



**2<sup>nd</sup> National Microbiological Survey 2007 (07NS2)**

**Bacteriological Safety of Fruit and/or Vegetable Juices and Smoothies**

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## **Executive Summary**

Sampling of unpasteurised fruit and/or vegetable juices and smoothies was undertaken by the Environmental Health Officers (EHO's) from the Health Service Executive (HSE) during May, June, July and August 2007. Eight hundred and seventeen samples were taken at random across the country in the retail and service sectors. Samples were tested for the following bacteria; *Salmonella* spp., *Listeria monocytogenes*, *Escherichia coli* and where possible, *Escherichia coli* O157. The main findings were as follows:

- All samples complied with the microbiological limits specified in the Commission Regulation (EC) No 2073/2005 for *Salmonella* spp. in unpasteurised fruit and vegetable juices (n=811) and *L. monocytogenes* in ready-to-eat (RTE) foods (n=811). These samples were classified as 'satisfactory'.
- *E. coli* O157 was not detected in 25g of any sample (n=436). Thus, all samples were classified as 'satisfactory' using the guideline criteria.
- Using the guideline criteria for *E. coli*, 99.4% (806/811) of samples were classified as 'satisfactory'. *E. coli* was detected at unsatisfactory levels (i.e. >1000 cfu/g) in 0.2% (2/811) of samples, i.e. one fruit juice and one fruit smoothie. Regulation 2073/2005 requires that in such cases the food business operator should make improvements in process hygiene. Follow-up action on these two unsatisfactory samples was taken by EHOs and repeat sampling showed satisfactory results.

The survey also included a questionnaire to capture further important product information on the samples provided by the EHO's. This included information on sample type,

source, preparation as well as key food safety labelling. A total of 578 (out of a possible 811) questionnaires were returned within the specified time period (a response rate of 71.3%), and these questionnaires were matched with the corresponding laboratory results. The following results were determined for samples which were accompanied by questionnaires;

- The majority of samples tested in this study were reported to be unpasteurised fruit and/or vegetable smoothies (n=297, 51%) and unpasteurised fruit juice (n=228, 39%).
- Most samples were reported to be obtained from juice bars (n=203, 35%), supermarkets (n=149, 25%), and restaurants (n=138, 24%).
- Eighty six percent of samples (n=499) were reported to be prepared on the establishment, rather than pre-packaged by a supplier (n=74, 13%).
- Out of the 86% of samples prepared on the establishment, 91% (n=456) were reported to be prepared at the point of sale, compared to 6% (n=30) which were reported to be pre-packaged.
- Three samples of 74 pre-packaged juices were reported not to be labelled with a 'use-by' date. These were in breach of Council Directive 2000/13/EC. Reporting of follow-up action by EHO's to FSAI on non-compliance with the labelling legislation was not a requirement of this study.

Overall, the survey findings indicate that in general the unpasteurised fruit and vegetable juices and smoothies available on the Irish market are compliant with relevant microbiological guidelines and standards.

## 1.0 Introduction

Fruit juices are no longer confined to the breakfast table. In recent years there has been renewed consumer appeal in this sector, largely due to the 'natural' and 'healthy' image associated with fruit and vegetable juices, and the improved availability of these products since the advent of the 'juice bar'. The increasing consumer demand for juices, has been coupled with a marked increase in the consumption of 'smoothies' (typically dairy and fruit juice based drinks), introduced onto the European market approximately 15 years ago. In fact, recent figures indicate the steady growth in this industry, with sales of juices and smoothies rising by 1.6 % between 2007 and 2008 in Western Europe alone (a market worth 23 million euro) (Beverage Daily, 2008). Moreover, with public policy campaigns advocating the beneficial role of fruit and vegetables in a healthy diet, juices and smoothies are well-placed for continued success on the European and US markets

Against this background of a growing market, and in the interest of public health, every step should be taken to prevent unpasteurised fruit and vegetable juices and smoothies becoming vehicles of foodborne infection. To-date, there have been no known foodborne outbreaks associated with unpasteurised juice or smoothies in the Republic of Ireland; however, several recent high-profile outbreaks associated with fresh fruit and vegetables and unpasteurised fruit juices have been reported world-wide (Vojdani *et al.* 2008). In particular, the outbreak of *E. coli* O157 from unpasteurised apple juice in 1999 (Cody, 1999), the US multi-state outbreak of *Salmonella* Typhimurium and Saintpaul from

unpasteurised orange juice in 2005 (Jain *et al.* 2009), and the US multi-state outbreak of *E. coli* O157 in spinach in 2006 (Wendel *et al.* 2009).

A detailed microbiological examination of fruit and vegetables, confirms the presence of a unique and diverse range of indigenous microflora on their outermost layer (Burnett, and Beuchat, 2000). Variations in surface morphology, internal tissue composition and metabolic activity (between different plants), results in a large variety of ecological niches of specific spoilage bacteria, moulds and yeasts. The occurrence of pathogenic micro-organisms within this microbial population, is usually the result of exposure to contaminated material (i.e. soil, manure, hands or water), during the growth, harvesting, distribution, or preparation of the food product (Beuchat and Ryu, 1997).

