]. Retailers distributed 78 percent of liquid milk in ROI, while distribution doorstep deliveries reduced to seven percent and catering increased to 15 percent [6]. A breakdown of distribution channels for NI is unavailable.

2.7.3 Branded versus own label milk
In the ROI liquid milk market, over 50 percent of sales of liquid milk in retail multiples is sold under retailers' own label while the remainder is sold under processors' brands [6]. This is primarily driven by discount pricing as own label milk retailed at discounts ranging from 26 percent to 38 percent compared with processors' brands in 2006 [6].

In NI, retailers own label milk sales have almost totally displaced processors' brands accounting for 95 percent of sales [6].

2.7.4 Types of milk available on the market
2.7.4.1 Whole, semi-skimmed and skimmed milk
The main types of milks available on the market are whole (full fat), semi-skimmed (low fat) and skimmed (fat free). Whole milk is the main type of milk consumed on IOI; however, recently the increasing awareness of the recommendation to reduce dietary saturated fat and the promotion of healthy eating, has resulted in an increase in demand for semi-skimmed and skimmed products. Semi-skimmed and skimmed milk products are produced by

skimming off separated cream and the removal of other fat from whole milk. In 2006, sales of whole milk on the island accounted for 73 percent of fresh milk sales, while sales of semi-skimmed and skimmed milk accounted for the remainder [6]. The fresh milk product profile in ROI is different to the UK, where in excess of 75 percent of sales is of semi-skimmed and skimmed milk [6].

Compositional quality of drinking milk
Marketing and quality standards for drinking milk are laid down in Council Regulation No. 2597/97, as amended. This legislation sets out the definitions for the types of drinking milk (as outlined in Section 1.4.1) and the permissible fat and protein content ranges for these milks.

The Regulation also permits the addition of milk protein, vitamins and minerals to drinking milk, provided that, in the case of protein enriched milk, the protein content is at least 3.8 percent.

Council Regulation 2597/97 also established a new freezing point requirement for drinking milk (a test to detect the illegal addition of water). Former legislation stipulated that the freezing point could not be higher than -0.52°C. The new freezing point requirement for drinking milk is stipulated in more general terms, i.e. it must be close to the average freezing point for raw milk recorded in the area where the milk originated.

The Regulation also specifies minimum standards relating to the mass and not-fat solids contained in drinking milk. These particular provisions applied from January 1999 but have since been withdrawn by Regulation 1602/99. All drinking milks which have been modified in any of the ways previously described must display clear and appropriate labelling on their packaging. Each Member State can choose to limit or ban protein enrichment and/or lactose reduction in drinking milk, but the UK and ROI Governments have not introduced any such restrictions.

Regulation 1602/99 further directed Member States to lay down appropriate rules to ensure that milk products contain at least the natural protein content of milk and to make provision for penalties to be applied if any part of the regulations is contravened. The establishment of uniform compositional standards is intended to enhance consumer confidence in the quality and nutritional value of drinking milk.

Milk imported into the EU must also comply with all aspects of Regulation 2597/97.

2.7.4.2 Organic milk
The market for organic milk on IOI is still very much a niche market.

While the organic milk retail market share in ROI has increased by 112.5 percent from €3.2 (£2.2) million in 2003 to €6.8 (£4.6) million in 2006; in real terms organic milk sales only accounted for one percent of total milk sales in 2006 [12].

There are approximately 20 producers of organic milk in NI, including four producers who are currently in the process of conversion. It is estimated that 14 million litres of organic milk were produced in NI in 2006. Organic milk is used both in the production of liquid milk and yogurt (Personal Communication, Industry Source, October 2007).

'Organic' is a term used to describe a particular method of production at farm level, and is therefore a 'process claim' rather than a 'product claim'. Claims for organic farming include the consideration and application of production methods that do not damage the environment; concern for animal welfare; sustainability; and the production of high quality goods.

Organic produce must be in accordance with the standard practices set out by the European Council Regulation 2092/91 as amended and monitored by certifying bodies in each country (Appendix B). Organic farming avoids the use of synthetic fertilisers, chemicals and/or additives. Produce which has been produced by genetic modification or contains any such produce cannot be considered organic.

The organic sector on IOI is regulated by the Department of Agriculture, Fisheries and Food (ROI) and the Department of Agriculture and Rural Development (NI). Farmers, processors and importers have to undergo a stringent annual inspection process before receiving a licence from one of the certification bodies to sell their produce as organic. All food produced to these standards is permitted to be labelled with the word 'ORGANIC'.

The question of whether organic food is significantly different to conventional food with respect to nutritional content or quality is still a matter of public and scientific debate, with published literature supporting both sides of the argument [13] - please see section 3.2.1 for further information. However, while the nutritional composition and quality of foods can be influenced by the farming system used, other factors can also have an effect. These factors include variations in plant or animal varieties, climatic conditions, prevailing soil types and farming practices such as irrigation, crop rotation and fertilising regimes [14].

Organic foods are subject to the same stringent food safety regulations as all food consumed, distributed, marketed or produced on IOI and so are considered as safe as any other food on the market.

2.8 In summary

The milk sector makes a valuable contribution to the economies of NI and ROI and in 2006 was valued at £327 (€491) million and €1,323 (£882) million, respectively.

Total milk production in 2006 was 1,902 million litres in NI and 5,083 million litres in ROI. There are nearly six times more milk producers in ROI compared with NI (22,000 compared with 3,800), nevertheless, NI producers supply just over twice the amount of milk compared with ROI producers (506,000 litres compared with 231,000 litres). Fourteen per cent of total milk supplies in NI are used for the production of milk for liquid consumption compared with ten per cent in ROI.

NI is the sole supplier of milk imports to ROI. In 2006, 612 million litres were imported into ROI, representing 30 percent of NI production.

The retail milk market was valued at £155.1 (€235.8) million in NI and €464.4 (£293.62) million in ROI in 2006. Liquid milk at retail level in ROI is comprised of domestically produced milk (82 per cent) and imported milk (18 per cent).

There is a 50/50 spilt in ROI between own-branded and processors' label milk compared with a 95/5 split in NI. Despite a shift in the types of milk purchased in recent years, whole milk is still the main milk type available on the IOI market (73 percent), with semi-skimmed and skimmed milk accounting for the remainder.

3. Nutrition and Health

3.1 Introduction

Milk and milk products, including cheeses and yoghurts, are a key food group in the healthy eating guidelines on the island of Ireland (IOI). In the Republic of Ireland (ROI), the dietary guidelines advise three portions of dairy a day for most people except teenagers and expectant and breastfeeding women where five portions a day are recommended [15]. In the UK, dairy products make up about one sixth of food intake by weight for a healthy balanced diet [16, 17]. This equates to approximately three portions of dairy foods a day for most people.

3.2 Nutritional composition of milk

Milk contains a wide variety of nutrients essential for health. These include protein, calcium, vitamin A and riboflavin. The nutritional composition of the three main types of milk is given in Table 3.1.

Table 3.1: Macro-nutrient and selected micro-nutrient composition of common cows' milks (per 100g)

	Type of Milk		
	Whole	Semi-skimmed	Skimmed
Water (g)	87.3	89.4	90.8
Energy (kcal)	66	46	34
(kJ)	274	195	144
Protein (g)	3.3	3.5	3.5
Fat (g)	3.9	1.7	0.2
Saturated Fat (g)	2.5	1.1	0.1
Sugar (g)	4.6	4.7	4.8
Lactose (g)	4.6	4.7	4.8
Calcium (mg)	118	125	120
Vitamin A (µg)	59	28	Trace
Riboflavin (mg)	0.23	0.24	0.22

Source: Food Standards Agency, 2002 [18]

The major protein in milk is casein, which in cow's milk is about 80 percent of the total; the other major proteins are lactalbumin and lactoglobulin. Milk is considered of high biological value with regard to protein because it is a good source of the essential amino acids. Whole milk has marginally less protein than skimmed or semi-skimmed milks, in which the fat fraction is replaced by protein.

Contrary to popular belief, milk is not a high fat or high saturated fat food based on the classification of low and high fat foods (Table 3.2) [19]. Nevertheless, due to the fermentation of carbohydrates in the gut of ruminant animals such as cows, there is a higher ratio of saturated fatty acids relative to unsaturated fatty acids in milk. The removal of fat from whole milk results in a reduction of the energy content of the milk. Semi-skimmed or low fat milk, in which approximately 50 percent of the fat is removed, reduces the energy content by 30 percent, while skimmed or fat free milk which has almost all the fat removed, has a reduced energy content of 50 percent (Table 3.1).

Table 3.2: Conditions for the classification of low fat foods

	Low	Free
	Not more than	
Fat	3 g per 100 g (solids) 1.5 g per 100 ml (liquids)	0.5 g per 100 g (solids) or 100 ml (liquids)
Saturated Fat	1.5 g per 100 g (solids) 0.75 g per 100 ml (liquids) and 10% of energy	0.1 g per 100 g (solids) 0.1 g per 100 ml (liquids)

Source: Codex Alimentarius Commission, 2004 [19]

Milk contains the disaccharide lactose and milk and its products are the only known sources of this sugar in the diet. This type of sugar, known as intrinsic sugar because it is not added to the food, is not associated with any adverse effects on dental health. Furthermore, milk tends to be high in protein, calcium and phosphates, which help to neutralise acid production in the mouth [20].

Milk is an important source of calcium in the diet. Along with other inorganic nutrients such as phosphorus and potassium the calcium content is dependent on the protein content. Therefore there is slightly more calcium in the lower fat milk varieties due to their higher protein content.

The levels of fat soluble vitamins present in milk are dependent on what the animal was fed and also on the level of fat present in the milk. Skimmed and semi-skimmed milks have lower levels of the fat soluble vitamins than whole milk. For this reason many manufacturers of skimmed and semi-skimmed milks fortify their products with a vitamin mix. Milk is also a good source of the water soluble B vitamins. Riboflavin levels, however, decline during storage and following exposure to light. Unpasteurised or raw milk is a source of vitamin C but, due to the heat applied during pasteurisation, there are substantial losses of this vitamin. Similarly, levels of thiamin are reduced during pasteurisation.

Table 3.3 provides the nutritional composition of a range of dairy products. A typical portion of semi-skimmed milk (200ml glass) is lower in fat and saturated fat than a standard portion of cheddar cheese (30g). It is also lower in sugar per portion than low fat yoghurt and flavoured milks. Flavoured milks tend to be a combination of whole and skimmed milks and are higher in sucrose due to the addition of sugar.

Table 3.3: Macro-nutrient composition of milks (per serving)

	Dairy Products			
	200ml glass of semi skimmed milk	Portion of cheddar cheese (45g*)	Pot of low fat yoghurt 125g	200ml flavoured milk
Water (g)	178.8	16.5	98.6	167.8
Energy (kcal)	92	187.2	97.5	128
(kJ)	390	776.3	413.8	540
Protein (g)	7.0	11.4	5.3	7.2
Fat (g)	3.4	15.7	1.4	3.0
Saturated Fat (g)	2.2	9.8	1.0	2.0
Sugar (g)	9.4	0.1	12.7	17.8
Lactose (g)	9.4	0	4.4	9.8
Sucrose (g)	0	0	6.1	7.8
Calcium (mg)	250	332	175	230
Vitamin A (µg)	56	227	12.5	56
Riboflavin (mg)	0.48	0.17	0.26	0.34

Note: Serving sizes as per Crawley, 1994 [21].
*Portion size for cheddar cheese is that used in a sandwich not a portion to be consumed on its own (30g).
Source: Adapted from Food Standards Agency, 2002 [22]

In addition to the fortification of reduced fat milk with vitamins and minerals lost during processing, an increasing number of milks on the market are fortified with other nutrients such as folic acid and functional ingredients, e.g. omega-3 and probiotic bacteria.

3.2.1 Nutritional quality of organic versus conventional milk

There is an ongoing debate over the nutritional attributes of organic versus conventional milk with published studies supporting both sides of the argument. Based on the balance of current scientific evidence, however, organic milk confers no additional nutritional benefits over conventionally produced milk.

The following sections outline the findings of two of the most recently published studies on the nutritional attributes of organic milk. The FSA in the UK is currently reviewing the available evidence in relation to the nutritional attributes of all organically produced foodstuffs.

3.2.1.1 Fatty acid content
A 12-month longitudinal study of the fatty acid content of organic versus conventional milk was conducted by researchers at the University of Glasgow [23]. Bulk-tank milk was collected each month from organic (n=17) and conventional (n=19) dairy farms in the UK. Organic milk was found to have a higher proportion of polyunsaturated fatty acids to mono-unsaturated fatty acids and of n-3 fatty acids than conventional milk, and contained a consistently lower n-6:n-3 fatty acid ratio (which is considered beneficial) compared with conventional milk.

The FSA conducted an assessment of the evidence provided by this study which included new evidence from a separate study on the composition of organic milk [24]. It concluded that, while the initial study showed that organically produced milk can contain higher levels of short-chain omega-3 fatty acids than conventionally produced milk, the evidence suggests that these fatty acids appear to be of limited health benefit compared to the longer chain omega-3 fatty acids found in oily fish [25, 26]. Short-chain fatty acids can be converted to these long-chain omega-3 fatty acids, which have been shown to be protective against cardiovascular disease. However the conversion rate of the short-chain fatty acids to the longer chain fatty acids appears to be very limited [27, 28]. Therefore, organic milk consumed in volumes consistent with a healthy dietwould not provide sufficient amounts of long-chain omega-3 fatty acids to provide significant health benefitsabove those associated with conventional milk [29].

3.2.1.2 Micro-nutrient content
Further analysis of the milk samples collected in the Glasgow study was conducted to determine the vitamin A (retinol), vitamin E (alpha-tocopherol) and beta-carotene contents. Conventionally produced milk fat had a higher mean content of vitamin A than organically produced milk fat, although there were no significant differences in the vitamin E or beta-carotene contents between the two types of milk fat [30]. The results considered confounding factors such as nutrition and herd yield.

3.3 Dietary composition patterns

3.3.1 Consumption based on market data

3.3.1.1 Island of Ireland
Total consumption of fresh milk in ROI was 568 million litres in 2006 [6]. This comprised 414.0 and 145.0 million litres of whole milk and reduced fat milk respectively, compared with 422.6 and 133.5 respectively in 2004 [31]. Per capita consumption of milk in ROI is now the highest in the EU at 0.4 litres per day (146 litres per annum) and double the EU average [32].

Despite the increase in milk consumption during 2005, there has been an overall decline in per capita consumption in ROI and indeed in the EU in recent years. Beverage consumer trends show increased favour towards water, juices and soft drinks. Despite this however, innovation in the liquid milk category has occurred to offset this decline, for example flavoured and probiotic milks.

3.3.1.2 Europe and worldwide
The role of milk in the traditional diet has varied greatly in different regions of the world. The tropical countries are not traditional milk consumers, whereas the more northern regions of the world, Europe (especially Scandinavia) and North America, have traditionally consumed far more milk and milk products in their diet. In tropical countries, where high temperatures and lack of refrigeration has led to the inability to produce and store fresh milk, milk has traditionally been preserved through means other than refrigeration, including immediate consumption of warm milk after milking, by boiling milk, or by conversion into more stable products such as fermented milks [11]. Even within regions such as Europe, the custom of milk consumption has varied greatly. There is high consumption of fluid milk in countries like Finland, Norway and Sweden compared to France and Germany where cheeses have tended to dominate dairy consumption (Table 3.4).

Table 3.4: EU milk consumption in 2005

Country	'000 tonnes	kg/capita
Finland	949	182.5
Sweden	1,340	149.5
Denmark	735	135.7
ROI	536	129.8
Netherlands	2,064	126.5
Spain	5,120	119.1
UK	6,500	111.2
Cyprus	83	115.0
France	5,851	93.9
Germany	7,643	92.7
EU-15	37,480	98.6
EU-10	5,221	69.6
EU-25	42,701	92.7

Note: EU-25 Member States include the original EU-15 Member States - Belgium, France, Italy, Luxembourg, Netherlands, Denmark, Ireland, UK, Germany, Spain, Portugal, Austria, Finland, Sweden, Greece; plus the ten new Member States (EU-10) which were accessed in 2004 - Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Malta, Poland, Slovakia, Slovenia.
Source: International Dairy Federation, 2007 [33]

3.3.2 Consumption based on dietary surveys

3.3.2.1 Adults

The North South Ireland Food Consumption Survey (NSIFCS) of adults aged 18 to 64 years (n=1,379) on IOI showed an average intake of whole milk, semi-skimmed, skimmed and fortified milks and other milks of 150, 88 and 5g/d, respectively [34]. Of the population studied 73 percent were consumers of whole milk and 45 percent were consumers of semi-skimmed, skimmed and fortified milks. The average intake among these consumers was 205 and 194g/d, respectively.

Men in the study consumed approximately 280g/d, while women consumed 210g/d. Women consumed more semi-skimmed, skimmed and flavoured milk than men (95g/d versus 80g/d); and less whole milk than men (110g versus 195g/d). Both groups drank the same amount of other milk (5g/d).