Physical processes like cutting, slicing, skinning and shredding of fresh produce, damage the surrounding protective outer barrier, in addition to creating a larger surface area for microbial populations to colonise. Penetration of this barrier also results in the excretion of nutritious fluids (including numerous phytoalexins), which can retard, but generally enhance microbial growth. This substrate promotes biofilm production which further assists in microbial proliferation, while also providing a protective layer, which makes bacterial removal/destruction all the more difficult (Beuchat *et al.* 2002). Thus, the process of food preparation, in this case for juice and smoothie products, has the potential to promote microbial growth, which can be exacerbated by incorrect product handling and storage. To preclude possible foodborne infection and to improve product shelf-life, foodstuffs generally incur at least one processing step (post-food preparation), designed

to reduce, or eliminate potential pathogenic and spoilage bacteria i.e. pasteurisation, sterilisation. In the case of unpasteurised juices and smoothies, high quality fresh ingredients, hygienic product preparation, proper food safety controls and the correct implementation of HACCP (Hazard Analysis and Critical Control Point) are important in controlling and preventing bacterial growth, since no further processing steps and in particular no heat treatment occurs. While unpasteurised juices and smoothies are favoured by the consumer for their nutritional content (the Irish Department of Health and Children currently advise that smoothies account for just one portion of the recommended 5 portions a day of fruit and vegetables, irrespective of how much is consumed) (*Safefood*, 2009) and their pleasing aesthetic appearance, the preparation of such products requires a continual commitment to high standards of food safety and hygiene to prevent the occurrence of foodborne infection.

This survey provides up-to-date information on the microbiological status of both unpasteurised juices and smoothies. It is more extensive than the previous 2002 survey (FSAI, 2002), thus reflecting the significance of these products at retail level. In addition, it assesses compliance with the microbiological limits for the relevant food safety criteria which are specified in Commission Regulation (EC) No 2073/2005 (Appendix 1).

## **2.0 Specific Objectives**

The primary aim of this study was to assess the microbiological safety of unpasteurised fruit and/or vegetable juices and smoothies on retail sale in the Republic of Ireland and where appropriate to assess compliance with the microbiological limits specified in Commission Regulation (EC) No 2073/2005 on Microbiological Criteria for Foodstuffs. A secondary aim of this study was to examine certain key aspects of labelling on pre-packaged products that are required to directly convey food safety information to consumers.

## **3.0 Method**

### **3.1 Sample Source**

Environmental Health Officers (EHO's) were requested to sample from retail establishments including juice bars, farmers markets, hotels, restaurants, supermarkets, corner shops and leisure centres.

### **3.2 Sample Description**

The four types of samples tested were;

- Unpasteurised fruit juices
- Unpasteurised vegetable juices
- Unpasteurised fruit and vegetable juices
- Unpasteurised smoothies (made from fruit and/or vegetables and yoghurt or milk or ice-cream)

Ideally, unpasteurised products prepared 'at point of sale' i.e. juice bars were sampled. However, when difficulties were encountered in acquiring an adequate number of these samples, then 'pre-packaged' unpasteurised juice/smoothies were sampled.



The following were specifically excluded from the survey;

- Pasteurised fruit juices
- Pasteurised vegetable juices
- Pasteurised fruit and vegetable juices
- Pasteurised smoothies

### **3.3 Sample Collection**

Sampling was undertaken by the EHO's from the Health Service Executive (HSE) during May, June, July and August 2007. Samples were taken in accordance with the following criteria;

- i) *For establishments preparing unpasteurised juices and smoothies at the point of sale:* only one sample of each product type was submitted i.e. one sample of orange juice, one sample of blackberry smoothie etc.
- ii) *For establishments selling pre-packaged unpasteurised juices and smoothies from a number of different manufacturers:* more than one product of each different type could be submitted, provided the samples were from different manufacturers.
- iii) Samples were a minimum of 200 ml.
- iv) All samples were transported to the laboratory under appropriate conditions i.e. in a cool box.
- v) EHO's completed sections one, two and three of the questionnaire provided (Appendix 3) at the time of sampling.

### 3.4 Sample Analysis

Samples were submitted to the HSE Official Food Microbiology Laboratories (OFML's)

for analysis. Samples were tested for the following bacteria:

- *Salmonella* spp.
- *Listeria monocytogenes*
- *Escherichia coli*
- *Escherichia coli* O157 (where possible)

**Table 1:** Analytical reference methods

Micro-organisms	Analytical reference methods
<i>Salmonella</i> spp.	ISO 6579 for detection of <i>Salmonella</i> spp.
<i>L. monocytogenes</i>	EN/ISO 11290-2 for the enumeration of <i>L. monocytogenes</i> *
<i>E. coli</i>	ISO 16649-1 or 2 for the enumeration of <i>E. coli</i>
<i>E. coli</i> O157	ISO 16654 for detection of <i>E. coli</i> O157

\* quantitative test only

### 3.5 Interpretation of Results

Samples were classified as outlined in Table 2.

**Table 2:** Classification of single samples obtained at retail level.

Pathogen/ Indicator	Micro-organism	Satisfactory	Acceptable	Unsatisfactory
Pathogen	<i>Salmonella</i> spp. *	Absent in 25 g	N/A	Present in 25 g
Pathogen	<i>Listeria monocytogenes</i> *	≤ 100 cfu/g	N/A	>100 cfu/g
Pathogen	<i>Escherichia coli</i> O157 ●	Absent in 25 g	N/A	Present in 25 g
Indicator	<i>Escherichia coli</i> ◆	≤ 100 cfu/g	>100 to ≤ 1,000 cfu/g	>1,000 cfu/g

\* Food safety criteria are laid down in Commission Regulation 2073/2005 for i) *Salmonella* spp. in unpasteurised fruit and vegetables juices and ii) *L. monocytogenes* in all ready-to-eat (RTE) foods. For this survey, single samples were assessed against the microbiological limits specified in Commission Regulation 2073/2005 (for further details see Appendix 1).

● There are no microbiological criteria in Commission Regulation 2073/2005 for Verocytotoxigenic *E. coli* (VTEC) in RTE foods, however Article 14 (Food Safety Requirements) of Commission Regulation 178/2002 states that food shall not be placed on the market if it is unsafe. The limits specified in Table 2 are based on the FSAI *Interim Guidance Note No. 3 on the Guidelines for the Interpretation of some RTE Foods Sampled at the Point of Sale*.

◆ A process hygiene criterion is laid down in Commission Regulation 2073/2005 for *E. coli* in unpasteurised fruit and vegetable juice (see Appendix 2). This criterion is applicable at the end of the manufacturing process but for the purpose of this survey, single samples obtained at retail level were assessed against the microbiological limits specified in Commission Regulation 2073/2005.

### **3.6 Questionnaire Data**

Upon receipt of the laboratory results, EHO's completed the questionnaire (Appendix 3) and the FSAI requested this to be submitted within six weeks of the survey completion date. Questionnaires received after this date, were excluded from the survey.

## 4.0 Results

### 4.1 General Microbiological Results

A total of 811 samples of unpasteurised (fruit and/or vegetable) juices and smoothies, were collected from the retail and service sectors throughout the Republic of Ireland. These samples were analysed by 7 OFML's. All samples tested for *Salmonella* spp (n=811), *L. monocytogenes* (n=811) and *E. coli* O157 (n=436) were classified as 'satisfactory' (Table 2). Ninety nine percent of samples tested for the microbial hygiene indicator *E. coli* were classified as 'satisfactory', 0.4% as 'acceptable' and 0.2 % as unsatisfactory (Table 3).

**Table 3:** Microbiological classification of unpasteurised (fruit and/or vegetable) juice and smoothie samples

<b>Micro-organism</b>	<b>Total Sample No.</b>	<b>No. of Satisfactory samples (%)*</b>	<b>No. of Acceptable samples (%)*</b>	<b>No. of Unsatisfactory samples (%)*</b>
<i>Salmonella</i> spp	811	811 (100%)	N/A	-
<i>Listeria monocytogenes</i>	811	811 (100%)	N/A	-
<i>Escherichia coli</i>	811	806 (99.4%)	3 (0.4%)	2 (0.2%)
<i>Escherichia coli</i> O157	436**	436 (100%)	N/A	-

\* Samples classified using limits specified in Table 2

\*\* 4 OFML's who tested a total of 436 samples, were able to test for *E. coli* O157

Levels of *E. coli* >100 cfu/g were reported in 0.6% (5/811) of samples. *E. coli* levels > 1,000 cfu/g (unsatisfactory levels) were reported in two of these samples. Details on the *E. coli* concentrations in these five samples are provided in Table 4. It should be noted that the presence of *E. coli* at unsatisfactory levels does not mean that the foods concerned were unsafe.

**Table 4:** *E. coli* counts >100 cfu/g recovered in five samples

Sample*	<i>E. coli</i> cfu/g	Classification	Prepared at 'Point of Sale'
Fruit Juice	240	Acceptable	Yes
Fruit Juice	320	Acceptable	Yes
Fruit Juice	800	Acceptable	Yes
Fruit Smoothie	20000	Unsatisfactory	Yes
Fruit Juice	34000	Unsatisfactory	Yes

\* None of the above samples were labelled or had use-by-dates

Further information on the number of samples submitted from each Health Service Executive (HSE) Region and Area and the number of samples analysed in each OFML can be found in Appendices 4 and 5, respectively. In addition, there is a breakdown of *Salmonella* spp., *L. monocytogenes*, *E. coli* and *E. coli* O157 results by HSE region and area, in Appendices 6, 7, 8 and 9 respectively.

Table 5 compares the results of the Irish 2002 study (FSAI 2002), a UK study (Little *et al.* 2002) and this current study. The Irish 2002 study tested unpasteurised fruit and/or vegetable juices samples for the pathogens *Salmonella* spp. (n=67 samples), *Listeria monocytogenes* (n=67 samples) and *E. coli* O157:H7 (n=29 samples). These pathogens were not detected in 25g of any sample examined. *L. monocytogenes* was quantified in 36 of the 67 samples analysed qualitatively. Colony counts <20 cfu/g were recorded for all samples. Testing was not carried out for the indicator organism *E. coli*. The UK

study (Little *et al.* 2002) did not detect *Salmonella* or *E. coli* O157 in 25g of the 291 samples of unpasteurised fruit and vegetable juices. However, *L. monocytogenes* was detected in two samples (0.7%), although both strains were found to be present at quantities  $\leq 20$  cfu/g. *E. coli* levels  $< 20$  cfu/g were reported for 99.6% (289/290) of samples, while an *E. coli* count in the range 20 to  $< 100$  cfu/g was reported for 0.4% (1/290) of samples. *E. coli* counts  $> 100$  cfu/g were not reported for any sample. This contrasts with the present study, in which *E. coli* was reported at levels  $> 100$  cfu/g in 5 samples (0.6%) (Table 5).

**Table 5:** Comparison of studies

Micro-organism	Parameters	Irish (FSAI) Study 2002♦ Samples (%)	UK Study 2002◇ Samples (%)	Irish (FSAI) Study 2007 Samples (%)
<i>Salmonella</i> spp	Absence in 25g	67 (100)	291 (100)	811 (100)
	Presence in 25g	0 (0)	0 (0)	0 (0)
<i>L. monocytogenes</i>	$\leq 100$ cfu/g <sup>⊕</sup>	36 (100)	2* (100)	811 (100)
	$> 100$ cfu/g	0 (0)	0 (0)	0 (0)
<i>E. coli</i>	$\leq 100$ cfu/g <sup>⊖</sup>	-†	290‡ (100)	806 (99.4)
	$> 100$ cfu/g		0 (0)	5 (0.6)
<i>E. coli</i> O157	Absence in 25g	29 (100)	291 (100)	436 (100)
	Presence in 25g	0 (0)	0 (0)	0 (0)

♦ FSAI, 2002

◇ Little *et al.* (2002)

⊕ *L. monocytogenes* results from the three studies are compared using the limit of 100cfu/g. However, it should be noted that all results from the Irish 2002 study and the UK study were reported as  $< 20$ cfu/g; while, the current study reported results as  $< 10$ cfu/g (n=201),  $< 20$ cfu/g (n=136) and  $< 100$ cfu/g (n=474).