A temporal analysis of milk intake was carried out on the ROI cohort of the NSIFCS population to investigate the pattern of consumption throughout the day and week [35]. Milk consumption showed mealtime peaks for morning, afternoon and evening, with consumption in the mornings higher than at other occasions. Whole and reduced fat milk intake was higher and much higher, respectively, at this time. Among consumers of full fat milk, consumption was lower at the weekend than during weekdays. The consumption of semi-skimmed milk was similar across all days of the week. The mean intake of full fat milk ranged from 217 to 263g/d among consumers and for semi-skimmed milk ranged from 206 to 229g/d.

The National Diet and Nutrition Survey (NDNS) of adults aged 18 to 64 years in Great Britain (GB) found that ninety four percent of the population consumed milk, both full fat and skimmed varieties. A mean daily intake of all milks (whole, semi-skimmed and skimmed milk) of 204g/d and 217g/d for the total population and population of consumers only, respectively, was reported [36].

Breaking consumption down by type of milk, the mean daily intake for the total population in GB was 48g/d whole milk, 125g/d semi-skimmed milk and 30g/d skimmed milk [37]. Seventy three percent of the population consumed semi-skimmed milk compared to 36 percent and 18 percent for whole milk and skimmed milk, respectively. Women were more likely to consume skimmed milk than men, and those in receipt of social benefit were more likely to drink whole milk. Forty-five percent of men and 56 percent of women reported not consuming milk as a drink, compared to 18 percent of men and 13 percent of women who never used milk on cereals and in puddings.

In a survey of 1,751 adults in Northern Ireland (NI), 59 percent of all milk used was semi-skimmed [38]. Sixty eight percent of non-manual and 70 percent of higher income households used semi-skimmed milk, compared with 54 percent of manual and 51 percent of lower income households. The study also reported that people in households with children were more likely to use whole milk compared to other households.

3.3.2.2 Children and adolescents

Analysis of the National Children's Food Survey of 5 to 12 year olds in ROI has indicated that the average milk consumption among this group was 276g/d [39]. Average consumption of whole milk was 238g/d; semi-skimmed, skimmed and fortified milk was 28g/d; and other milks (e.g. processed milks) was 10g/d.

A survey in NI found that 55 percent children aged 12 to 17 years and 42 percent children aged 5 to 11 years reported using semi-skimmed milk [38]. Children from working class households were less likely to consume semi-skimmed milk; and older girls were found to be five times more likely to consume no milk compared with younger children and adolescent boys. Five percent of girls aged 12 to 17 years consumed no milk at all.

In GB the NDNS survey of children and young people aged 4 to 18 years found that five percent of all respondents reported no consumption of milk, with the older age groups containing a higher proportion of non-milk consumers [37]. Younger age groups were most likely to drink whole milk but by seven over 50 percent of the cohort were consuming lower fat versions.

A further survey by the NDNS of 1.5 to 4.5 year olds [37] found that toddlers were mainly drinking whole milk, consuming on average 214g/d per day with four percent of the population consuming skimmed milk. Fifty-seven percent of children were found to have been given whole milk before 12 months of age, 55 percent semi-skimmed milk before the age of two years and five percent skimmed milk before 4.5 years. Two percent of children had been given semi-skimmed milk before they were nine months and four percent before aged one.

Current recommendations indicate the introduction of whole cows' milk as a drink only after the age of 12 monthswhile children can be given semi skimmed milk from the age of two, and skimmed milk aged 5 years or more, provided that the child is a good eater and has a healthy diet [40, 41]. The rationale for the introduction of the lower fat options only at a later age is due to the lower energy and fat soluble vitamin content of these milks. Before the age of 12 months breast milk is recommended but, in the event of alternative feeding, formula or follow-on milks from six months are recommended due to the fact they are fortified with iron and cows' milk is a poor source of iron.

Cows' milk can be added in small amounts to foods to soften them from six months onwards [42].

3.4 Contribution to nutrient intake

Among the total population studied in the NSIFCS milk and yoghurt contributed seven percent to total energy intake and to nine, six and eleven percent of energy from fat, carbohydrate and protein, respectively (McGowan et al. 2001; Harrington et al. 2001). Milk and yoghurt contributed significant amounts to the following nutrients: calcium, 34.7%; total vitamin A, 14.2%; riboflavin, 24.1%; vitamin B12, 24.2%; biotin and panthothenate, 15.6%; and phosphorus, 17.3%.

Twenty three percent of women and 10.7% of men had calcium intakes below the adequate requirement and 8.4% and 2.9% of women and men had intakes below the lower reference nutrient intake (LRNI).

In the NDNS of adults aged 19 to 64 years in GB, milk and milk products contributed 43% of calcium intake [36]. Two percent of men and five percent of women were found to have calcium intakes below the LRNI.

In the National Children's Survey 28% of boys and 37% of girls in ROI were found to have inadequate intakes of calcium [35], as a result of low dairy intake.

Preliminary data from the National Teen's Survey in ROI demonstrated that 42 percent of teenage girls have inadequate calcium intakes (Personal Communication, Irish Universities Nutrition Alliance, January 2008).

In GB milk and milk products contributed 47 and 48 percent of calcium intake for girls and boys, respectively [37]. Nevertheless, one in eight boys and one in four girls aged 11 to 14 years had a daily intake of calcium below the LRNI. For 15 to 18 year olds, nine percent of boys and 19 percent of girls were found to have intakes below the LRNI.

In the younger age group (1.5 to 4.5 year olds) the contribution of milk to calcium intake declined with increasing age, yet milk remained the main source of calcium in the diet for this age group. In the under four year olds, 11 percent of children were found to have calcium intakes below the LRNI for calcium, while in the older group 24 percent of children had calcium intakes below the LRNI.

Another nutrient of importance in this age group is iron. The NDNS found that 84 percent of children under the age of four years had intakes of iron below the recommended nutrient intake (RNI) with 16 percent having intakes falling below the LRNI. Measures of iron status in this group were inversely related to the consumption of milk and milk products [43]. Calcium has been identified as an inhibitor of iron absorption but is thought to have little effect in complex meals [44]. The displacement of iron rich and iron enhancing foods when large quantities of milk are consumed is the most likely factor driving the association between iron status and milk. This is supported by the fact that children consuming more than 400g milk per day consumed less amounts of meat, fish, eggs, cereals and fruit. However, iron status was not affected in those children who consumed moderate or high amounts of these foods plus 400g of milk per day. This data highlights the need for a balance of all foods in the diet.

3.5 Milk and health

Milk and other dairy foods provide rich dietary sources of many nutrients, most notably calcium. However, like other whole foods, milk and dairy foods provide a mixture of nutrients and other bio-active compounds that are likely to work in synergy once ingested.

Reports on the health benefits of milk and dairy products have in the past mostly focused on bone health, however it is now recognised that milk and dairy foods have broader benefits on health. Milk and dairy products also play a role in cardiovascular disease and certain cancers; and there is emerging evidence to suggest that they have the potential to play a role in weight management.

3.5.1: Bone health

Bone is a living organ continually being broken down (bone resorption) and built up (bone formation) in a process known as bone remodelling or turnover. This cycle ensures that bone is maintained in an optimal condition and also that the blood has enough calcium to maintain other metabolic reactions that are calcium-dependent.

Up until the attainment of peak bone mass (PBM), by approximately age 20 to 30 years, the process of bone formation exceeds that of bone resorption. Thereafter, bone mass starts to decline as the process of bone resorption exceeds that of bone formation resulting in a net bone loss. This process is accelerated in women after the onset of menopause when approximately one third of cortical (dense outer layer) bone tissue and one half of cancellous (spongy inner layer) bone tissue are lost due to the changes in hormonal levels. In men bone loss is more gradual but can be accelerated (as in women) by a decrease in physical activity and muscle strength.

During childhood and adolescence the attainment of a high as possible PBM is the most important aspect of bone health, while in adulthood the prevention of excess bone loss is the key issue. PBM and bone loss are strong predictors of the risk of osteoporosis. Osteoporosis is a condition characterised by low bone mass and micro architectural deterioration of bone tissue which leads to an increased risk of fracture. Osteoporosis is a disabling disease and is described as a silent disease as it often goes unnoticed until a fracture occurs.

Bone health is influenced by many factors. However, the raw materials for bone remodelling during growth and in later years must be supplied by the diet. Milk and dairy foods are rich sources of the nutrients required for bone metabolism and growth including protein and calcium, and are positively associated with bone health. Vitamin D also plays an essential role in bone health; however, milk is not a particularly rich source of this nutrient.

About 90 percent of the calcium in the body is found in the skeleton. At birth the skeleton contains approximately 25g of calcium which increases approximately forty fold to 1000g by the time PBM is attained in late adolescence. This additional calcium must come from the diet with milk and dairy products being one of the most readily bio-available sources.

The influence of dairy consumption has been investigated in many studies. Investigators in one meta-analysis concluded that calcium and dairy products were effective at augmenting bone gain during growth, retarding age-related bone loss and reducing osteoporotic fracture risk [45]. While in another review, which specifically looked at the evidence evaluating the effect of dairy foods in bone health, the most favourable effects were observed in women under the age of 30 years [46].

In the latter review, the authors highlighted the fact that dairy foods would be expected to have varying effects on bone health given their varied nutritional composition. Milk and yoghurt have a lower sodium and protein concentration compared with cheese. High intakes of animal protein and sodium have been associated with increased urinary calcium excretion in metabolic studies [47, 48]. The ratio of calcium to either sodium or protein seems to be the crucial factor in determining this effect [45, 49]. The negative effect of protein and sodium are primarily seen in those with low calcium intakes.

There are only two studies that have compared the effect of different dairy products on bone health, one in Asian women [50] and one in osteoporotic female patients [51]. Both of these studies found a favourable effect of milk on bone health markers compared to total dairy intake and cheese alone. This highlights the importance of differentiating the different types of dairy sources when studying their impact on health.

While calcium has a pivotal role in bone health, there is now increasing evidence that it is only one of several factors at play. Studies investigating the effect of calcium supplementation on bone health have shown a reduction in the risk of fracture by 30 percent in post-menopausal women taking doses of 1000mg/d [52]. However, among other age groups the evidence is less clear.

One review of 58 studies, including cross sectional, cohort and randomised controlled studies, which sought to establish the role of calcium intake, from either supplements or diet, on childhood bone mineralisation was published in 2007 [49]. The authors concluded that the evidence was inconclusive to support the promotion of increased dairy intake to achieve dietary calcium intakes in children and adolescents beyond current intakes.

Furthermore, a meta-analysis of randomised controlled trials investigating the effects of calcium supplementation on bone density in healthy children was conducted [53]. The investigators concluded that calcium supplementation only provided a modest benefit on bone mineral density that was unlikely to have an impact on fracture risk later in life.

The authors of these reviews highlight the many limitations of the data available, including few studies that corrected for body size and the fact that many studies included children with already adequate baseline calcium intakes. The studies also raise the question of whether current US recommended intakes for adolescents are too high. In the US 1300mg calcium/d is recommended compared to 800 to 1000mg/d in the UK and 1200mg/d in ROI. However, more importantly, they underpin the existing evidence suggesting that bone health is about more than calcium intake. Physical activity, most specifically weight bearing exercise, is also paramount in attaining good PBM and maintaining bone strength.

3.5.2 Cardiovascular disease

Cardiovascular disease (CVD), which includes stroke and coronary heart disease, is a leading cause of death on IOI and indeed worldwide. Some of the major risk factors for CVD, which include high blood cholesterol and triglyceride levels, hypertension, obesity and diabetes are modifiable through the diet.

CVD has been well studied, particularly in relation to the role that diet plays in the development of these diseases. Nevertheless, only a small number of studies have set out to evaluate the effect of milk and dairy products on the development of CVD. In spite of the small number of studies, the evidence to date provides a strong indication that milk and dairy products play a protective role in these conditions.

The role of dietary fat and in particular saturated fat in the development of heart disease has been well established [54] and there is increased emphasis on the need to replace higher fat foods with lower fat varieties, including milk and dairy products. Whole milk itself at 3.9 percent fat [22] is not considered to be a high fat food, although it does contain relatively higher levels of saturated fat when compared with low fat varieties. Nevertheless, there is a misconception among the general public that milk, including lower fat varieties, is ‘fattening’ and should be avoided altogether.

Among the Caerphilly cohort, a representative sample of men from South Wales who were followed for 19 to 23 years, a median (144ml/day) or higher milk intake was associated with a reduced risk of ischaemic stroke4 (Relative odds 0.52) and ischaemic heart disease (Relative odds of 0.88) compared to low milk consumers [55]. This data supported the findings from a previous review of ten cohort studies, involving over 400,000 men and women, which revealed a 13 percent lower risk of heart disease and a 17 percent lower risk of stroke for those with the highest milk consumption compared to the lowest [56]. The authors point out that most of the consumption of milk was in the form of full fat milk in these studies. These data support the inclusion of milk in the diet for cardiovascular health.

One of the key mechanisms through which milk and other dairy products are thought to protect against CVD is by lowering blood pressure. The Dietary Approaches to Stop Hypertension (DASH) diet, which is characterised by a diet rich in fruits and vegetables and low fat dairy products and low in other fats, has been associated with lowering blood pressure [57]. The DASH diet has been shown to reduce systolic blood pressure by 5.5mmHg and diastolic blood pressure by 3.0mmHg [57]. In a review of the results of the DASH diet the inclusion of three to four servings of dairy products, in addition to a high fruit and vegetable intake, reduced systolic blood pressure by 2.7mmHg and diastolic blood pressure by 1.9mmHg, compared to a diet rich in fruits and vegetables but low in dairy products [58]. This data indicates that the inclusion of milk and other dairy foods in the diet can double the hypotensive effect seen with fruits and vegetables alone.

One of the key features of the DASH studies, which have included approximately 500 adults, is the very high compliance to the diet, indicating that it is achievable in practice.

In a review published in 2000, which included several studies including the DASH diet, the authors concluded that there is consistent and reproducible evidence that the consumption of dairy products has a beneficial effect on blood pressure [59].

The Framingham Children's Study, a prospective study which followed 106 children from pre-school years into adolescence, demonstrated that a dairy-rich diet (> two servings per day), in association with high intakes of fruit and vegetables (> four servings per day), leads to beneficial effects on blood pressure in children [60].

3.5.3 Cancer

While some of the evidence is not yet convincing, there appears to be a positive relationship between the consumption of dairy products and the reduced risk of colorectal cancer. There is limited evidence to suggest that milk and dairy products are causative agents of breast and prostate cancer and thus no conclusions can be drawn.

3.5.3.1 Colorectal cancer

A meta-analysis of ten cohort studies involving 534,536 participants was conducted as part of the Pooling Project of Prospective Studies of Diet and Cancer [61]. Due to the large number of participants in this analysis, milk was differentiated from other dairy foods. The analysis found that participants who consumed less than 70g of milk a day had an increased risk of developing colorectal cancer (relative risk of 0.85) compared to those who consumed 250g or more of milk per day. In practical terms this finding translates into 'people who consumed less than a quarter of a glass of milk every day had 15 percent more risk of colorectal cancer than those who consumed one glass of milk or more a day' [62]. With the exception of ricotta and cottage cheese, which were also found to be protective, other dairy foods had little or no impact on colorectal cancer risk.

[4] Most strokes are classified as ischaemic where tissue damage or death are caused by a blockage of the blood supply to the brain. A smaller proportion of strokes are hemorrhagic in origin where blood vessels leak blood into surrounding brain tissue.

A more recent study of 45,306 Swedish men aged 45 to 79 years found that men who consumed more than 1.5 glasses of milk per day had a 33 percent lower risk of developing colorectal cancer, compared with men who drank less than two glasses per week, and this beneficial effect was unrelated to the fat content [63].

The report published by the World Cancer Research Fund and the American Institute for Cancer Research in October 2007 stated that the evidence on milk from cohort studies is reasonably consistent and that milk probably protects against colorectal cancer [64].

3.5.3.2 Breast cancer
Fat intake is considered a risk factor for breast cancer and as a result concern has arisen over the role of dairy foods in breast cancer development. As part of the Pooling Project of Prospective Studies of Diet and Cancer the relationship between dairy product consumption and breast cancer was also investigated [65]. There was no consistent relationship between breast cancer risk and total or individual dairy product intake shown in the study. Other, more recent, studies support these findings [66, 67].

According to the report published by the World Cancer Research Fund and the American Institute for Cancer Research, the evidence is limited regarding milk and dairy products and breast cancer and therefore no conclusion can be drawn [64].

3.5.3.3 Prostate cancer
A meta-analysis of 11 case-control studies (not as strong as cohort/prospective studies) found that high consumers of milk were 46 percent more likely to develop prostate cancer compared to low consumers [68]. In a subsequent review of prospective cohort studies, no conclusive association was found between milk or dairy products and prostate cancer [69].

The report published by the World Cancer Research Fund and the American Institute for Cancer Research also stated that evidence is inconsistent from both cohort and case-control studies, and that there is limited evidence suggesting that milk and dairy products are a cause of prostate cancer [64].

3.5.4 Body weight
With the rising rates of obesity globally much focus has been given to the dietary factors that influence body weight. Recently a number of studies have indicated a beneficial effect of including milk and dairy products in the diet in the control of body weight.

Cross sectional studies amongst adults have provided consistent data showing an inverse association between dairy food intake and body weight [70-76]; however, data from cohort studies have not shown any consistent link amongst children and adolescents [77-79].

The Caerphilly study of adult men reported an inverse association between milk and body weight but identified that high milk consumers were more physically active than low milk consumers [55]. The Quebec Family study of adults found a positive association between whole fruit and low fat milk intake and body weight [80]. In contrast no relationship was found between dairy intake and long-term weight gain in the Health Professionals Follow Up Study [81].

A follow-up on the Framingham Children's Study, a prospective study which followed 99 of the original 106 participants from age six into adolescence, demonstrated that a dairy-rich diet was associated with smaller weight gains and smaller increases in body mass index (BMI) [82].

Similarly to the prospective studies, intervention trials also yielded inconsistent data. Zemel and colleagues found a significant decrease in body mass index and waist circumference with a dairy rich diet in obese adults [83] yet other authors have found no effect [84]. Gunther et al. (2005) found no difference in body weight or body fat mass between normal weight young women who consumed low, medium or high amounts of dairy foods over a one year period [85]. However, in a follow-up six months after the study, women who were assigned a high dairy diet were found to have maintained a higher dairy intake compared to the low dairy group [86, 87]. At this follow up stage those who were consuming more dairy products, and hence had higher calcium intakes, had a lower body fat mass than those with lower dairy intakes. This suggested that calcium may have a role to play in weight control. Furthermore, while the impact was small it indicated that the influence of dairy foods on weight is in the longer rather than shorter term.

Further analysis of the NSIFCS data showed that women who consumed two-thirds of a pint of whole milk per day were no more likely to be associated with excess weight gain compared with those who drank only a few drops of milk [88, 89].

In a recent review it was proposed that some of the inconsistencies found in the studies above could be attributable to differences in the nutritional composition between dairy products and the difficulties in assessing dietary intake accurately [90]. In addition it was highlighted that multiple factors are involved in weight regulation and that dairy foods may in fact be a marker for healthy lifestyle behaviours. One proposed mechanism through which dairy intake may positively influence body weight is through calcium influencing lipid metabolism, however intervention trials using calcium have not demonstrated any effect [91].

3.6 Labelling

Labelling allows consumers to make informed decisions about the food they eat and also builds confidence in products. The general labelling of food products is governed by Council Directive 2000/13/EC on the Labelling, Presentation and Advertising of Foodstuffs, while nutrition labelling is governed by Council Directive 90/496/EEC. The latter only applies, however, if a nutrition claim is made. Both pieces of legislation are currently being reviewed at EU level.

3.6.1 General food labelling requirements

Council Directive 2000/13/EC sets out general provisions on the labelling of pre-packaged foodstuffs to be delivered to the ultimate consumer. Sale of loose (over the counter) non-prepackaged food (when it is packaged on the premises from which it is to be sold), is governed by Article 14 of Directive 2000/13/EC. This legislation permits individual Member States to decide what labelling information needs to be shown, and how it should be displayed, subject to the condition that the consumer still receives sufficient information. The only requirement for foods sold loose specified on IOI is that the name of the product must be given.

Directive 2000/13/EC is implemented in ROI by the European Communities (Labelling, Presentation and Advertising of Foodstuffs) Regulations 2002 (S.I. No. 483 of 2002) and in NI by the Food Labelling Regulations (NI) 1996 (SR NI 1996 No. 383), as amended. Enforcement of this legislation lies with the FSAI in ROI and the District Councils in NI.

Directive 2003/89/EEC, amending directive 2000/13/EC, concerns the labelling of allergens in foodstuffs. This legislation requires food manufacturers to indicate the presence of potential allergens (from a list of 12 as laid down in the Directive) if they are used as ingredients in pre-packed foods, including alcoholic drinks, regardless of their quantity. Milk and milk products are governed by this Directive.

3.6.2 Nutrition labelling

The nutrition labelling of foodstuffs is governed by Council Directive 90/496/EEC, as amended. This piece of legislation states that nutrition labelling is compulsory where a nutrition claim is made. In this instance, and in other instances where nutrition labelling is provided voluntarily, the information given must consist of one of two formats - group one (the 'Big Four') or group two (the 'Big Eight'). Group one consists of energy value, protein, carbohydrate and fat; while group two consists of the latter four plus sugars, saturates, fibre, and sodium. Nutrition labelling may also include starch, polyols, mono-unsaturates, polyunsaturates, cholesterol and any minerals or vitamins that are listed in the legislation.

Nutrition information must be given 'per 100g or 100ml'. It may also be given 'per serving size', provided that the serving size is also stated.

This piece of legislation applies to prepackaged foodstuffs to be delivered to the ultimate consumer and also foodstuffs intended for supply to 'mass caterers', i.e. restaurants, hospitals, canteens, etc. It does not, however, apply to non-prepackaged foodstuffs packed at the point of sale at the request of the purchaser or prepackaged with a view to immediate sale.

3.6.2.1 Nutrition and health claims

Over the past number of years there has been a substantial increase in the number and type of nutrition and health claims appearing on food labels within the EU. As a result, in July 2003, the European Commission adopted a proposal to harmonise national legislations regulating the use of nutrition and health claims made on foods marketed within the EU. Regulation (EC) No. 1924/2006, on nutrition and health claims made on foods marketed within the EU, was introduced on January 19, 2007 and is applicable since July 1, 2007.

The main aim of this new Regulation is to allow consumers to make informed food choices, by ensuring that they receive accurate information and are not misled. Claims made on foods must be clear and understandable by the average consumer. Claims that exaggerate a food's expected health benefits and/or are not adequately substantiated by scientific evidence will no longer be permitted.

This Regulation is wide in scope and covers the use of all wording and symbols which imply that a food provides a particular nutritional or health benefit. It also applies to nutrition and health claims made in commercial communications whether in the labelling, presentation, or advertising of foods to be delivered to the final consumer.

The Regulation does not apply to claims made in non-commercial communications, such as dietary guidelines or advice issued by public health authorities and bodies, or non-commercial communications and information in the press and in scientific publications.

It is the responsibility of all food business operators (FBOs) to ensure claims they make on foods are authorised. Claims that are not authorised under this Regulation will not be permitted.

All health claims must be submitted to the Food Standards Agency (FSA)/Food Safety Authority of Ireland (FSAI) for authorisation by the European Food Safety Authority (EFSA). The submission procedure for health claims is dependent upon the type of claim.

Some claims can be authorised without the submission of a full dossier, and these include: health claims describing or referring to the role of a nutrient or other substance in the growth, development and functions of the body; or to psychological and behavioural functions; or, without prejudice to Directive 96/8/EC, slimming or weight control, or reduction in the sense of hunger, or an increase in the sense of satiety, or the reduction of the available energy from the diet.

Three categories of health claims require the FBO to submit a detailed dossier of information in justification of the claim, for assessment by EFSA. These include claims on disease risk reduction; claims which refer to children's development and health; and any additions of claims to the Community list of authorised health claims, based on newly developed scientific evidence and/or which include a request for the protection of proprietary data.

In order to be used, nutrition and health claims must not be false, ambiguous or misleading; give rise to doubt about the safety and/or the nutritional adequacy of other foods; encourage or condone excess consumption of a food; state, suggest or imply that a balanced and varied diet cannot provide appropriate quantities of nutrients in general – subject to derogation; or refer to changes in bodily functions which could give rise to or exploit fear in the consumer, either textually or through pictorial, graphic or symbolic representations.

Foods or certain categories of foods must comply with specific nutrient profiles in order to bear nutrition or health claims. These nutrient profiles are to be established by the Commission by January 19, 2009 at the latest.

Nutrient profiles will particularly take account of the fat, saturated fat, trans fat, sugar and salt/sodium content of foods; the role and importance of the food and the contribution to the diet of the general population or certain risk groups; and the overall composition of the food and the presence of nutrients that have been scientifically recognised as having an effect on health.

When a nutrition or health claim is made, nutrition labelling is required but must appear in Group Two format as set out in Article 4(1) of Directive 90/496/EEC. In addition, the amounts of substances to which a nutrition or health claim relates that do not appear in the nutrition labelling, must also be stated in the same field of vision as the nutrition information and be expressed according to Article 6 of Directive 90/496/EEC.

3.6.2.2 Nutrient profiling

The Nutrient Profiling model was developed by the FSA to provide Ofcom[5] with a tool to enable the differentiation of foods that are high in fat, salt and sugar (HFSS), from those which are not, with the aim of improving the balance of food advertising to children.

The FSA recently confirmed that its nutrient profiling model does not classify whole milk as a high fat, salt, sugar food, and is therefore allowed to be advertised during children's TV programmes [92]. Further information on the FSA's Nutrient Profiling Model is available on the FSA's website [93].

3.7 Cows' milk – related hypersensitivity

3.7.1 Milk allergy

Allergy to cows' milk is the most common food allergy in childhood and affects two to seven percent of babies under one year of age [94]. Cows' milk allergy is more likely to develop in children from families with a history of atopic (allergic) disease [95]. The allergic baby reacts to cows' milk protein resulting from direct exposure or indirect exposure via breast milk from the mother who has consumed dairy products. Infant formula and follow-on formula based on goats' milk protein are not suitable alternatives because similar allergenic proteins are also found in goats' milk [96].

The symptoms of cows' milk allergy are similar to other types of food-related and non food-related allergies. Usually these include skin rash, diarrhoea, vomiting, stomach cramps and possibly brochoconstriction (difficulty in breathing). In severe cases, exposure to milk protein may trigger an anaphylactic reaction [97]. Milk allergy has been implicated in subtle behavioural changes such as irritability and insomnia [98, 99].

[5] Ofcom is the independent regulator and competition authority for the UK communications industries, with responsibilities across television, radio, telecommunications and wireless communications services.

The prognosis for childhood cows' milk allergy is good with up to 90 percent of cases resolving by about three years of age [100]. The reason why certain individuals retain their allergic status into adulthood may be a consequence of the specific type of allergic mechanism they have [101]. Cows' milk allergy is a complex disorder and numerous milk proteins, including casein and whey proteins, have been implicated in allergic responses. In addition, the severity of a reaction to any of these proteins can differ significantly among allergic individuals. Diagnosis must be based on a combination of case history and clinical verification [102].

Heat treatments such as pasteurisation can reduce or eliminate the allergenicity of certain milk proteins, thereby making certain pasteurised foods accessible to certain allergic individuals. However, the allergenicity to proteins such as casein is unaffected by such treatments. The only proven therapy for cows' milk allergy is strict elimination of cows' milk from the diet [103]. This can have adverse ramifications in terms of the nutritional adequacy of the diet [104].

3.7.2 Milk intolerance

Milk intolerance, also known as cows' milk protein intolerance, is also common in babies and children. The general symptoms are similar to those observed in cases of milk allergy but without any skin or respiratory effects and no threat of anaphylactic reaction. The resolution of the condition is similar to that recorded for milk allergy.

Milk intolerance is often confused with lactose intolerance, which has a different underlying physiological mechanism. Milk intolerance is the result of an immune system dysfunction whereas lactose intolerance is caused by a digestive system dysfunction. The prevalence of milk intolerance on IOI has not been quantified but it is estimated that approximately five per cent of the population has this condition [105].

3.7.3 Lactose intolerance

Lactose is the main sugar found in milk. This is broken down by the enzyme lactase into its constituent monomers, glucose and galactose, which are absorbed into the bloodstream. Digestion occurs in the small intestine. A deficiency in this enzyme causes lactose intolerance [106]. This can be exacerbated by intestinal pathologies associated with other diseases such as coeliac disease, inflammatory bowel disease and Crohn's disease [107-109]. Undigested lactose ferments in the gut resulting in bloating, diarrhoea, abdominal pain and lactic acid production [110]. Other symptoms include headache, fatigue and bad breath. Symptoms begin about 30 minutes to two hours after eating or drinking foods containing lactose. The severity of symptoms depends on many factors, including the amount of lactose a person can tolerate and a person's age, ethnicity, and digestion rate [111, 112].

Lactose intolerance is more common in adults than children and is also more prevalent in certain populations, with Asian, African and Hispanic populations showing a high prevalence (up to 90 percent) as they lack the enzyme 'lactase' to breakdown lactose [113, 114]. The prevalence of lactose intolerance on IOI has not been quantified but it has been estimated that in the UK, ROI, Northern Europe and America, on average, about five percent of the adult population has this condition [96].

Although a lactose avoidance diet will reduce the risk of symptoms, this is nutritionally unwise and usually unnecessary [115]. Other milks, such as goats' milk, are not suitable replacements as they contain similar levels of lactose. An individual with lactose intolerance may be able to tolerate a certain amount of milk and/or dairy products in their diet. Lactase enzyme supplements are available which can be consumed with food to aid digestion [110]. Tolerance to lactose can be improved by adjusting the form, frequency and quantity of lactose-containing food to which the individual is exposed [112, 116, 117].

3.8 The promotion of milk consumption on the island

3.8.1 Organisations

The National Dairy Council and the Dairy Council are the trade and professional organisations responsible for the generic promotion of dairy products in ROI and NI, respectively. Through various advertising campaigns and nutritional programmes, they actively ensure that consumers continue to receive the latest scientific information about dairy products and their role in a healthy, balanced diet [118].

3.8.2 School milk scheme

The School Milk Scheme is an EU initiative aimed at promoting and encouraging the consumption of milk among school children. The provisions of the scheme are laid down in Commission Regulation (EC) No. 2707/2000 as amended. This Regulation sets out rules for applying Council Regulation (EC) No 1255/1999 as regards Community aid for supplying milk and certain milk products to pupils in educational establishments.

To be eligible to participate in the scheme, pupils must be in regular attendance at nursery schools and other pre-school establishments administered or recognised by the Member State's competent authority (crèches and childminding concerns operated for commercial gain are not eligible for aid); primary schools; or secondary schools.

The scheme is funded by the EU and individual Member States. The maximum quantity eligible for aid is 0.25 litres of milk distributed per pupil per school day. Entitlement to aid is calculated on the basis of the number of pupils entered on the applicant's (school) roll. Aid is payable solely for products manufactured in the Community and purchased in ROI/NI, as applicable.

The list of products eligible for aid under the Scheme is contained in Commission Regulation (EC) No. 2707/2000 as amended. It includes heat-treated whole/semi-skimmed/skimmed milk; milk flavoured with chocolate or otherwise; and milk yoghurt processed from milk indicated at 1.5 percent minimum fat content.

In addition, to take account of the accession of new Member States to the EU and varying consumption habits in them, new products, introduced under Regulation 816/2004, were made eligible for aid (Categories III, IV and XII). The list of products eligible for aid is set out in Annex I of the legislation.

The School Milk Scheme was introduced in ROI in 1982 [119]. The Department of Agriculture, Fisheries and Food is responsible for the management of the scheme in ROI and has issued procedures for its operation [120]. In August 2006, a new School Milk Scheme was launched in ROI which broadened the range of milk products available to include flavoured milk, low-fat and fortified options [119]. In addition, the Department, in conjunction with the National Dairy Council, provided 1,000 refrigeration units free of charge for school milk to some schools participating in the Scheme. This was in response to qualitative research findings which demonstrated that lack of refrigeration of school milk was a key barrier to participation in the scheme [121]. There are currently 1,465 schools participating in the scheme in ROI (2006/7 academic year). This figure comprises 41 Montessori schools, 1,282 national schools, 91 secondary schools and 51 special schools (Personal Communication, Department of Agriculture, Fisheries and Food, October 2007).

The School Milk Scheme in NI is administered centrally by the Department of Agriculture and Rural Development (DARD) and locally by the five Education and Library Boards. In the 2004/5 academic year, 72 percent of the 1,047 nursery and reception/primary/special schools with pupils receiving nursery or primary education in NI were participating in the scheme. Based on an average daily consumption per school day of one-third of a pint, the number of children taking milk on an average daily basis at schools participating in the scheme during 2004/5 was 58,851 or 45 percent (Personal Communication, DARD, 20 September 2007).

3.9 In summary

Milk contains a wide variety of nutrients essential for health including protein, calcium, vitamin A and riboflavin. Contrary to popular belief, milk is not classed as a high fat food, nevertheless, lower fat varieties now offer consumers choice.

Milk consumption on the island of Ireland is high with an average consumption of whole milk amongst adults of 150g/d and low fat milks 88g/d. Men tend to consume more milk than women. There is, however, a general overall decline in per capita consumption of milk on the island and across the EU.

The health effects of milk and dairy products have in the past primarily focused on bone health. It is now recognised that the benefits of milk and dairy products also include the lowering of blood pressure; a protective effect against certain cancers such as colorectal cancer; and a potential role in the control of body weight.

Allergy to cows' milk is the most common food allergy in childhood and affects two to seven percent of babies under one year of age with the majority of these allergies resolving by age three. Milk and lactose intolerance is often confused with allergy; while the latter is an immune system dysfunction, lactose intolerance is due to the absence of the enzyme lactase and more common in adulthood.

4. Food Safety

4.1 Overview

Foodborne illness is caused by the consumption of, or contact with, food that has been contaminated with some type of microbiological, biological, chemical or physical hazard (Table 4.1).

Table 4.1: Types of food contaminants

Hazard	Example
Microbiological	Bacteria, viruses, yeasts, moulds,
Biological	Parasites, bone, hair, insects, faeces
Biochemical	Prions
Chemical	Pesticides, toxins, cleaning liquids, veterinary drug residues
Physical	Glass, metal, wood, string, dirt, etc.