\* 291 were tested qualitatively and *L. monocytogenes* was detected in 2 samples. These two positive samples were then quantified for *L. monocytogenes*.

⊖ *E. coli* results are compared using the limit of 100cfu/g. However, it should be noted that the UK study reported results as  $< 20$  cfu/g (n=289) and 20 to  $< 100$ cfu/g (n=1). The current Irish study reported results as  $< 10$  cfu/g (n=331),  $< 20$  cfu/g (n=5) and  $< 100$ cfu/g (n=470).

† *E. coli* was not tested for in the previous Irish 2002 study (FSAI, 2002)

‡ Only 290 of the 291 samples were examined for *E. coli* in the UK 2002 study

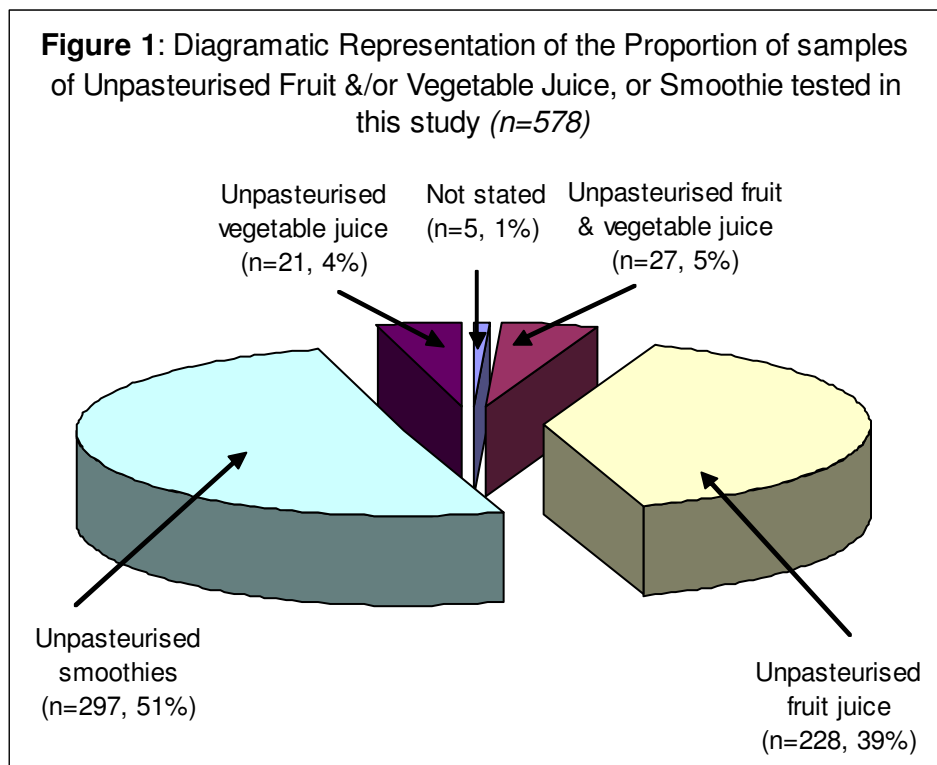
## **4.2 Survey Questionnaire Results**

The survey included a questionnaire with product information provided by the EHO's, on sample type, source, preparation and key food safety labelling. A total of 578 (out of a possible 811) questionnaires were returned within the specified time period (a response rate of 71.3%), and these questionnaires were matched with the corresponding laboratory results. Due to the small number of acceptable and unsatisfactory samples, the microbiological status of this subset of 578 samples was considered representative of the overall sample population presented in Table 3.