This chapter will look at the microbiological, biochemical and chemical aspects of the milk supply chain. This will include the associated hazards and risks, and the controls in place to minimise any associated risk.

4.2 Microbiology

4.2.1 Introduction

In addition to being a nutritious food for humans, milk provides an excellent growth medium for micro-organisms. These naturally present organisms cause spoilage of the milk, such as souring, and a number of the organisms associated with milk are pathogenic bacteria that can cause foodborne illness. Pasteurisation readily eliminates such organisms from milk.

The adoption of pasteurisation by the milk industry and cattle disease eradication programmes for tuberculosis (TB) and brucellosis from the 1950s to the 1980s, has meant that milk is no longer a common source of human infection [122]. Nevertheless, a clear distinction must be drawn between the hazards of drinking raw milk and the safety of properly pasteurised and safely stored milk. Improperly performed pasteurisation and the occurrence of contamination after pasteurisation are the most common explanations for problems in pasteurised milk [123].

This section will describe the impact of foodborne illness and its associated pathogens and their relationship with milk; explore the milk supply chain and describe the inherent risks; detail the measures that can be adopted throughout the milk supply chain to produce a product of the highest microbiological quality and safety.

4.2.2 Foodborne human infections associated with milk [6]

4.2.2.1 Introduction

It is clear that intensive methods now used on farms and at the dairy have public health implications with the potential for infecting a large number of people should control measures fail. Milkborne outbreaks of infectious intestinal disease, however, are uncommon.

Consumption of milk ranked very low as a disease risk food group in a major review of data from England and Wales for the years 1996 to 2000 [124]. Milkborne outbreaks represented only two percent of all outbreaks of foodborne origin reported in England and Wales from 1992 to 2000 but were characterised by significant morbidity, principally related to the importance of Verocytotoxigenic *Escherichia coli* (VTEC) O157, *Campylobacter* and *Salmonella* Typhimurium as milkborne pathogens [124].

4.2.2.2 Human outbreaks associated with milk

Data from population-based studies and surveillance systems have been analysed to estimate the burden of infectious disease associated with milk.

Outbreak data from the island of Ireland (IOI)

According to the Food Safety Authority of Ireland's (FSAI) foodborne outbreak database, there was only one milkborne outbreak in the Republic of Ireland (ROI) in the last decade and this occurred in November 2000. The outbreak of S. Typhimurium occurred in a crèche and five children became ill, one was hospitalised. The outbreak was associated with unpasteurised milk, however the evidence was circumstantial (Personal Communication, Health Protection Surveillance Centre, May 2007).

In Northern Ireland (NI), there has been no reported outbreak of infectious intestinal disease associated with the consumption of liquid milk over the past decade.

Outbreak data from England and Wales

Between 1992 and 2000, 1,774 general foodborne outbreaks of infectious intestinal disease (IID) were reported [124]. In 27 (two percent) of these, milk was reported as a likely vehicle of infection. Unpasteurised milk (52 percent) was the most commonly reported vehicle of infection in milkborne outbreaks, with milk sold as pasteurised accounting for the majority of the rest (37 percent).

There are differences in contributory faults depending on whether or not the milk was pasteurised. Amongst the outbreaks attributed to milk sold as pasteurised, inadequate heat treatment (in five of the ten outbreaks) was most commonly recorded, followed by cross contamination (in four of the ten) and inappropriate storage in two outbreaks. In one of these outbreaks both inadequate heat treatment and cross contamination was recorded. However, 'infected cattle' was the most commonly reported fault in unpasteurised milk outbreaks (three of 17

outbreaks), followed by cross contamination (two) and inappropriate storage (two). 'No fault' was more commonly detected and reported in unpasteurised milk outbreaks (seven) than in outbreaks involving pasteurised milk (one).

The most commonly detected pathogens associated with milkborne outbreaks were *Salmonella* (37 percent), VTEC O157 (33 percent) and *Campylobacter* (26 percent). Over the surveillance period of 1992 to 2000 the proportion of outbreaks attributed to VTEC O157 infection increased whilst those caused by *Campylobacter* decreased [124].

[6] Tracing individual episodes of human infection to a particular food is inherently difficult. Estimating the risks associated with consuming different foods is a complex epidemiological process. Disease risks from foods can only be derived from the analysis and interpretation of a large body of evidence. This evidence includes laboratory infectious disease surveillance data; hospital episode statistics; food intake surveys; outbreak surveillance data; death statistics; and special studies related to infectious disease outbreak investigations. It should be noted that caution must be exercised in attributing infections to specific foods.

In the period 1992 to 2000 a total of 27 milkborne outbreaks occurred in England and Wales involving 662 people. There were 67 hospital admissions but no mortalities. Whilst the average number of people affected was on a par with other outbreaks of foodborne origin, the risk of hospital admission was three times higher. This may in part be due to the age profile, as young children are likely to drink more milk than adults. Within the different milk types, there were no differences associated with outbreak size or the risk of hospitalisation [124].

In England and Wales from 1996 to 2000, only six percent of cases of indigenous foodborne disease (n=1,724,315) were attributed to milk consumption (Table 4.2) [124]. However, the comparatively high case fatality is related to mortality due to VTEC infection.

Table 4.2: Estimated annual impact of indigenous foodborne disease, by selected food group and type, England and Wales 1996 to 2000

Food Group/Type	Cases (%)	Death (%)	Case-Fatality Rate*
Poultry	502,634 (29)	191 (28)	38
Chicken	398,420 (23)	141 (21)	35
Eggs	103,740 (6)	46 (7)	44
Red meat	287,485 (17)	164 (24)	57
Beef	115,929 (7)	67 (10)	58
Seafood	116,603 (7)	30 (4)	26
Shellfish	77,019 (4)	16 (2)	21
Milk	108,043 (6)	37 (5)	34
Other dairy products	8,794 (0)	5 (0)	55
Vegetable/Fruit	49,642 (3)	14 (2)	29
Complex foods	453,237 (26)	181 (26)	40
Infected food handler	67,157 (4)	14 (2)	20

Note: *Deaths/100,000 cases
Source: Adak et al, 2005 [124]

The actual estimated disease risk associated with milk is low at four cases/million servings, compared with other food groups (Table4.3).

Table 4.3: Estimated risks associated with food groups and type, England and Wales 1996 to 2000

Food Group/Type	Disease Risk*	Disease Risk Ratio	Hospitalisation Risk†	Hospitalisation Risk Ratio
Poultry	104	947	2,063	4,584
Chicken	111	1,013	2,518	5,595
Eggs	49	448	262	583
Red meat	24	217	102	227
Beef	41	375	153	339
Seafood	41	374	293	650
Shellfish	64	5,869	1,121	2,490
Milk	4	35	133	295
Other dairy products	2	17	14	32
Vegetable/Fruit	1	NA	8	NA

Notes: * Cases/1 million servings
† Hospitalisations/1 billion servings
NA, not applicable
Source: Adak et al., 2005 [124]

While milkborne infections were low in terms of disease risk, the health care impact arising from milkborne infection for the surveillance period was quite high in terms of general practitioner visits and hospitalisation (Table 4.4).

Table 4.4: Estimated annual healthcare impact of indigenous foodborne disease, by selected food group and type, England and Wales 1996 to 2000

Food Group/Type	General Practitioner Cases (%)	Hospital cases (%)	Hospital Days (%)
Poultry	159,433 (35)	9,952 (45)	41,645 (41)
Chicken	129,271 (28)	9,005 (41)	36,425 (36)
Eggs	19,554 (4)	552 (3)	3,410 (3)
Red meat	80,805 (18)	1,231 (6)	10,935 (11)
Beef	34,981 (8)	429 (2)	4,284 (4)
Seafood	23,998 (5)	828 (4)	3,690 (4)
Shellfish	12,861 (3)	134 (1)	752 (1)
Milk	40,755 (9)	3,681 (17)	14,176 (14)
Other dairy products	1,561 (0)	67 (0)	402 (0)
Vegetable/Fruit	11,912 (3)	702 (3)	2,932 (3)
Complex foods	103,409 (22)	4,175 (19)	20,646 (20)
Infected food handler	14,007 (3)	736 (3)	3,113 (3)

Source: Adak et al, 2005 [124]

Outbreak data from the EU

The 2005 EU Zoonoses report [125] provided for the first time extensive data on foodborne disease outbreaks. However, the data differed somewhat between Member States and details of outbreak settings and sources were not available for the majority of outbreaks.

The most common cause of outbreaks in the EU in 2004 was *Salmonella*, causing 215 (73.9 percent) outbreaks and 68.9 percent of individual cases. Dairy products (including milk) were implicated in 2.17 percent of *Salmonella* general outbreaks and accounted for 4.7 percent of people hospitalised as a result of these outbreaks [125].

Of the 87 outbreaks caused by pathogenic *E. coli* during 2004, the source in one case was traced back to an organic dairy in Denmark with a small-scale contamination. In this Danish outbreak there were 25 confirmed cases caused by *E. coli* O157: H- of phage type 8 [125].

Dairy products were associated with three (1.7 percent) of bacterial toxin outbreaks [125].

A review of foodborne disease annual reports from France and seven other industrialised countries indicated that milk and milk products were implicated in one to five percent of total bacterial outbreaks; however, details about the type of product and milk involved were usually not provided [126]. In particular it was not possible to find out in many outbreaks what heat treatment, if any, the milk product had undergone. It also compared data from published annual reports and unpublished data and noted that 60 outbreaks were described in the literature and a further 69 were recorded in unpublished data. Of note, *Salmonella* species were responsible for 48 percent of the published outbreaks and only 10.1 percent of the unpublished outbreaks. This study demonstrates the limitation of surveillance systems and the difficulties in estimating the contribution of milk and milk-products to foodborne disease.

Outbreak data from the US

A major review of 12 pasteurised milkborne outbreaks in the US revealed a wide range of pathogens and considerable associated morbidity [123] (Table 4.5).

Table 4.5: Review of pasteurised milk outbreaks in the United States, 1960 to 2000

Date	Location	Pathogen	Setting	Total no. ill (confirmed)	Mechanism of contamination
Nov 1966	Florida [127]	*Shigella flexneri* type 2	Community	97 (97)	After pasteurisation
Jul-Aug 1975	Louisiana [128]	*Salmonella* Newport	Military base/ Community	49 (49)	Unknown
Sep-Oct 1976	New York [129]	*Yersinia enterocolitica* O:8	School	38 (38)	After pasteurisation
Oct 1978	Arizona [130]	S. Typhimurium	Community	23 (23)	After pasteurisation
Jun-Jul 1982	Tennessee, Arkansas, Mississippi [131]	*Y. enterocolitica* O:13, 18	Community	172 (172)	Unknown
Jun-Aug 1983	Massachusetts [132]	*Listeria monocytogenes* 4b; phage type 2425A	Community	49 (40)	Unknown
Apr 1984	Kentucky [133]	S. Typhimurium	Convent	16 (16)	Inadequate pasteurisation
Mar-Apr 1985	Illinois [134]	S. Typhimurium	Community	>150,000 (>16,000)	After pasteurisation
Mar-Apr 1986	Vermont [135]	*Campylobacter jejuni* O:2, 36	School	33 (8)	Inadequate pasteurisation
Jul 1994	Illinois [136]	*L. monocytogenes* 1/2b	Picnic	45 (11)	After pasteurisation
Oct 1995	Vermont, New Hampshire [137]	*Y. enterocolitica* O:8	Community	10 (10)	After pasteurisation
Mar-Apr 2000	Pennsylvania, New Jersey [123]	S. Typhimurium, phage type 21, R-type AKSSuT	Community	93 (38)	After pasteurisation

Source: Olsen et al, 2004 [123].

4.2.3 Pathogens associated with milk

4.2.3.1 Introduction

The presence of foodborne pathogens in milk is due to direct contact with contaminated sources in the dairy farm environment and to excretion from the udder of an infected animal. The microbiological flora of raw milk consists of those organisms that may be present on the cow's udder and hide and on milking utensils or lines. The prevalence of foodborne pathogens in milk is influenced by numerous factors such as farm size, number of animals on the farm, hygiene, farm management practices, geographical location and season [138].

Most foodborne pathogens inhabit the ruminant intestinal tract and therefore dairy cattle are considered a major reservoir of *Salmonella*, *Campylobacter* and VTEC. The presence of foodborne pathogens in bulk tank milk is directly linked to faecal contamination that occurs primarily during milking; however, some foodborne pathogens can cause mastitis in which case the organism can be directly excreted into milk.

Introduction of raw milk contaminated with foodborne pathogens into processing plants and their persistence in biofilms represents an important risk of post-pasteurisation contamination that could lead to exposure of the consumer to pathogenic bacteria [138].

From a human health perspective, there is quite an extensive list of infectious diseases that may be acquired from unpasteurised or recontaminated milk; including campylobacteriosis, salmonellosis, yersiniosis, listeriosis, tuberculosis, brucellosis, staphylococcal enterotoxin poisoning, streptococcal infections, Q Fever (*Coxiella burnetti* infection) and VTEC infection.

Salmonella, VTEC O157 and *Campylobacter* are the most frequently detected pathogens in milk-related outbreaks in the European region [125].

In this section the pathogenic micro-organisms that are found in milk are identified and described and their relevance to bovine health and impact on human health through outbreaks of foodborne illness are detailed.

4.2.3.2 Verocytotoxigenic Escherichia coli (VTEC)

Bovine animals are a known reservoir of *E. coli* O157 and the gastrointestinal tract appears to be transiently colonised with these organisms [139]. Raw milk has been described as a source of infections caused by VTEC serotype O157:H7 [140, 141].

The mechanism for raw milk contamination with *E. coli* O157 is unclear. In vitro studies have suggested that teat contamination could lead to intra-mammary infection [142], thus, the pathogen could be shed in the milk. Faecal contamination of milk is another route of transmission.

Since sources include, apart from faeces, rumen contents, saliva and the farm environment, the organism may contaminate the hair on the cow's hide, or the udder and the teat surface. Contamination of the milk will result in the cross contamination of the equipment used for milking, filtering, cooling and storage, as well as farm personnel.

The prevalence of *E. coli* O157 in raw milk from tanks is generally low. *E. coli* O157 is isolated more often from milk from individual animals or from milk filters than from bulk tank samples [143]. These observations suggest that milk could be contaminated frequently, but that the contamination in the bulk tank is generally diluted to levels too low to detect [144]. The result of this is that cases may occur infrequently, and an outbreak of *E. coli* O157 via consumption of unpasteurised dairy products could continue for several months without a noticeable increase in incidence in reported infections. Such an incident was described in a prolonged US outbreak associated with commercially distributed raw milk [141].

The FSAI report on Zoonoses in ROI for 2004 indicated that VTEC O157 was not found in any of the 74 and 184 milk and milk products tested at processing and retail levels, respectively [145].

In a study carried out by the Food Science Department, Queen's University Belfast, between June 1999 and June 2000, 420 samples were collected from two NI dairies. The samples were collected from sites from raw milk silos, raw milk tankers, clarifier and separator de-sludge units, balance tanks and drains. Overall, nine samples (2.14 percent) tested positive for VTEC O157 [146].

A study of the microbiological quality and effect of heat processing on cows' milk in the UK[7] showed that 52 percent of the 610 raw milk samples contained detectable levels of *E. coli* whilst two (1.1 percent) of the 1,413 pasteurised milk samples were positive [147].

An all-island study of in-line milk filters from dairy holdings found that of the 97 farms that participated, 12 percent (n=12) were found to be positive for the presence of *E. coli* O157 based on culture methods [148]. No organisms were cultured from any of the corresponding bulk tank milk samples.

The all-island Food Micro Database [149] showed that in 2002 and 2003, 53 and 68 samples, respectively, of dairy origin were tested for *E. coli* O157. Eight of 31 raw milk samples tested in 2002 were positive. There were no positive dairy samples in 2003.

Human outbreaks

The emergence of VTEC O157 reinforces the need for maintaining good controls on milk production. In addition children, who are particularly vulnerable to VTEC O157 and its sequelae, are greater consumers of milk.

In the largest outbreak of VTEC O157 infection in England and Wales to date, 114 people became ill and 28 were admitted to hospital in February 1999 following the consumption of improperly pasteurised milk from a local dairy in North Cumbria [150]. It was concluded that smaller farm dairies in the UK, as distinct from the larger commercial dairies, pose the greatest risk to consumers because of potential difficulties for them in the maintenance of equipment and post-pasteurisation integrity [150].

In Denmark an outbreak of VTEC O157 lasted from September 2003 to March 2004 and was limited to the greater Copenhagen area [151]. Consumption of organic Jersey milk from a small dairy was associated with infection [152]. Environmental and microbiological investigations at the suspected dairy were unable to confirm the presence of the outbreak strain, but the outbreak stopped once the dairy was closed. It is likely that the outbreak was due to limited environmental contamination of the milk after pasteurisation or to intermittent inadequate heat treatment due to the specific properties of Jersey milk (see Appendix C).