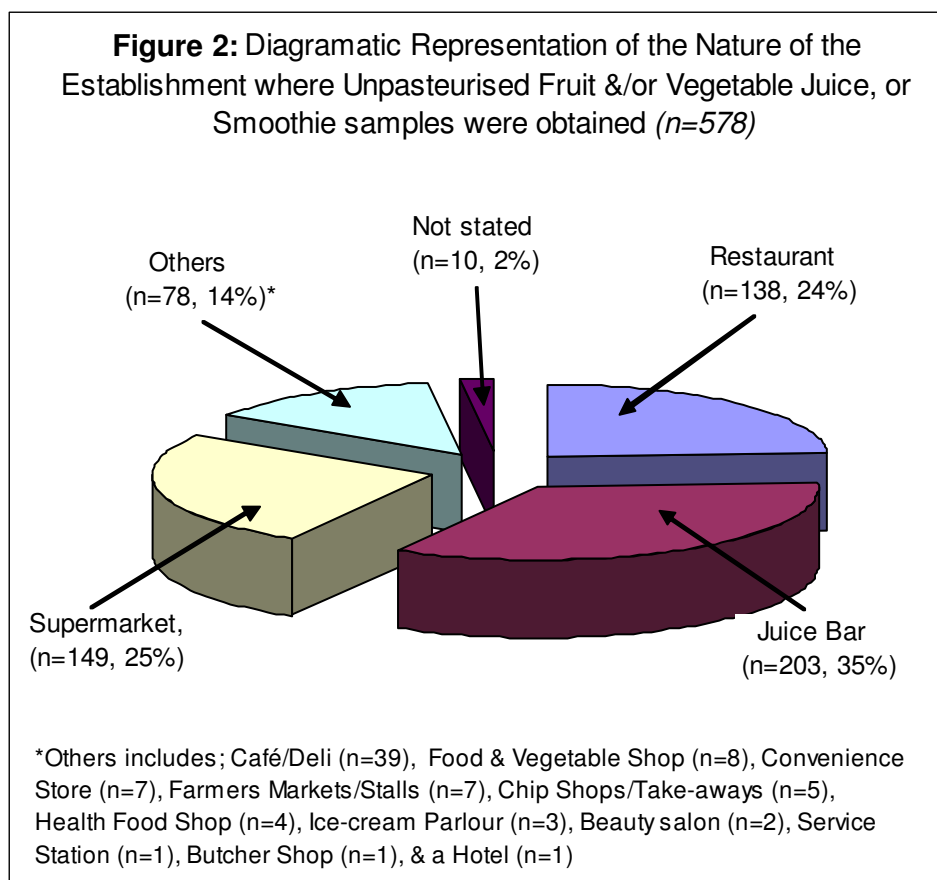
### 4.2.1 Sample type

The majority of samples tested in this study were reported to be unpasteurised smoothies (n=297, 51%) and unpasteurised fruit juice (n=228, 39%). The minority of samples tested were reported to be unpasteurised vegetable juice with/without fruit juice (n=48, 9%). Where the beverage type was not recorded on the questionnaire, these samples were reported as 'Not stated' (n=5, 1%) (Figure 1).



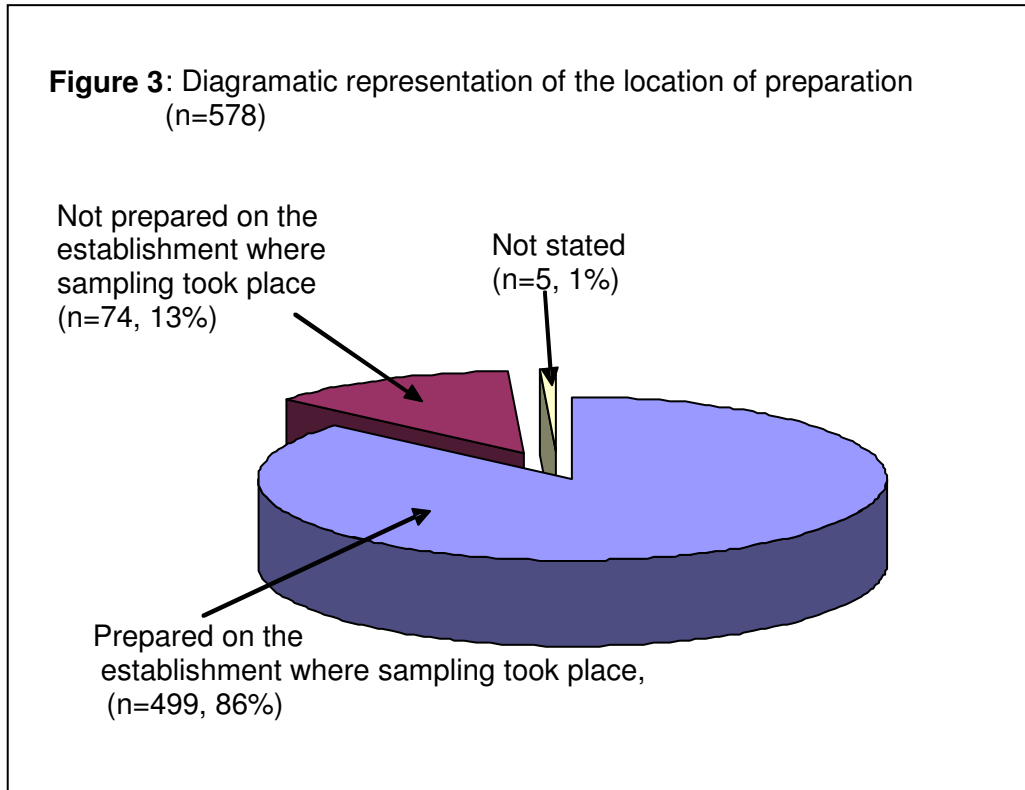
#### 4.2.2 Sample source

Most of the samples tested in this study were reported to be obtained from juice bars (n=203, 35%), supermarkets (n=149, 25%), and restaurants (n=138, 24%). The other samples examined, were reported to be obtained from a selection of establishments and were put under the collective heading of 'Others'(n=78, 14%). Of these, café/deli's (n=39, 6.8%), fruit and vegetable shops (n=8, 1.4%), convenience stores (n=7, 1.2%) and farmers markets and fruit stalls (n=7, 1.2%) were reported to be the establishments most frequently sampled. Where the type of establishment was not recorded on the questionnaire, these samples were reported as 'Not stated' (n=10, 2%) (Figure 2).