An outbreak in Scotland raised particular concern about milkborne transmission of this pathogen, because it was associated with the consumption of pasteurised milk [153]. The outbreak involved 100 cases, forty-six in children under 15 years and 32 under five years. Almost one third of cases required hospital admission. Nine of the affected children aged nine months to 11 years developed Haemolytic Uremic Syndrome (HUS) and, of these, six children required dialysis.

[7] Data not presented separately for NI.

4.2.3.3 Listeria monocytogenes

Listeria species are widespread in nature and live naturally in plants and soil environments. Cattle are likely to become infected through consumption of water and feedstuffs contaminated with faeces and other cattle secretions/excretions [154].

Listeria monocytogenes can be shed in the milk and faeces of asymptomatic cows [155]. Faecal contamination of pastures or vegetables has been implicated as a source of contamination for ruminants. Therefore, spreading untreated manure onto pastures and croplands is regarded as a risk factor for *L. monocytogenes* foodborne disease and also other pathogens [138].

L. monocytogenes can grow in a wide range of temperatures and pH, thus enabling it to grow in refrigerated raw milk [156].

The most recent data for the prevalence of *L. monocytogenes* in foods in ROI showed that of the 252 and 24 milk products tested at processing and retail levels, respectively, none was positive for *L. monocytogenes* [145].

A survey of two milk processing plants for *L. monocytogenes* conducted in NI in 2003 reported a 44.4% incidence of *Listeria* spp. (22.2% *L. monocytogenes*) in raw milk. This survey also found that the incidence of *Listeria* on equipment was 18.8% (6.3% *L. monocytogenes*) and 54.7% in the environment (40.6% *L. monocytogenes*). On one occasion, *Listeria welshimeri* was isolated from pasteurised milk, probably demonstrating post-pasteurisation contamination of the product. The main environmental sources of *L. monocytogenes* were considered to be a floor drain and stainless steel steps [157]. A study of the microbiological quality and effect on heat processing of cows' milk in UK dairies[8], showed that *Listeria* spp. were detected in 222 (37%) of the 610 raw milk samples and five (0.4%) of the 1,413 pasteurised milk samples. *L. monocytogenes* was detected in 101 (17%) of the raw milk samples [147].

A report from the all-island Food Micro Database showed that of the raw milk samples tested in 2002 (n=9) and 2003 (n=12), none was positive [149]. There were also no positives in the 62 samples of pasteurised milk taken in 2002; however, eight (2.7 percent) of the 291 samples taken in 2003 were positive. The authors expressed concern regarding the positive results from pasteurised milk, given that organisms of the genus *Listeria* are temperature sensitive and should be destroyed by pasteurisation. They proposed that their isolation from pasteurised products may be the result of post-pasteurisation contamination.

Human outbreaks

Dairy products have been associated with approximately half of the reported listeriosis outbreaks in Europe and have mostly been linked to unpasteurised milk or its products [158]. The eight investigated outbreaks up to 2004 [158] resulted in almost 400 cases and over 60 fatalities in Europe (See Table 4.6). Two of the outbreaks involved milk.

Table 4.6: Reported listeriosis outbreaks in Europe caused by milk

Year	Country	Product type	Number of cases (deaths)	Serotype
1949 to 1957	Germany [159]	Raw milk	About 100	NA*
1986	Austria [160]	Raw milk/ vegetables	28 (5)	1/2a

Note: *Data not available.
Source: Lunden et al., 2004 [158]

4.2.3.4 Salmonella

Salmonellosis is an important disease in cattle and calves and the serovars Typhimurium and Dublin are considered to be the primary serovars isolated. Frequently adult cattle show no clinical signs of the infection but calves of four to six weeks are at risk of serious or fatal infections. Survivors of *Salmonella* Dublin infections may shed these organisms for several months and therefore be a source of infection not only for other animals but also for humans. Unpasteurised milk and milk products are vehicles for the pathogen into the food chain [161]. While S. Dublin is considered a cattle-adapted pathogen, it may also cause severe systemic infections in humans, in particular in immunocompromised individuals who consume raw milk from infected carrier cows.

Contamination of milk and milk products by *Salmonella* in ROI is assessed through the compulsory monitoring programme based on Regulation (EC) No. 853/2004 (S.I. No. 910/2005, as amended). More than 17,000 milk and milk products were sampled and tested in 2004 [145]. *Salmonella enterica* was isolated from two of the 5,884 samples of milk powder and one of the 29 samples of raw milk taken at processing level. The latter sample was identified as *Salmonella* Typhimurium but the other two positives were not serotyped. No S. *enterica* was isolated from the 223 samples of heat-treated milk.

A study of the microbiological quality and effect of heat processing of cows' milk from UK dairies[8], identified *Salmonella* spp. in two (0.3 percent) of the 610 raw milk samples, whilst none was reported for the pasteurised milk samples [147]. Data for NI is unavailable separately from overall UK data.

An all-island study of in-line milk filters from dairy holdings conducted in 1998 found that five percent of the ninety-seven farms that participated were *Salmonella* positive, based on culture methods. No organisms were cultured for any of the corresponding bulk tank milk samples [162].

Human outbreaks

The relative importance of salmonellosis in humans is difficult to estimate as it is contended that outbreaks may not be recognised for several reasons [123]. Milk is an extremely common foodstuff which makes reporting exposure to milk likely, obscuring an association. Common serotypes such as S. Typhimurium also make detection more difficult if subtyping analyses are not conducted.

At least 700 people were infected in a outbreak of S. Dublin described in the UK in 1979 [163]. While in California between 1971 and 1975, over a third (44 cases out of 113) of human S. Dublin infections were associated with drinking raw milk [164].

An outbreak of *Salmonella* Java phage type 'worksop' occurred in 14 toddlers in England and Wales in 1997. Illness was significantly associated with the consumption of a particular brand of fresh (pasteurised) fortified milk sold for toddlers [165].

Antimicrobial resistance

The increase in the numbers of antibiotic resistant strains of bacteria is of great concern to public health specialists. The use of antimicrobials in food animals contributes to the development of antimicrobial resistance and the dissemination of multi-drug-resistant bacteria such as *Salmonella* strains [166]. Antimicrobial drugs are used to treat patients with severe and invasive salmonellosis and can be life saving. Antimicrobial resistance limits treatment options in the event of serious illness.

S. Typhimurium definitive Type 104 (DT104) has been shown to be resistant to five or more antimicrobial agents including ampicillin, chloramphenicol, streptomycin, sulphamethoxazole, tetracycline; and R-type ACSSIT. Illnesses caused by multidrug-resistant *Salmonella* species are more difficult to treat.

An outbreak of multi drug-resistant S. Typhimurium occurred in Pennsylvania and New Jersey in 2000 [123]. The outbreak was associated with pasteurised milk consumption. It was concluded that contamination occurred after pasteurisation because of environmental conditions in the plant.

S. Typhimurium resistant type AKSSuT that caused this outbreak appears to be emerging and raises similar concerns to those that surround S. Typhimurium definitive Type 104.

4.2.3.5 Campylobacter

Campylobacter jejuni is a common commensal in the alimentary tract of milking cows, but it is not clear how the milk becomes contaminated with the organism [167].

Cow manure is a principal reservoir of *Campylobacter* and farm practices using manure as a fertiliser are considered a risk factor for the occurrence of foodborne disease [138]. The authors also noted that dairy cattle can be infected through ingestion of water and feeds which are contaminated with C. jejuni from faeces and animal secretions. The organism can be shed in the milk of asymptomatic cows.

Pasteurisation readily eliminates the organism from milk.

The most recent zoonoses data for ROI from 2004 show that *Campylobacter* was not detected in any of the 1,282 non-meat samples tested [145].

A study of the microbiological quality and effect on heat processing of cows' milk in UK dairies[7] identified *Campylobacter spp*. in five (0.8 percent) of the 610 raw milk samples, whilst none was reported for the pasteurised milk samples [147].

A report from the all-island Food Micro Database showed that none of the 184 food samples, including ready-to-eat foods and vegetables tested in 2002, or the 325 samples tested in 2003, was positive for *Campylobacter* species [149]. The report does however point out that few tests were carried out on dairy products.

Human outbreaks

Contaminated cows' milk, consumed unpasteurised or incompletely pasteurised, is a well-documented cause of both outbreaks and sporadic cases of campylobacteriosis [145, 168]. Two prominent features of this association are recontamination of bottled pasteurised milk caused by bird pecking of the foil caps and also the practice of drinking raw milk on school field trips or other youth activities.

A major review of milk-based *Campylobacter* infection identified 13 outbreaks in England and Wales from 1978 to 1981 [167]. A school or institution was the setting for five of the larger outbreaks and severe weather conditions or electricity failures were cited in three instances.

A ten-year review of outbreaks in the US documented 20 raw milk-related outbreaks among school children and adolescents with 458 cases and a very high attack rate of 45 percent of consumers of raw milk [169]. It was noted that in 1992 in the US the unsafe practice of drinking raw milk during field trips continued.

In recent years during an outbreak of campylobacteriosis in Germany, 28 of 38 children and three of four accompanying adults fell ill after consuming raw milk while visiting a farm [170]. In May 1995 in Gloucestershire in the UK, 12 special needs children in a care unit were infected by drinking pasteurised milk from bottles with damaged tops [171]. A case control study conducted in NI linked a local rise in *Campylobacter* with the consumption of milk which had been pecked by birds [172].

Most campylobacteriosis case-control studies have identified the consumption of raw milk as a risk factor for sporadic cases [173-177]. The great majority of campylobacteriosis cases are isolated or sporadic while outbreaks are rare. If the *Campylobacter* risk from milk was only looked at in the context of outbreaks its importance would be greatly underestimated.

4.2.3.6 Staphylococcal food poisoning

Staphylococcus aureus is an important cause of mastitis in dairy cows throughout the world and is another pathogen that is found frequently in bulk tank milk. The bovine mammary gland can be a significant reservoir of enterotoxigenic strains of *S. aureus* [138]. Tondo et al. conducted a study on a milk processing plant to determine the source of *S. aureus* contamination and showed that contaminated raw milk was the main source of contamination of the final dairy products [178]. The frequency of enterotoxigenicity amongst staphylococcal strains is highly variable and studies on *S. aureus* isolated from cows showed enterotoxigenicity ranging from 0 to 56.5 percent [138].

Human outbreaks

There have been no known outbreaks of intestinal disease caused by *Staphylococcus* aureus on IOI.

4.2.3.7 Streptococcus

Streptococci are Gram positive cocci in the family Streptococcaceae. Many members of the genus Streptococcus are pathogenic for humans and animals. *Streptococcus uberis* is one of the more important environmental pathogens implicated in bovine mastitis, accounting for a significant proportion of subclinical and clinical intramammary infections in both lactating and nonlactating cows [179]. *Streptococcus equi* subsp. *zooepidemicus* has also been implicated in sporadic cases of cattle mastitis [180].

Streptococcus equi subsp. *zooepidemicus* (beta-hemolytic; Lancefield group C) is an opportunistic pathogen that causes a variety of infections in many species including humans. *S. equi* subsp. *zooepidemicus* is a commensal on the tonsils, upper respiratory tract, skin and urogenital tract of horses, and can be transmitted by a variety of mechanisms including aerosols and wound infections. It has also been found in healthy carriers of some other species. Good hygiene practices during milking can reduce exposure to environmental streptococci and decrease the risk of mastitis in ruminants. Some cases of *S. equi* subsp. *zooepidemicus* mastitis in ruminants were associated with hand milking and are suspected to have resulted from contact with horses or donkeys. Many human infections of *S. equi* subsp. *zooepidemicus* are linked to the consumption of unpasteurised dairy products [138].

Human outbreaks

Streptococcus equi subsp. *zooepidemicus* contamination of milk in England in 1984 resulted in 12 people being hospitalised, eight of whom died [181].

4.2.3.8 Brucellosis

Brucellosis is a zoonotic disease of major importance worldwide. It is caused by bacteria of the genus *Brucella* (*B. melitensis*, *B. abortus*, *B. suis*, *B. neotomae*, *B. ovis*, and *B. canis*) [145]. Brucellosis is a severe infection and can last for several years. Bovine brucellosis is a highly contagious cattle disease, which is spread by contact with infected female cattle, aborted foeti or discharged placental tissues and fluids. The disease has serious financial ramifications for the primary producer.

Though the organism is killed by pasteurisation or cooking, brucellosis can be transmitted to humans through consumption of contaminated food such as unpasteurised milk or milk products [182]. However, direct or indirect contact with infected cattle, sheep or goats is the most important transmission route.

The symptoms of brucellosis in humans are generally flu-like and may include fever, sweats, headaches, back pains and physical weakness. Severe infections of the central nervous systems or lining of the heart may occur.

Brucellosis can also cause long-lasting or chronic symptoms that include recurrent fevers, joint pain and fatigue [183]. Human cases of brucellosis within the EU remain low in comparison to other foodborne bacterial infections (1,337 reported cases of brucellosis in 2004 relative to 395,455 reported cases of bacterial foodborne infections) and are, for the most part, attributable to *Brucella melitensis* which is most probably linked to infection in small ruminant animals [184].

Brucellosis in ruminant animals and swine is a notifiable disease in ROI. While vaccination is not permitted, an eradication programme for bovine brucellosis in ROI, comprising a test and slaughter policy, is in operation with mandatory notification of abortions. ROI does not have OBF (Officially Brucellosis Free) status, however, the number of restricted herds, the percentage of herds testing positive for brucellosis in ROI, has been less than 0.5 percent since 2001 and 0.05 percent in 2004 [145]). Laboratory positive samples and individual outbreaks continue to fall year on year with a sharp decline in both between 2004 and 2005 and further decreases registered in the first three months of 2006. This has prompted the Minister for Agriculture, Fisheries and Food to call for a final effort to eradicate the disease from the national herd [185].

In NI, due to a number of comprehensive control measures undertaken by Department of Agriculture and Rural Development (DARD), the status of the NI herd is OBF [182].

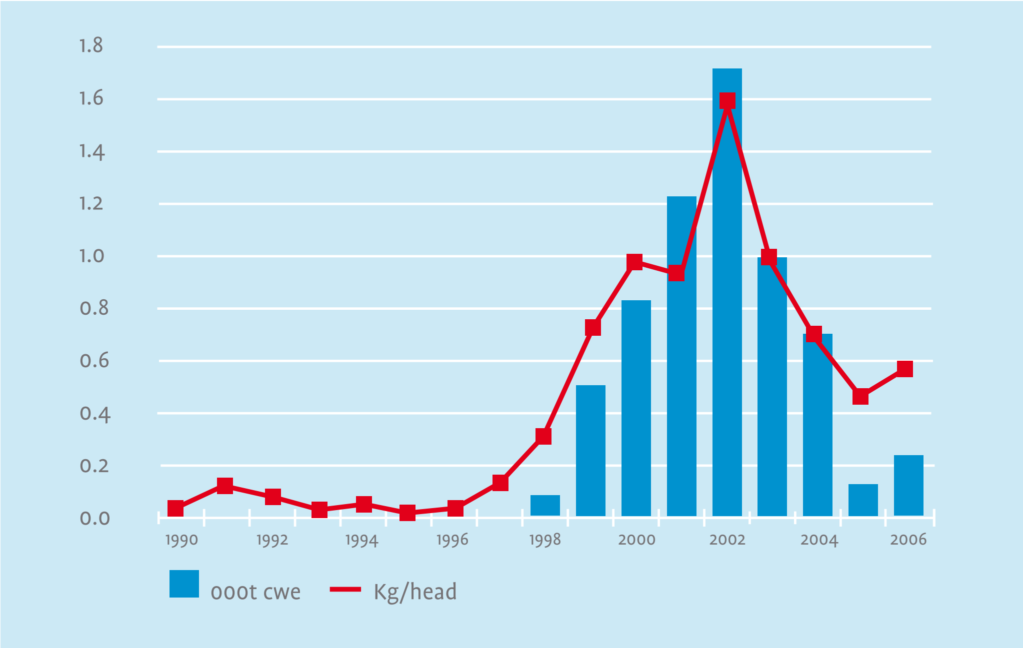
Human outbreaks

From 1995 to 2004 the number of human brucellosis cases notified in ROI was less than 20 annually, but in 2004, 60 cases were reported in that year alone [186]. However, it is important to bear in mind that 2004 was the first year that laboratories in ROI were legally required to notify human cases and notifications classified as probable may be a reflection of past infection rather than acute infection.

It is of note that 88 percent of cases in ROI for 2004 were aged over 35 years and that 98 percent of cases in NI are over 15 years of age [187]. The pattern does not fit with peak milk consumption and suggests findings that occupational exposure (veterinarians, farmers and abattoir workers) is now the major risk factor for this disease [188].

Figure 4.1 indicates the current situation in NI.

Figure 4.1: Reports of *Brucella sp* (all specimen types) 1999 to 2006 Northern Ireland



Source: CDSC NI, 2007 [187]

Due to the significance of this disease, a number of interagency initiatives have been implemented to target this group. Guidance for farmers and their families have been issued to avoid acquiring infection. In addition, a care pathway for general practitioners has been implemented to assist them with the diagnosis and management of brucellosis (Personal Communication, Communicable Disease Surveillance Centre NI, May 2007).

On IOI, there have been no known cases of brucellosis directly associated with the consumption of milk/milk products (Personal Communication, Communicable Disease Surveillance Centre NI, May 2007).

4.2.3.9 Mycobacterium bovis/Tuberculosis

The vast majority of human tuberculosis (TB) cases are due to infection with *Mycobacterium tuberculosis* as a result of inhalation of the bacilli (usually from another human) into the lungs. A more rare form of human TB is associated with infection by *Mycobacterium bovis* which also causes bovine tuberculosis [145].

Transmission of TB from animals to humans occurs mainly through consumption of raw milk and raw milk products from infected cattle [125]. It is prevented by heat-treatment such as the pasteurisation of milk and milk products. The introduction of pasteurisation, eradication programmes implemented in cattle, in combination with the vaccination of humans, has significantly reduced human infections caused by *M. bovis*.

Bovine TB is a notifiable animal disease and there are eradication programmes on-going in both NI and ROI, neither jurisdiction being officially bovine tuberculosis-free (OTF) in accordance with the Community legislation. Indeed, the most recent Food and Veterinary Office (FVO) missions to ROI and NI identify shortcomings in the TB eradication programmes and express some reservations about their efficacy [189-191].

Data from the EU shows that Great Britain (GB) and ROI reported the highest proportion of infected existing herds during 2005 [125]. The incidence rate of bovine TB in the ROI herds did not vary significantly between 1998

(7.2 percent) and 2001 (7.0 percent). However, routine tuberculin testing of cattle reveals a decline in the number of positive herds from 2002 (3.5 percent) which continued in 2004 (3.0 percent) [145]. In 2005 these figures remained similar in ROI while in GB reported numbers of infected cattle herds were down to 3.2 percent at the end of 2005 compared to 4.0 percent in 2004 [125, 192] .

Advice has been issued to farmers in NI in relation to dealing with TB in cattle herds [193].

Human outbreaks
M. bovis is no longer considered a significant zoonotic disease on IOI. In NI, 12 human cases of *M. bovis* were notified between 2000 and 2005 [194]. This represents 3.1 percent (n=387) of the total number of human TB cases over the period [194]. Eight of the individuals infected were aged over 50 and are therefore likely to reflect reactivation of earlier infection (two had a previous history of TB). Seven had no obvious reported risk factors (Personal Communication, Communicable Disease Surveillance Centre NI, May 2007).

In ROI, three cases (1.5 percent of total TB cases) of *M. bovis* were notified in 2005 [195]. There were a total of 27 human cases in ROI between 2000 and 2005 [196].

Public health measures such as the pasteurisation of milk and animal TB eradication programmes are responsible for these improvements.

4.2.3.10 Non-food safety related microbiological risks associated with milk

Mycobacterium avium paratuberculosis
Mycobacterium avium subspecies *paratuberculosis* (MAP) is the causative organism of Johne's disease in animals, primarily domestic ruminants [197].

Due to the similarities between the symptoms and pathological changes in the guts of humans with Crohn's disease and those that occur in cattle with Johne's disease, a proposed link between MAP and Crohn's disease has been put forward, although the association between the two remains a very controversial subject.

An FSA-funded report published in 2006 stated that there was no definitive evidence to support the link, and MAP is therefore not regarded as a foodborne pathogen [197]. The British Government has decided to continue to advocate the precautionary principle and attempt to minimise exposure of the public to this organism [198, 199]. The FSA published a strategy for reducing the levels of MAP in milk including components relating to hygienic milking practices; effective pasteurisation of milk; and reducing the level of MAP in dairy herds [200].

A systematic review and meta-analysis published in 2007 found that a causal role of MAP in the aetiology of Crohn's disease can neither be confirmed nor excluded with certainty [201].

Foot and Mouth Disease
Foot and mouth disease has no implications for the human food chain [202-204]. While bovine foot and mouth disease is transmissible to humans, it crosses the species barrier with difficulty and with little effect [205]. Human infection seems to be associated with close contact with infected animals [206]. The last human case reported in the UK occurred in 1966 [207].

4.2.4 Milk spoilage

Gram positive bacteria make up the major part of the microflora of freshly drawn milk. If freshly drawn milk is stored at ambient temperatures (~30°C) then these organisms, particularly the Lactococci (and *Lactococcus lactis* in particular) will dominate the flora producing lactic acid (0.16 percent) causing a pH drop from 6.7 to 4.6. *L. lactis* will eventually form 90 to 99 percent of the bacterial population and the lactic acid content rises to 1 percent. At this pH the lactococci themselves die off. The lactobacilli then take over (principally *Lactobacilli casei*) which produce very large amounts of lactic acid, up to 4 percent. These activities give rise to conventional souring of milk. Subsequent proteolysis occurs, mainly caused by yeasts and some lipolysis caused principally by moulds.

When fresh milk is stored at refrigeration temperatures, which most is, then psychrotrophs, and principally *Pseudomonas* spp. will predominate quite quickly. These organisms spoil through the production of partially heat stable lipolytic and proteolytic enzymes and perhaps also through the production of phospholipases. Proteases attack casein principally yielding peptides and amino acids. There may also be the formation of glycopeptides which can degrade further. Lipases release fatty acids, which may be degraded to give carbonyl and other highly flavoured volatile compounds which give overt signs of spoilage.

Bitty cream defect is due to the actions of the spores of the organism *Bacillus cereus* which only need to be present at <1.0 spores/ml to cause problems. Pasteurisation activates the spores which germinate and outgrow in the pasteurised product. The vegetative cells produce two enzymes, phospholipase and protease. The phospholipase attacks the phospholipid fat globule membrane exposing the triglyceride interior. The exposed triglyceride tends to make the globules adhere together and then the cream will not disperse in hot liquids such as tea or coffee. The only way to control the problem is to store the milk at less that 10°C immediately after pasteurisation until consumption. The low temperature will prevent outgrowth, although germination will occur. If bitty cream is allowed to develop then the protease produced will cause gelation.

4.2.5 Ensuring milk quality and safety

4.2.5.1 Quality parameters

The microbiological quality of raw milk is measured by total bacterial count (TBC) and somatic cell count (SCC). TBC is an indication of the state of hygiene on each dairy farm and SCC provides an indication of the health status of each herd. High numbers of somatic cells normally indicate a mastitis infection or udder damage often caused by a faulty milking machine or improper use of milking equipment. Regulation (EC) No. 853 sets out limits for SCC.

Producers are not permitted to sell milk for human consumption if the SCC is in excess of 400,000 per ml. This standard is based on the average SCC over a three month period. If the standard is exceeded, producers have three months to investigate and make improvements. However, if the SCC still exceeds the standard after this period, a producer will not be allowed to sell milk for human consumption until the three monthly average falls below 400,000 per ml. A reduction in SCC is also related to improved compositional quality payments and lower SCC penalties.

The most recent TBC and SCC data for NI for the first three months of 2006 and 2007 are presented in Table 4.7.

Table 4.7: Northern Ireland Milk Quality Statistics - Weighted Arithmetic Average ('000 per ml)

	TBC		SCC	
Month	2006	2007	2006	2007
January	15	14	201	209
February	14	15	205	212
March	15	15	215	215
April	14	17	213	228
May	16	15	232	223
June	15	17	241	244

Source: Department of Agriculture and Rural Development, 2007 [208]

Guidance has been issued by the Quality Assurance Branch of DARD in relation to SCC [209].

4.2.5.2 Food handler hygiene

All food business operators must ensure that food handlers are supervised and instructed and/or trained in food hygiene matters commensurate with their work activity. This is in accordance with Chapter XII Annex II of EC Regulation 852/2004 on the hygiene of foodstuffs. Meeting this requirement is about having the necessary skills to do the job. There is no legal requirement to attend a formal training course or obtain a qualification, although many businesses may want their staff to do so. The necessary skills may also be obtained in other ways, such as through on-the-job training, self-study or relevant prior experience.

In NI, guidance in relation to food hygiene instruction/training/supervision has been issued by the Department of Health [40] and the Local Authorities Coordinators of Regulatory Services [210].

The FSAI in ROI has a food safety training policy [211]. It established the Food Safety Training Council (FSTC), which comprises representatives from education and training, the food industry, and inspectors from the official agencies with responsibility for food safety, such as health boards and local authorities. The FSTC advises the FSAI on the contribution to food safety through training; levels of skills required for best practice in food safety; and guidelines for assessing the impact of food safety training in the work environment. The Authority, with input from the FSTC, has set training standards for the foodservice, retail, and manufacturing sectors. These standards are outlined in a series of food safety training guides covering three levels of skills: induction, additional, and for management.

They have also published a Guidance Note on the Inspection of Food Safety Training and Competence [212]. The purpose of this document is to establish a consistent approach to the inspection of the training and competence of operational staff dealing with food, and the provision of advice to food businesses in relation to training.

4.2.5.3 Codes of practice

An international code of hygienic practice for milk and milk products was issued by the Codex Alimentarius Commission [213] and includes the production, processing and handling of such products within its scope. The overarching principles of the code are as follows from raw material production to the point of consumption, dairy products should be subject to a combination of control measures, and these control measures should achieve the appropriate level of public health protection; good hygienic practices should be applied throughout the food chain, so that milk and milk products are safe and suitable for their intended use; wherever appropriate, hygienic practices for milk and milk products should be implemented within the context of HACCP; and control measures should be validated as effective. The code establishes criteria for various aspects of the chain such as environmental, structural, operational and personal hygiene; documentation and record keeping; establishment design and facilities; transportation; labelling and training.

4.2.6 Pasteurisation

Pasteurisation by use of heat implies the destruction of all disease-producing organisms in milk. The pasteurisation of milk is achieved by heating at 63°C for 30 minutes, or at 72°C for 15 seconds at minimum (high temperature short time, or 'HTST' method). These treatments are sufficient to destroy the most heat-resistant of the non-sporeforming pathogenic organisms. In addition, milk pasteurisation temperatures are sufficient to destroy all yeasts, moulds, gram-negative, and many gram-positive bacteria [214].

In addition to the HTST method, milk can also be treated with ultra high temperatures (UHT). This is done by applying to the raw milk a continuous flow of heat entailing the application of a high temperature for a short time (not less than +135°C for not less than a second), the aim being to destroy all residual spoilage micro-organisms and their spores.

Whilst pasteurisation is an effective step in preventing the transmission of pathogenic organisms it is important to note that improper handling after pasteurisation can recontaminate milk.

4.2.6.1 Consumption of unpasteurised milk

Although numerous studies have documented that foodborne pathogens of public health significance have been isolated from bulk tank milk and are capable of causing disease in humans, several studies show that people continue to consume raw milk.

A qualitative study in ROI conducted in 1998 reported that many farm families consume raw milk, simply because it is a traditional practice and it is less expensive to take milk from the bulk tank than buying pasteurised retail milk [215]. Additionally the study found that farmers generally believe their milk to be risk free on the basis of 'routine' test results and of better quality than pasteurised milk.

To identify how widespread the consumption of raw milk is in ROI, members of the Local Authority Veterinary Officers Association (County Council Veterinary Inspectors) carried out a study on 230 dairy farms over 8 counties (Cork, Carlow, Donegal, Kildare, Waterford, Westmeath, Wexford and Wicklow) in 1998, and found that unpasteurised milk was consumed by the farm family on 84 percent of farms. The survey also revealed that of the total human population drinking raw milk, 20 percent were in the higher risk categories of young children and elderly persons [162].

A recent study conducted in ROI assessed milk consumption on dairy farms (n=100) in Kilkenny in 2007 [216]. Unpasteurised milk was consumed by 48 percent of farm families. In 80 percent of these households, all members of the family consumed the unpasteurised milk, including young children and the elderly. The reasons for consuming unpasteurised milk were convenience (81%); cost (62%); taste preference (62%); tradition (60%); healthier and more natural (19%); and no risk (15%). Seventy one percent believed that there was a risk associated with unpasteurised milk consumption, with brucellosis being the main harmful bacteria/disease cited as a risk (74%). Surprisingly, 66 percent of those who drank their own milk unpasteurised continued to do so in spite of acknowledging the risk associated with the practice.

An outbreak of brucellosis in the herd was the main change of circumstances cited that would definitely cause them to stop this practice (98%), followed by Johne's disease and BSE (80%), TB (43%), high TBC (16%), high SCC (10%) and presence of *Salmonella* (2%).

The main advantage of pasteurising milk was to reduce the level of micro-organisms it contains and increase milk's shelf-life. Only ten percent of farmers surveyed owned a home pasteurisation unit. Only two of the owners used the pasteuriser daily, the remainder used it either usually (n=3), sometimes (n=2) or never (n=3).

In respect of the legislation governing the sale of raw cows' drinking milk, in NI the UK Government has assessed the public health risks and proposed a ban on the sale of raw cows' drinking milk three times since 1984, most recently in 1997. Each time, the Government decided not to give effect to its proposal in the face of consumer opposition. Producers also resisted a ban. On each occasion additional measures to protect consumers were introduced. Examples of such measures include effectively restricting sales of raw cows' drinking milk at the farm gate; introducing health warning labelling; increasing the frequency of inspection; and microbiological sample testing of raw cows' drinking milk at registered production holdings.

The current controls in NI are similar to those in England and Wales. Under the new consolidated EU hygiene rules, Member States are specifically able to introduce or maintain national rules prohibiting or restricting the placing on the market, within its territory, of raw milk or raw cream intended for direct human consumption. This removes any uncertainty about the legal basis for national controls in this area [217]. Although there are no known sales of raw cows' drinking milk in NI [217], it has been highlighted by the NI '*E. coli* O157 Taskforce' Report that there remains, however, the possibility that unpasteurised milk (cow/sheep or goat) may be used on farms in NI for personal use by the farmer, his/her family or visitors [218]. This view has also been expressed in a Welsh context by the FSA where it is thought that many farmers and their families consume raw drinking milk produced on their own farms [219].

Currently there is no sale of unpasteurised milk to shops within NI. However, there is a legal provision for untreated milk to be sold via farm gate sales or doorstep deliveries. Farm gate sales may include the provision of untreated milk in the catering sale to bed and breakfast guests resident on a dairy farm or via tea rooms on open farms. These sales must be conducted under a clear message that informs customers that the milk sold is untreated and may be harmful to health. To date the sale of milk in this manner does not seem to be a particular problem within NI [218].

In ROI, the sale of unpasteurised milk for direct human consumption is only permitted by obtaining written approved from the Department of Agriculture, Fisheries and Food. From July 1997 to December 2006 no such approvals were granted, thus the sale of unpasteurised milk has effectively been prohibited.

4.2.7 Legislation

The legislation in place to ensure the safety of milk throughout the food chain in both NI and ROI is the new hygiene legislation, commonly referred to as the 'Hygiene Package'. As EU regulations, the legislation is directly applicable law. The regulations are:

- *Regulation (EC) 852/2004 on the hygiene of foodstuffs;*
- *Regulation (EC) 853/2004 laying down specific hygiene rules for food of animal origin; and*
- *Regulation (EC) 854/2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption.*

The general hygiene requirements for all food business operators are laid down in Regulation 852/2004. Regulation 853/2004 supplements Regulation 852/2004 in that it lays down specific requirements for food businesses dealing with foods of animal origin. Regulation 854/2004 relates to the organisation of official controls on products of animal origin intended for human consumption. The legislation introduces a 'farm to fork' approach to food safety by including primary production (that is, farmers and growers) in food hygiene legislation, for the first time in the majority of cases. Also included in the package is Directive 2004/41, which repeals the previous EU legislation and in relation to dairy in particular, repeals Directive 92/46/EEC.

In addition to the regulations included in the 'hygiene package' there are a number of implementing regulations that support the application of the regulations. One such regulation that has specific relevance to the safety of milk is Commission Regulation (EC) No 2073/2005 of 15 November 2005 on the microbiological criteria for foodstuffs. As this is an EU regulation, it applies directly in both NI and ROI and lays down the food safety and process hygiene criteria for certain micro-organisms in respect of a range of foodstuffs. The process hygiene criteria for pasteurised milk and other pasteurised liquid dairy products specify limits in respect of *Enterobacteriaceae* at the end of the manufacturing process. In the case of unsatisfactory results it is specified that checks should be made in respect of the efficiency of the heat treatment, prevention of recontamination and the quality of the raw materials.

4.2.7.1 Implementing legislation

The Hygiene Package is implemented in NI under the Food Hygiene Regulations (NI) 2006 and in ROI by the European Communities (Food and Feed Hygiene) Regulations 2005 (S.I. No. 910/2005), as amended. In respect of the implementation of the regulations in NI, dairy farms are registered and inspected by the DARD Quality Assurance Branch (QAB) on behalf of the FSA. In addition to the registration of milk production holdings, food businesses processing milk and dairy products require approval under the hygiene package. DARD QAB also inspects milk pasteurisation plants. These plants must monitor pasteurisation effectiveness. They are required to have flow diversion systems that monitor the temperature the milk is pasteurised at and can divert the milk back for re-processing where necessary.

The QAB has published a guide for milk producers on the implementation of the Food Hygiene Regulations 2006 [220].

With respect to the implementation of the hygiene legislation in ROI, the Dairy Inspectorate and the Veterinary Inspectorate of the Department of Agriculture, Fisheries and Food and Local Authorities, respectively, carry out the work on behalf of the FSAI. This includes the approval of premises and the conduct of inspections and audits.