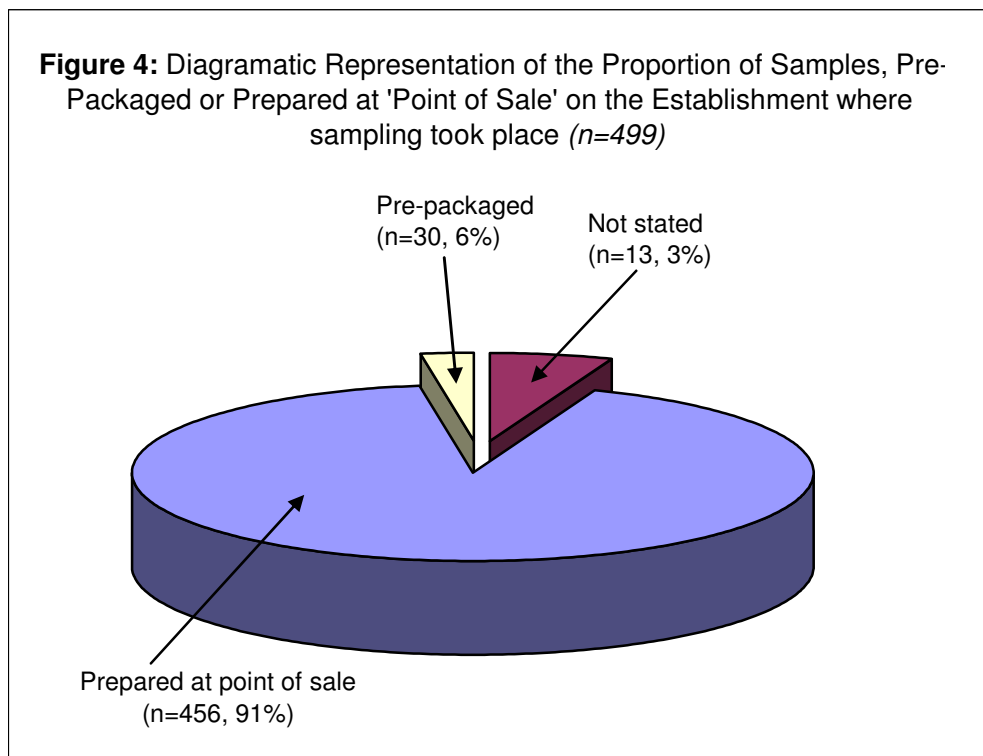
### 4.2.3 Location of preparation

Of the 578 samples examined, the majority of these samples were reported to be prepared on the establishment where sampling took place (n=499, 86%), rather than prepared by a supplier (n=74, 13%). Where the site of sample preparation was not recorded on the questionnaire, these samples were reported as 'Not stated' (n=5, 1%) (Figure 3).



#### 4.2.4 Samples prepared on the establishment where sampling took place

Of the 499 samples (86%) which were prepared by the FBO on the establishment where sampling took place (Figure 3), 91% of these samples (n=456) were reported to be prepared at the point of sale, compared to 6% (n=30) which were reported to be pre-packaged. Where preparation at the point of sale was not stated on the questionnaire, these samples were recorded as 'Not stated' (n=13, 3%) (Figure 4).



#### **4.2.5 Key food safety labelling of samples**

Ninety (16%) of all samples returned with questionnaires (n=578) were reported to be labelled, 81 of these samples (90% of all labelled samples) were reported to have a 'use-by-date' and 6 of these samples (7% of all labelled samples) were reported to be labelled as 'unpasteurised'.

Of the 456 samples prepared at the point of sale, 6 (1.3%) were reported to be labelled. Two (0.5%) of these samples were reported to have 'use-by-dates'. No sample was labelled as 'unpasteurised' (Table 6). There is no legal requirement for labelling of pre-packaged foodstuffs sold directly to the consumer from the establishment in which they were prepared.

In contrast, there is legal requirement for the labelling of pre-packaged products which are sold on a different establishment, to the one on which they were originally prepared. These products must comply with the labelling requirements of Council Directive 2000/13/EC (transposed into national legislation by S.I. 483 of 2002). This directive states that the date of minimum durability, in this case the 'use-by-date', is legally required on the label. Three (4%) of the 74 pre-packaged products (prepared in a different establishment to the one in which they were sold) were reported not to have a 'use-by-date' and were therefore in breach of this legislation (Table 6). With regard to labelling of a product as 'Unpasteurised', Article 5 (paragraph 3) of Council Directive 2000/13/EC states that *'The name under which the product is sold shall include or be accompanied by particulars as to the physical condition of the foodstuff or the specific*

*treatment which it has undergone (e.g. powdered, freeze-dried, deep-frozen, concentrated, smoked) in all cases where omission of such information could create confusion in the mind of the purchaser*'. Therefore, if a juice/smoothie has undergone a pasteurisation process this must be clearly indicated on the label. Assessment of compliance with this labeling requirement was not made as this would have required knowledge of the manufacturing process.

In contrast, there is no legal requirement to label juices/smoothies that have not undergone pasteurisation treatment with information that they are 'unpasteurised'. Despite this, it was noted that 6 (8%) of the 74 pre-packaged products (prepared on a different establishment to one they were sold on) carried this information voluntarily on their label (Table 6).

**Table 6:** Labelling of Samples

<b><u>Point of Sale/ Pre-packaged</u></b>	<b><u>Prepared in establishment where sampling took place</u></b> (n=499)	<b>No. of Samples Labelled (%)</b>	<b>Use-by-date on Label (%)</b>	<b>'Unpasteurised' on Label (%)</b>
Point of Sale	456	6 (1.3)	2 (0.5)	0 (0)
Pre-packaged	30	9 (30)	7 (23)	0 (0)
Not Stated	13	1 (8)	1 (8)	0 (0)
	<b><u>Not prepared in establishment where sampling took place</u></b> (n=74)	<b>No. of Samples Labelled (%)</b>	<b>'Use-by-date' on Label (%)</b>	<b>'Unpasteurised' on Label (%)</b>
Pre-packaged	74	74 (100)	71 (96)	6 (8)
	<b><u>Preparation Not Stated</u></b> (n=5)	<b>No. of Samples Labelled (%)</b>	<b>Use-by-date' on Label (%)</b>	<b>'Unpasteurised' on Label (%)</b>
Point of Sale	2	0 (0)	0 (0)	0 (0)
Pre-packaged	0	0 (0)	0 (0)	0 (0)
Not Stated	3	0 (0)	0 (0)	Not Stated
<b>Total</b>	<b>578</b>	<b>90</b>	<b>81</b>	<b>6</b>

Appendix 10 contains a more comprehensive breakdown of the labelling results from this study. Reporting by EHO's to FSAI on follow-up action for samples non-compliant with the labelling legislation was not a requirement of this study.

## 5.0. Discussion

### 5.1. General Microbiological

100% (n=811) of the unpasteurised fruit and/or vegetable juices and smoothies on retail sale in the Republic of Ireland, complied with the microbiological limits laid down in Commission Regulation 2073/2005 for *Salmonella* (n= 811) and *L. monocytogenes* (n=811). In addition, 100% (n=436) of samples complied with the guideline criteria for *E. coli* O157 and 99.8% (n=809) of samples complied with the guideline criteria for *E. coli* (i.e. these 809 samples were classified as either satisfactory or acceptable). Only 0.2% (n=2) of samples were classified as unsatisfactory for *E. coli*.

While, Enterobacteriaceae are reported to be a common occurrence on fruit and in particular on vegetables (Little *et al.* 2002), Commission Regulation (EC) No 2073/2005 specifies a process hygiene criterion for *E. coli* (a member of the Enterobacteriaceae family) in unpasteurised fruit and vegetable juices. Failure to comply with this criterion requires the food business operator to take corrective action, i.e. improvements in production hygiene and selection of the raw materials. *E. coli* on raw ready-to-eat fruit and vegetables are associated with faecal contamination which may be introduced *via* the raw ingredients or during preparation by poor hygiene practices (Ibenyassine *et al.* 2007). Although two ‘unsatisfactory’ results for *E. coli* were reported in this survey, it is important to also note that ‘satisfactory’ results were obtained in these samples for certain pathogenic members of the Enterobacteriaceae family (i.e. *Salmonella* spp. and *E. coli* O157) and also for *L. monocytogenes*, indicating that these samples were safe with respect to these organisms. Furthermore, follow-up action on the two samples which



were unsatisfactory for *E. coli* was taken by EHOs and repeat sampling showed satisfactory results.

While historically unpasteurised juice was considered non-hazardous due its acidic nature, we now know that *Salmonella* spp., *L. monocytogenes* and especially *E. coli* O157 can survive for extended periods of time in low pH foods (Gahan, *et al.* 1996; Oyarzabal *et al.* 2003; Duffy *et al.* 2006). In particular, Oyarzabal *et al.* (2003) reported the survival of these three pathogens in apple juice, banana juice, orange juice, pineapple juice and white grape concentrate, over a twelve week period. After this time, there was less than a 90% reduction (<1 log cfu/g) in the number of some of these pathogens in some of the juice products examined. Oyarzabal's study highlights the difficulty in eliminating these pathogens from low pH foodstuffs, when present. While the natural acidity of juices and smoothies may prevent the multiplication of pathogens, even low levels of contamination can be problematic when dealing with low infectious dose pathogens like *Salmonella* and in particular *E. coli* O157. While no smoothie related outbreaks have been found in the literature, these two pathogens have been reported to be the aetiological agents in previous foodborne outbreaks associated with unpasteurised juice products (CDC, 1997; Cook *et al.* 1998; Parish, 1998; CDC, 1999; Cody *et al.* 1999; Krause, 2001). In fact, the US Food and Drug Administration (FDA) only considers undiluted lemon and lime juice to be acidic enough to prevent bacterial survival and even then they recommend that lemon and lime juice should be treated like other juices, and that the time taken for a 5 log reduction (during normal storage conditions) should be determined (FDA, 2001). Moreover, the bacteriostatic effect of acid can be lost, if there is a deterioration in the

quality of the juice or smoothie product (i.e. through the growth of mould), resulting in an increase in pH, bacterial cell recovery and cell division. For this reason, the complete absence of *Salmonella* spp. and *E. coli* O157 reported in the samples tested, was a welcome result. In addition, any shifts in pH could have a marked effect on psychrotrophic bacteria like *L. monocytogenes*. Unlike, *Salmonella* and *E. coli* O157, *L. monocytogenes* has the ability to grow slowly at temperatures as low as 0°C in a high nutrient environment, if the pH is neutral/favourable (Gill and Reichel,1989; Walker *et al.*, 1990). Therefore, a short shelf life of chilled unpasteurized juices is important for food safety. The ‘satisfactory’ results reported for all samples, from the quantitative analysis carried out for *L. monocytogenes* in this survey, is also a reassuring result. In more general terms, the findings of this study are in agreement with similar studies, that the occurrence of these pathogenic bacteria on fresh produce (Little *et al.* 1997; Sagoo, 2001; 2003a, 2003b;WAFMP, 2006) or in ready-to-eat (RTE) foods, such as juices and smoothies (FSAI, 2002; Little *et al.* 2002; DHSV, 2005) is typically rare.

## **5.2. Survey Questionnaire**

The majority of samples examined in this study were reported to be unpasteurised smoothies (51%), and unpasteurised fruit juices (39%). These products were most frequently sampled from juice bars (35%), supermarkets (25%) and restaurants (24%). These sampling trends are similar to those reported in a recent *Safefood* (2009) report. The most popular locations for purchasing smoothies reported in the *Safefood* survey were juice/smoothie bars (54%), supermarkets (34%) and cafes (6%).

Eighty six percent of samples tested in this study were prepared on the food establishment and 91% of these were prepared at the actual point of sale, eliminating the need for storage of the final product and reducing the risk of bacterial growth. The large number of samples taken for analysis at the point of sale, is also in-line with the recent *Safefood* survey on smoothies (*Safefood*, 2009). This survey indicated that there is a stronger preference for made-to-order smoothies in the Republic of Ireland (as oppose to pre-packaged and home-made smoothies in Northern Ireland), suggesting that the sampling regime in this study reflects current consumer trends.