4.2.8 Extension of the shelf-life of milk

The aseptic nature of the processing and packaging pasteurised liquid milk products receive means that the shelf-life is largely dependent on the survival and growth of spoilage micro-organisms rather than pathogens [221].

The relatively short shelf-life of pasteurised milk has resulted in the development of UHT (ultra high temperature) milk for ambient distribution, which has gained widespread acceptance and popularity in many countries. In other areas, however, UHT milk has not been accepted by consumers because of the perceived 'cooked' taste of the product.

Pasteurised milk has a shelf-life from only a couple of days in some countries to over 20 days in the US. On IOI the shelf-life of milk is approximately 12 days. The reason for the variation in shelf-life is both local legislation and technological factors, such as raw milk quality, processing methods, hygiene in filling and, last but not least, the quality of the cold chain. Centralisation of the dairy industry, increased competition among dairy companies and less frequent shopping cycles have reinforced the requirement to increase the keeping ability of pasteurised liquid milk. Demands for longer shelf-life and wider distribution of milk and milk products have resulted in the development of processes and packaging concepts to increase the shelf-life of these products in cold chain distribution.

The temperature of storage and distribution is of paramount importance for the keeping ability of the milk. It has been reported that for pasteurised milk, in general, for every 2°C increase in storage temperature, the keeping ability is reduced by 50 percent [222].

4.3 Chemical residues and contamination

4.3.1 Introduction

Cows' milk can act as a carrier matrix for chemical residues and contaminants and therefore be a source of exposure to them.

Cows' milk has been shown to act as a reservoir for environmental toxins including Ochratoxin A [223], while significantly higher blood and milk levels of lead, zinc and aluminium have been detected in animals farmed in the vicinity of ore smelters. The correlation between the heavy metal levels in both sources is highly significant [224]. Similarly, cows' milk is known to act as a reservoir for polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F) and the levels of these compounds in milk serve as an indicator of environmental pollution [225, 226]. In general, these compounds tend to be fat soluble and are not fully metabolized *in vivo*. Consequently, they have a tendency toward bio-accumulation and levels in milk can be orders of magnitude greater than those in the diet [227, 228]. This has implications for the establishment of safe levels [229].

4.3.2 EU safe levels for contaminants in cows' milk

A 'contaminant' is defined under Council Regulation 315/93/EEC as "any substance not intentionally added to food, which is present in such food as a result of the production (including operations carried out in crop husbandry, animal husbandry and veterinary medicine), manufacture, processing, preparation, treatment, packaging, transport or holding of such food, or as a result of environmental contamination."

Maximum permissible levels in cows' milk have been established for a number of environmental contaminants within the EU. Commission Regulation (EC) No 1881/2006 was introduced to control the levels of specific contaminants in foodstuffs - cows' milk including lead, aflatoxin M1, dioxin (sum of PCDDs, PCDFs and polychlorinated biphenyls (PCBs)) (Table 4.8). Cows' milk is specifically defined as 'raw milk, milk for the manufacture of milk-based products and heat-treated milk'.

Table 4.8: Maximum allowable levels for contaminants in cows' milk in the EU

Product	Contaminant	Maximum level
Raw milk (as defined in Regulation (EC) No. 853/2004), heat-treated milk and milk for the manufacture of milk-based products	Lead	0.02 mg/kg wet weight
Raw milk (as defined in Regulation (EC) No. 853/2004), heat-treated milk and milk for the manufacture of milk-based products	Aflatoxin M1	0.05 μg/kg wet weight
Raw milk and dairy products (as defined in Regulation (EC) No 853/2004)	Sum of dioxins (PCDDs & PCDFs)	3 pg WHO-PCDD/F-TEQ /g fat*
	Sum of dioxins & dioxin-like PCBs (PCDDs, PCDFs & PCBs)	6 pg WHO PCDD/F-PCB-TEQ /g fat*

Note: * expressed in World Health Organisation (WHO) toxic equivalents, using the WHO-TEFs (toxic equivalency factors, 1997).

4.3.3 EU maximum residue levels in cows' milk

The residues of concern in cows' milk are derived from the administration of veterinary medicinal products (VMPs). There are several pieces of EU legislation pertaining to the definition, licensing and marketing of VMPs in the EU[8,9]. These do not include medicated feedingstuffs or any additives for use in the formulation of feedingstuffs[10,11]. The European Agency for the Evaluation of Medicinal products (EMEA) co-ordinates the scientific evaluation of the safety, quality and efficacy of medicinal products for human and veterinary use for licensing throughout the EU. EC decisions agreed under this system are binding on Member States and there is no scope for Member States to take a final national decision on a product out of line with a majority Community opinion.

The Irish Medicines Board (IMB) is the designated competent authority for the licensing of VMPs in ROI, although the Department of Agriculture, Fisheries and Food can authorise the use of certain medicines in exceptional circumstances[12]. In NI, the Veterinary Medicines Directorate is responsible for the licensing of VMPs. VMPs controlled under this legislation are not for sale to the general public and require a prescription for use by authorised personnel.

Current EU legislation requires the establishment of a maximum residue level (MRL) for all pharmacologically active substances in VMPs marketed in the EU for administration to food-producing animals. The conditions for establishing an MRL are set out in Council Regulation (EEC) No. 2377/90. MRLs for VMP active substances that are authorised for use in dairy cows are included in Annexes I, II or III of the Regulation.

Under Council Directive 96/23/EC, each Member State is required to implement residue surveillance plans and to submit their programmes annually to the Commission for approval. Third Countries wishing to export animal products to the EU are similarly required to satisfy the European Commission that their residue surveillance measures provide equivalent guarantees for EU consumers.

4.3.4 ROI National Residue Monitoring Programme

The National Residue Monitoring Programme in the ROI is carried out by the Department of Agriculture, Fisheries and Food. A variety of substances are included in analysis such as various drug residues, banned substances and certain contaminants. According to the provisions of the Commission's recommendation of 16 November 2006 on the monitoring of background levels of dioxins, dioxin-like PCBs and non-dioxin-like PCBs in foodstuffs, ROI is required to monitor a minimum of seven milk samples per annum for dioxins, furans and dioxin-like PCBs. Samples are taken from domestic food-producing species and from products imported from Third Countries, mostly on a routine targeted basis but also on suspicion, including follow-up investigations. The results for 2003 to 2005 are presented in Appendix D [230-232]. The total number of milk samples analysed increased by approximately 21 percent between 2003 and 2005. The positive VMP residues detected were Group B1 veterinary drugs which are described as antibacterial substances including sulphonomides and quinolones. Over 200 samples of milk were analysed for these compounds each year. Two positive samples were recorded in 2004 and 2005.

The ROI National Residue Monitoring Programmes for 2003 to 2005 did not record milk samples positive for pesticide residues (carbamates, pyrethroids, organochlorine and organophosphorus compounds), chemical elements (e.g. heavy metals), mycotoxins or dyes.

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[8] Directive 2004/28/EC of the European Parliament and of the Council of 31 March 2004 amending Directive 2001/82/EC on the Community code relating to veterinary medicinal products (OJ L 136, 30.4.2004, p. 58)

[9] Council Directive No. 2001/82/EC of 6 November 2001 on the Community code relating to veterinary medicinal products (OJ L 311, 28.11.2001, P. 1)

[10] Council Directive 90/167/EEC of 26 March 1990 laying down the conditions governing the preparation, placing on the market and use of medicated feedingstuffs in the Community (OJ L 092 , 07.04.1990, P. 42 – 48)

[11] Council Directive of 23 November 1970 concerning additives in feeding-stuffs (70/524/EEC) (OJ L 270, 14.12.1970, p. 1)

[12] Part III of the Animal Remedies Regulations, 2005 (S.I. No. 734 of 2005), which implements Directive 2001/82/EC as amended by Directive 2004/28/EC

4.3.5 NI surveillance for veterinary medicine residues and contaminants

In NI DARD collects and analyses samples for the National Surveillance Scheme (NSS) on behalf of the Veterinary Medicines Directorate. According to the provisions of the Commission's recommendation of 16 November 2006, the UK, as a whole, is required to monitor a minimum of 19 milk samples per annum for dioxins, furans and dioxin-like PCBs. In addition, milk samples are usually analysed for Annex IV (banned) substances, antimicrobials, anthelmintics, non-steroidal anti-inflammatory drugs (NSAIDS), pesticides and PCBs, heavy metals and mycotoxins [233]. In 2003, one of 174 milk samples contained Aflatoxin M1 (0.06 mg/kg) above the action level (0.05 mg/kg) [234]. This was a result of feed contamination. Samples taken during a follow-up investigation did not exceed the action level. No breaches of maximum permissible levels of the contaminants analysed were detected in samples taken during the 2004 monitoring programme [235]. In 2005, lead was detected in one of 42 milk samples at levels (88 mg/kg) above the reference point (20 mg/kg) [233]. No breaches were recorded during a follow-up investigation. There is no indication that any of these positive samples originated in NI.

Samples taken in NI are analysed by the Agri-Food and Biosciences Institute (AFBI) laboratories in Belfast (Veterinary Science Division at Stormont and Food Chemistry Branch, Newforge Lane). DARD also carry out follow-up investigations. The results of the NSS are published quarterly in the Medicines Act Veterinary information Service (MAVIS) and in the Veterinary Medicines Directorate annual report in July each year. The overall conclusion regarding VMP residues in the Annual Report on Surveillance for Veterinary Residues in Food in the UK for each year from 2003 to 2005 was that in the UK (including NI) authorised uses of VMPs did not result in residues of human health concern [233-235].

4.3.6 Growth hormones

An assessment of the potential adverse effects to human health from hormone residues in bovine meat and meat products, which was carried out on behalf of the European Commission in 1999, resulted in two pieces of legislation pertaining to prohibited substances used in cattle production[13],[14]. A risk to the consumer was identified for the six commercial hormones evaluated in this opinion. In particular, an increased risk of adverse health effects was identified in pre-pubertal children. No threshold level, and therefore no acceptable daily intake (ADI), could be established for any of the six hormones evaluated when administered to cattle for growth promotion purposes. The prohibited substances include stilbenes, stilbene derivatives, their salts and esters, thyrostatic substances, oestradiol 17 and its ester-like derivatives and beta-agonists. Substances having oestrogenic (other than oestradiol 17 and its ester-like derivatives), androgenic or gestagenic action are also provisionally prohibited.

Over 200 milk samples were analysed for prohibited substances that have an anabolic effect and other unauthorised substances during the 2003 to 2005 ROI National Residue Monitoring Programmes. No positive samples were returned [230-232]. Similarly, in the Annual Report on Surveillance for Veterinary Residues in Food in the UK no positive samples were detected during this period [233-235].

4.3.7 Radioactivity

4.3.7.1 ROI monitoring

Radioactivity above natural background levels results from human activities including nuclear power generation, industrial and medical waste and fallout from nuclear testing. In ROI, the Radiological Protection Institute of Ireland (RPII) is the competent authority charged with sampling and analysis of a number of food matrices, including cows' milk, for radioactivity under contract to the FSAI.

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[13] Council Directive 96/22/EC (OJ L125, p3, 23/05/1996) of 29 April 1996 concerning the prohibition on the use in stockfarming of certain substances having a hormonal or thyrostatic action and of beta-agonists, and repealing Directives 81/602/EEC, 88/146/EEC and 88/299/EEC13

[14] Directive 2003/74/EC (OJ L262,p17, 2003) of the European Parliament and of the Council of 22 September 2003 amending Council Directive 96/22/EC concerning the prohibition on the use in stockfarming of certain substances having a hormonal or thyrostatic action and of beta-agonists

Certain radionuclides, such as caesium-137 and strontium-90, are known to concentrate in milk. These radionuclides are investigated as part of the annual monitoring programme during which samples are taken at processing plants on a quarterly basis. Caesium-137 was not detected in any of the 68 composite milk samples taken over the period 2003 to 2005. Strontium-90, for which the analytical limit of detection is lower, was detected in certain samples. An exposure assessment was carried out for strontium-90 and its daughter product yttrium-90 for an adult male and an infant. In combination with exposure estimates from other sources in the environment, the risk of mortality from cancer associated with the consumption of milk was no different from the general risk of mortality from cancer. While the risk estimates for the period 2003 to 2005 are negligible, they show an increase during this time period [236].

4.3.7.2 UK (NI) monitoring

Radioactivity monitoring in NI is co-ordinated across all 26 District Councils, which are members of a nationwide network known as the Local Authorities Radiation Network (LARNET). The aim of this network is to provide independent quality assured information on local radiation matters. This monitoring is carried out under the auspices of the Environment and Heritage Service which, together with other UK agencies, publishes an annual report on Radioactivity in Food and the Environment (RIFE). This details the results of the radiological monitoring of food, environmental materials and dose rates throughout UK, and is published after an assessment is conducted by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS).

The radioactivity monitoring programme for NI is designed to complement that for the rest of the UK and to take account of the possibility of long-range transport of radionuclides. Dose rates are monitored on beaches and seafood, and indicator materials, including milk, are collected from several coastal locations. Milk is sampled at selected farms or dairies approximately once per month. In NI, samples were taken in counties, Antrim, Armagh, Down, Fermanagh and Tyrone during the 2004 and 2005 sampling programmes. They were analysed for tritium, carbon-14, sulphur-35, strontium-90 and several caesium isotopes. The levels of all isotopes were very low in both 2004 and 2005 and gave no cause for concern.

The 2004 and 2005 RIFE reports concluded that, for the whole of the UK, even the most exposed members of the public received radiation doses from food, the environment and direct radiation that were below the legal EU and UK statutory limits [237, 238].

4.4 Product traceability and recall

4.4.1 Introduction

In recent years high profile incidents, such as BSE, have focused attention on how the supply chain operates, from production through processing, and finally distribution. Such 'scares' have the potential to seriously damage consumer confidence in the food chain, whether they present real or perceived food safety risks. They have also highlighted serious deficiencies in traceability systems and also in European Law. The consequence of this was the formulation and adoption of EU Commission Regulation (EC) No. 178/2002 which lays down the general EU principles and requirements of food law including traceability and recall requirements. This regulation was implemented on 1 January 2005.

4.4.2 Traceability requirements

Regulation (EC) No 178/2002 was introduced to increase consumer confidence in the safety of all foods and to ensure that all businesses involved in the production, manufacture, distribution or retail of food and drink items have a reliable traceability system in place.

Article 18 of regulation No. 178/2002 requires that traceability of 'food, feed, food producing animals, and any other substance intended to be, or expected to be, incorporated into a food or feed, shall be established at all stages of production, processing and distribution.' This system effectively means that the principle of 'one-up, one-down' traceability should be established at each point in the supply chain. In the event of a foodborne hazard being identified in a particular batch of milk, or a case of foodborne illness associated with the consumption of milk having been reported, a full traceability system will permit identification of where that produce has originated; the raw materials involved in its production; who handled the produce since it was produced; how it has been stored during transit; and the final destination of the produce. This information enables a rapid and targeted recall of a potentially hazardous product.

The EU recently published a document outlining traceability requirements [239].

4.4.2.1 Health/identification marks

Council Directive 853/2004/EC states that food business operators must ensure that 'products of animal origin', have a health mark, in compliance with certain criteria laid down in Regulation (EC) 854/2004, to facilitate traceability. For that purpose, the following information must appear on the packaging or, in the case of a non-packaged product, in the accompanying documents:

- *Abbreviated name of the country in which the establishment is located, e.g. IE for RoI, or UK for the United Kingdom;*
- *Identification of the establishment or factory vessel by its official approval number; and*
- *One of the following abbreviated forms of 'European Union': CE - EC - EG - EK - EF – EY.*

All the letters and figures must be fully legible and grouped together on the packaging in a place where they are visible from the outside without any need to open the packaging. This enables an enforcement officer to identify the factory in which the product was packaged. All such establishments that meet the specified hygiene requirements and are licensed, are allocated a code number, which is part of the health mark along with the code of the particular country. The competent authority in each country is obliged to maintain a list of approved premises.

Where Regulation (EC) 854/2004 does not provide for the application of a health mark, an identification mark must be applied in accordance with Annex II, Section I of Regulation (EC) 853/2004.

Health marking is an important element of any traceability system. However, it should not be confused with, or related to, country of origin as is often the case. A product produced in one country, exported to another country where it is repackaged and relabelled, can bear the identification mark of the factory in which the latter activities took place.

4.4.3 Product recall

The objective of a product recall is to protect public health by informing consumers of the presence on the market of a potentially hazardous foodstuff and by facilitating the efficient, rapid identification and removal of the unsafe foodstuff from the distribution chain. There are two levels of product recall:

1. *Recall – the removal of unsafe food from the distribution chain extending to food sold to the consumer; and*
2. *Withdrawal – the removal of an unsafe food from the distribution chain not extending to food sold to the consumer.*

In addition to laying down the requirements for product traceability and recall, Regulation (EC) No. 178/2002 (mentioned earlier), also established the Rapid Alert System for Food and Feed (RASFF), which is a notification system operated by the European Commission to exchange information on identified hazards between Member States. In each Member State there must be a single liaison contact point to deal with alerts arising within that State, or issued by RASFF. The FSA in NI and FSAI in ROI are the primary contact points on IOI.

Notifications of alerts are issued by the single liaison contact point within each Member State to official agencies and food businesses relating to an identified hazard and are classified in either one of two categories, "For Action" or "For Information". Action is required when there is an identified direct or indirect risk to consumers. Information alerts do not require action, but relate information concerning a food or feed product that is unlikely to pose a risk to health, e.g. inform relevant authorities of consignments blocked at border inspection posts.

The FSAI has issued a Guidance Note [240] relating to Product Recall and Traceability (applicable only to food) and also a Code of Practice on Food Incidents and Food Alerts [241]. A similar guidance document has been issued by FSA NI, Guidance Note on EC Directive 178/2002 [242], and includes guidance on product recall and traceability.

In ROI, a "National Crisis Management Plan" was developed by the FSAI in conjunction with all of the official agencies so that a structured, co-ordinated and efficient response to any food safety crisis can be employed where the event arises. The FSA has set up an Incidents Taskforce to strengthen existing controls in the food chain so that the possibility of future food incidents occurring may be reduced. It also aims to improve the management of such incidents when they do occur [243].

4.5 In summary

The adoption of pasteurisation by the milk industry and cattle disease eradication programmes for TB and brucellosis from the 1950s to the 1980s has meant that milkborne disease is no longer a cause of human infection. Illness as a result of consuming pasteurised milk is very low, however, of those who have become ill there are a disproportionate number of children and a comparatively high case fatality related to mortality due to VTEC. Other organisms associated with milk-related outbreaks include *Salmonella* and *Campylobacter*. There have been no significant outbreaks of milkborne illness on the island of Ireland in recent years.

While pasteurisation is the single most significant step in controlling milkborne infections, improper handling and storage of post-pasteurised milk can result in recontamination. In spite of the well-documented public health evidence in support of pasteurisation many individuals, and in particular farm families, continue to consume unpasteurised or raw milk. This is made even more surprising given that 66 percent of those who consume raw milk acknowledge the inherent risks in doing so.

Milk can act as a carrier matrix for chemical residues and contaminants. Monitoring programmes in ROI and NI routinely test for all chemical residues such as dioxins, furans and dioxin-like PCBs, as well as veterinary residues and growth hormones. On the basis of the results of these ongoing tests there are currently no causes for concern from the chemical contamination of milk.

5. Conclusions

5.1 Introduction

Milk contains many of the essential nutrients and minerals including protein, calcium and the water soluble B vitamin group required for a healthy diet and thus is a very important part of the diet on the island of Ireland (IOI).

As a primary source of calcium, milk and diary foods provide the essential substrates for bone metabolism and there is evidence that calcium may play a role in the mediation of body weight control. Other health benefits attributed to milk and dairy products include a protective effect in the development of heart disease and stroke, which appears to be mediated primarily through a positive influence on blood pressure and a positive relationship of milk consumption with colorectal cancer has been demonstrated.

Milk consumption is high amongst infants and children but thereafter there is a drop in consumption, particularly amongst teenage girls, which is carried into adulthood.

The main barrier to consumption of milk identified among consumers during focus groups was the perception that it is a high fat food. This is not in fact the case. Whole milk contains approximately 3.9 percent fat and according to the Codex Alimentarius does not meet the criteria of a high fat or high saturated fat food. Semi-skimmed and skimmed milks, which contain 1.7 and 0.2 percent fat, respectively, have grown in popularity. While low fat or semi-skimmed milk are seen to have all the benefits of full fat milk from a nutrition and sensory perspective but without the extra fat, some consumers continue to reduce consumption even of these low fat varieties because of the perceived fat content.

Before the introduction of pasteurisation on IOI in the 1950s, milk was a significant vector in the transmission of foodborne illnesses, most notably tuberculosis. Nowadays milk can be considered a low risk food with less than two percent of all outbreaks in England and Wales in the period 1992 to 2000 being attributed to it. Of the outbreaks which did occur, unpasteurised milk was the most common vector; however, in relation to outbreaks/illnesses associated with pasteurised milk, improperly performed pasteurisation and the occurrence of contamination after pasteurisation were often found to be the reason.

This review collates and considers the information available in the public domain (regulatory, scientific) on the health and food safety implications of the milk supply chain. On the basis of the evidence the review highlights a number of issues for stakeholders in the milk supply chain, including producers, processors and distributors, as well as retailers, consumers and public health professionals.

5.2 Conclusions

5.2.1 Primary producers and processors

- *Good hygiene during milking can reduce exposure to environmental micro-organisms reducing the pathogenic load in raw milk and the risk of animal diseases such as mastitis. Dairy farmers are obliged by regulations to employ good agriculture, hygiene and animal husbandry practices at farm level.*
- *Milk processors are also obliged to employ good manufacturing and hygiene practices.*

5.2.2 Distributors and transporters

- *Distributors and transporters should ensure that milk and milk products under their control are handled and stored correctly.*
- *It is essential, and indeed a legal requirement, that the chill chain is maintained throughout the food chain.*

5.2.3 Retailers and Caterers

- *As the front line of the food industry, retailers and caterers have a legal onus of responsibility to their customers in ensuring the safety of the food that they present.*
- *Worker hygiene and hygienic practices are legal requirements and are central to the prevention of cross-contamination.*
- *HACCP is at the core of good food safety practice.*
- *The chill chain should be maintained at all stages along the food chain, including delivery to food premises.*
- *Caterers should offer a variety of milk products where possible, including whole and semi-skimmed/skimmed milks to promote choice for those who wish to avail of a lower fat option.*

5.2.4 Consumers

5.2.4.1 Healthy eating

Toddlers and Young Children

- *Milk is an important source of calcium in the diet of young children.*
- *Cows' milk should not be introduced before the age of 12 months but can be used to soften foods from six months onwards.*
- *Whole milk should be given until two years of age, after which semi-skimmed or low fat may be introduced.*
- *Skimmed or fat free milk should not be given to children younger than five years of age.*
- *Milk consumption by toddlers should ideally be part of a varied and balanced diet encompassing all food groups. Excessive consumption of milk can result in the displacement of other important foods in the diet such as meat and fruits and vegetables and in particular compromise iron status.*

Primary School Aged Children

- *Parents and guardians should encourage their children to consume milk and dairy products from an early age thereby facilitating patterns of healthy eating.*
- *A wide range of milk and dairy products should be included in children's diet to support peak bone mass attainment.*
- *Milk and water are the preferred options to soft drinks.*
- *Flavoured milks offer an option for children who do not like the flavour of plain milk; however, due to their higher sugar content these should be consumed with meals for dental health.*

Teenagers

- *During the teenage years the consumption of milk and dairy products declines particularly among girls. This appears to be related to the perception that milk and dairy products are fattening. Milk is not high in fat content, however, for those who consume a lot of milk, low fat options which retain the nutritional benefits of whole milk, should be considered.*

Adults

- *Semi skimmed (low fat) and skimmed (fat free) milks are widely available as alternatives and provide a lower fat option if consumers are concerned about their fat intake. These milks have lower energy values but maintain the nutritional properties of full fat milk.*
- *Milk can be consumed as a drink but also in the context of mealtime occasions, for example with cereal or as an ingredient in puddings.*

Health Professionals

- *The importance of milk and dairy products in the diet should be promoted, especially amongst teenage girls.*
- *The continued consumption of milk and associated benefits in doing so should be promoted to young women.*
- *The broader health benefits of milk in the context of dairy products as a food group should be promoted. Dairy is no longer just about calcium and bone formation and development; it plays a role in the lowering of blood pressure; it has a protective effect against certain cancers such as colorectal cancer; and has a potential role in the control of body weight.*
- *Data of adult consumption patterns indicate that the promotion of milk and dairy products in the context of mealtimes and with cereals or puddings is relevant for consumers. The adult data also indicates scope for increasing the consumption of milk as a drink.*
- *The establishment of milk and other dairy products as a normal part of the diet from an early age should be promoted to parents and guardians.*
- *The perception that milk is a high fat food is the main barrier to consumption, especially among teenage girls and young women. This perception needs to be addressed, as milk per se is not a high fat food.*

5.2.4.2 Food hygiene

- *Consumers should check the 'use by' date on unopened cartons/bottles of milk at point of purchase. Cartons/bottles should also be checked to ensure that they have not been tampered with.*

- *Growth of pathogenic bacteria can occur if the cold chain is not maintained during the transport of foodstuffs to the home. Raw meat should be packed in separate bags or containers away from other foods, particularly ready-to-eat foods such as milk and dairy products, to avoid potential cross-contamination. The use of insulated bags or freezer bags is recommended during transportation. Milk and other chilled and frozen food should be transported home as quickly as possible and put it in the fridge or freezer straightaway.*

- *Milk should be stored at refrigeration temperatures of 5°C or less ideally in an opaque container to avoid the production of off-flavours.*

- *Milk should be returned to the fridge as quickly as possible after pouring out the required amount.*

- *Anyone who drinks unpasteurised milk is at potential risk of being exposed to a number of food poisoning bacteria. Those at most risk include young children, the elderly, pregnant women or those whose immunity is low. The safest option is to drink milk that has been pasteurised. Farming families are strongly advised to either buy pasteurised milk for home consumption or to pasteurise their own milk with a reliable home pasteuriser.*

Appendices

Appendix A: Milk Terms Explained

Flavoured milk: Milk to which flavours such as chocolate, strawberry and banana have been added.

Fortified milk: Reduced fat or skimmed milk with extra calcium and other vitamins, such as vitamin D, added.

Pasteurised milk: Milk which has been subjected to heat treatment to destroy harmful bacteria and improve its keeping quality. Pasteurisation has little effect on milk's nutritive value.

Homogenised milk: Milk is forced through a tiny orifice under pressure to break down fat globules so that the cream is distributed evenly through the milk, resulting in a smooth, uniform texture.

Ultra heat treated (UHT) or long-life milk: Milk which has been subjected to an ultra high temperature normally in the range 135 to 150° in combination with appropriate holding times. It is specially packed and will keep for several months, unopened, without refrigeration. Once opened, however, it should be kept refrigerated. This milk is often used for single portions in the catering industry.

Appendix B: Organic Certification Bodies on IOI

The Department of Agriculture, Fisheries and Food in ROI has approved three organic organisations for certification and inspection services, namely:

1. *Bio-dynamic Agricultural Association of Ireland ("Demeter");*
2. *Irish Organic Farmers and Growers Association (IOFGA); and*
3. *Organic Trust Ltd.*

The Department of Agriculture and Rural Development in NI has approved three organic organisations in addition to the above:

1. *Soil Association;*
2. *Organic Farmers and Growers; and*
3. *Organic Food Federation.*

Appendix C: Gross composition of milk of various breeds, g/100g

	Body Wt. (kg)	Milk Yield (kg)	Fat (%)	Protein (%)	Lactose (%)	Ash (%)	Total Solids (%)
Holstein	640	7360	3.54	3.29	4.68	0.72	12.16
Brown Swiss	640	6100	3.99	3.64	4.94	0.74	13.08
Ayrshire	520	5760	3.95	3.48	4.60	0.72	12.77
Guernsey	500	5270	4.72	3.75	4.71	0.76	14.04
Jersey	430	5060	5.13	3.98	4.83	0.77	14.42
Shorthorn	530	5370	4.00	3.32	4.89	0.73	12.9

Note: Holstein: 12.16% T.S. x 7360 kg/lactation = 895 kg of total solids produced/lactation (140% of her body wt.!)
Jersey: 14.42% T.S. x 5060 kg/lactation = 730 kg of total solids produced/lactation (170% of her body wt.!)
Source: Webb, B.H., A.H. Johnson and J.A. Alford. (1974). Fundamentals of Dairy Chemistry. Second Ed. AVI Publishing Co., Westport, CT., Chap. 1.

Appendix D: Department of Agriculture, Fisheries & Food, ROI: Results of the 2003 to 2005 National Residue Monitoring Programmes: Milk samples

Chemical group	Samples analysed			Positive samples		
	2005	2004	2003	2005	2004	2003
Group A - (Prohibited Substances) Substances having anabolic effect and unauthorised substances						
Stilbenes, stilbene derivatives, and their salts and esters	0	0	0	0	0	0
Antithyroid agents	0	0	0	0	0	0
Steroids	0	0	0	0	0	0
Resorcylic acid lactones including zeranol	0	0	0	0	0	0
Beta-agonists	0	0	0	0	0	0
Substances which are prohibited and for which no MRL could be established	249	232	236	0	0	0
Total analysed	249	232	236	0	0	0
Group B - Veterinary Drugs and Contaminants: B1 - Antibacterial substances, including sulphonomides, quinolones*						
Antibacterial substances, including sulphonomides, quinolones	254	225	235	2	2	0
Group B - Veterinary Drugs and Contaminants: B2 - Other veterinary drugs						
Antihelminthics	247	223	223	0	0	0
Anticoccidials, including nitroimidazoles	0	0	0	0	0	0
Carbamates and pyrethroids	0	0	0	0	0	0
Sedatives	0	34	3	0	0	0
Non-steroidal anti-inflammatory drugs	0	0	0	0	0	0
Other pharmacologically active substances	0	0	0	0	0	0
Total analysed	247	257	226	0	0	0

Group B - Veterinary Drugs and Contaminants: B3 - Other substances and environmental contaminants						
Organochlorine compounds	60	67	53	0	0	0
Organophosphorus compound	60	67	53	0	0	0
Chemical elements	140	100	3	0	0	0
Mycotoxins	69	67	88	0	0	0
Dyes	0	0	0	0	0	0
Total analysed	329	301	197	0	0	0
Overall total analyses	1079	1015	894	2	2	0

Note: * Includes samples taken under joint Food Safety Authority of Ireland/Department of Agriculture, Fisheries and Food programme.
Source: Department of Agriculture, Fisheries and Food 2004, 2005, 2006 [230-232].

Glossary

Acceptable daily intake: The amount of a particular chemical in food which, based on all facts known at the time, is thought not to present any possibility for adverse health effects if ingested daily over a lifetime. ADI=NOEL x 10 (Interspecies uncertainty) x 10 (safety factor).

Body mass index: Body weight expressed in kilograms divided bythe square of height expressed in metres (BMI=kg/m^2). It provides an indirect measure of body fatness.

Case-control study: An epidemiological study in which the participants are chosen based on their disease or condition (cases) or lack of it (controls) to test whether past or recent history of an exposure such as smoking, genetic profile, alcohol consumption, or dietary intake, is associated with the risk of disease.

Cohort study: A study of a (usually large) group of people whose characteristics are recorded at recruitment (and sometimes later), followed up for a period of time during which outcomes of interest are noted. Differences in the frequency of outcomes (such as disease) within the cohort are calculated in relation to different levels of exposure to factors of interest, for example smoking, alcohol consumption, diet, and exercise. Differences in the likelihood of a particular outcome are presented as the relative risk comparing one level of exposure to another.

Crohn's disease: A chronic, episodic, inflammatory condition of the gastrointestinal tract characterized by inflammation of the bowel and skip lesions. The main gastrointestinal symptoms are abdominal pain, diarrhoea (which may be bloody) or constipation, vomiting and weight loss.

Cross sectional study: The observation of a defined population at a single point in time or time interval. Exposure and outcome are determined simultaneously.

Johne's disease: A chronic, progressive, infectious disease of cattle and other ruminant species caused by the bacteria Mycobacterium avium paratuberculosis. The infection is characterised by a gradual thickening of the intestinal wall over a period of several years which compromises the absorptive capacity of the animal leading to weight loss, intermittent to chronic diarrhoea, and ultimately death.

Liquid milk: Milk for human consumption, or 'drinking milk'.

Lower reference nutrient intake: The amount of a nutrient that is enough for only the small number of people who have low requirements (2.5%). The majority need more.

Manufacturing milk: Milk used in the production of milk products such as milk powders, cheese and yoghurts.

Maximum residue level: The maximum permissible concentration of a residue in a food, agricultural or animal feed commodity as a result of permitted agricultural or veterinary chemical usage. MRLs are not safety limits for human health although these (e.g. the ADI) are taken into consideration when establishing the MRL which is invariably lower. A MRL is not a toxicological limit and a violation is not necessarily a cause of concern for public or animal health.

Meta-analysis: Combines the results of several studies that address a set of related research hypotheses.

Pathogen: A disease-causing micro-organism.

Peak bone mass: The amount of bony tissue present at the end of the skeletal maturation reached at the age of 30 to 35 years.

Peak to trough ratio: The ratio of milk supplied during the peak month of production, as measured by milk deliveries versus that supplied in the lowest month's production.

Prospective study: A study in which the subjects are identified and then followed forward in time to establish relationships between outcome and exposure variables.

Randomised control trial: A study in which a comparison is made between one intervention (often a treatment or prevention strategy) and another (control). Sometimes the control group receives an inactive agent (a placebo). Groups are randomised to one intervention or the other, so that any difference in outcome between the two groups can be ascribed with confidence to the intervention. Neither investigators nor subjects usually know to which condition they have been randomised; this is called 'double blinding'.

Recommended nutrient intake: The daily intake which meets the nutrient requirements of almost all (97.5%) apparently healthy individuals in an age and sex-specific population.

Third Country: A country other than a Member State of the European Union.

Zoonose: A disease of animals that can be transmitted to humans.

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