Three pre-packaged products examined in this study (prepared on a different establishment to the one on which they where sold in), were reported not to carry a 'use-by-date' on their label and were therefore in breach of Council Directive 2000/13/EC. The presence of a 'use-by' date on such products is an essential food safety requirement ensuring that products are consumed within a short, safe period of time after manufacture. The importance of such labelling is reflected in the fact that 71 pre-packaged samples were reported to state the 'use-by-date' on their label. A survey for compliance of labelling requirements for fruit juice was completed by the FSAI in 2004 (FSAI, 2004). This survey found a 66% compliance of pre-packaged juices with all the labelling aspects of Council Directive 2000/13/EC, however the number of samples with/without 'use-by-dates' was not stated and therefore could not be compared directly with the results of the current survey. There is no legal requirement to label unpasteurised juices/smoothies (prepared in a different establishment to the one on which they where sold) as 'unpasteurised', however, it was reported that six products provided

this information voluntarily on their label. The provision of this information is recommended by the FSAI as it is essential for vulnerable consumers who are advised to avoid consumption of unpasteurised juices.

## 6.0. Conclusions

- Overall, the survey findings suggest that the unpasteurised fruit and vegetable juices and smoothies available on the Irish market are safe and that the majority are of good microbiological quality.
  - All samples complied with the microbiological limits specified in Commission Regulation (EC) No 2073/2005 for *Salmonella* in unpasteurised fruit and vegetable juices (n=811) and *L. monocytogenes* in RTE foods (n=811). These samples were classified as ‘satisfactory’.
  - *E. coli* O157 was not detected in 25g of any sample (n=436). These samples were classified as ‘satisfactory’ based on the guideline criteria used in this survey.
  - *E. coli* was present at levels < 100 cfu/g in 99.4% (811/806) of samples and these were therefore classified as ‘satisfactory’ based on the guideline criteria used in this survey.
- The results reported in this study are also in agreement with other similar studies, that pathogenic bacteria of concern are typically rare in RTE products such as unpasteurised fruit and/or vegetable juices and smoothies.
- Three samples of 74 pre-packaged juices were reported not to be labelled with a ‘use-by’ date. These samples were in breach of Council Directive 2000/13/EC.

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## APPENDIX 1

**Table 1:** Food safety criteria for i) *Salmonella* spp. in unpasteurised fruit and vegetable juices and ii) *L. monocytogenes* in ready-to-eat foods as specified in Commission Regulation (EC) No 2073/2005 on Microbiological Criteria for Foodstuffs

Organism	Food category	Sampling plan <sup>⊗</sup>		Limit <sup>∇</sup>		Analytical reference method	Stage where the criterion applies
		n	c	m	M		
<i>Salmonella</i> spp.	Unpasteurised fruit and vegetable juices (ready-to-eat)	5	0	Absence in 25g		EN/ISO 6579	Products placed on the market and during their shelf life
<i>L. monocytogenes</i>	Ready-to-eat foods able to support the growth of <i>L. monocytogenes</i> , other than those intended for infants and for special medical purposes	5	0	100 cfu/g		EN/ISO 11290-2	Products placed on the market and during their shelf life
		5	0	Absence in 25g <sup>¥</sup>		EN/ISO 11290-1	Before the food has left the immediate control of the food business operator who has produced it
	Ready-to-eat foods unable to support the growth of <i>L. monocytogenes</i> , other than those intended for infants and for special medical purposes	5	0	100 cfu/g		EN/ISO 11290-2	Products placed on the market and during their shelf life

<sup>⊗</sup> For official sampling, single samples are permitted at retail level (single sampling should be done in the context of a monitoring and surveillance programme).

<sup>∇</sup> When testing against food safety criteria provides unsatisfactory results, the product or batch of foodstuffs must be recalled or withdrawn from the market in accordance with Article 19 of Regulation 178/2002.

<sup>¥</sup> This criterion applies to products before they have left the immediate control of the producing food business operator, when s/he is not able to demonstrate, to the satisfaction of the competent authority, that the product will not exceed the limit of 100 cfu/g throughout the shelf-life.

**NOTE:**

For a full interpretation of these criteria please consult Commission Regulation (EC) No 2073/2005<sup>1</sup> and the EU Guidance document on official controls<sup>2</sup>:

1. [http://www.fsai.ie/legislation/legislation\\_update/2005/Dec05/Reg2073\\_2005.pdf](http://www.fsai.ie/legislation/legislation_update/2005/Dec05/Reg2073_2005.pdf)
2. [http://www.fsai.ie/legislation/food/eu\\_docs/Food\\_hygiene/EU\\_Guidance\\_882.pdf](http://www.fsai.ie/legislation/food/eu_docs/Food_hygiene/EU_Guidance_882.pdf)

## APPENDIX 2

**Table 1:** Process hygiene criterion for *E. coli* in unpasteurised fruit and vegetable juices as specified in Commission Regulation (EC) No 2073/2005 on Microbiological Criteria for Foodstuffs

Organism	Food category	Sampling plan		Limit <sup>∇</sup>		Analytical reference method	Stage where the criterion applies
		n	c	m	M		
<i>E. coli</i>	Unpasteurised fruit and vegetable juices (ready-to-eat)	5	2	100 cfu/g	1000 cfu/g	ISO 16649-1 or 2	Manufacturing process

<sup>∇</sup> When testing against process hygiene criterion provides unsatisfactory results, improvements in production hygiene and selection of raw materials should be undertaken.

**NOTE:**

For a full interpretation of these criteria please consult Commission Regulation (EC) No 2073/2005 <sup>1</sup> and the EU Guidance document on official controls <sup>2</sup>:

1. [http://www.fsai.ie/legislation/legislation\\_update/2005/Dec05/Reg2073\\_2005.pdf](http://www.fsai.ie/legislation/legislation_update/2005/Dec05/Reg2073_2005.pdf)
2. [http://www.fsai.ie/legislation/food/eu\\_docs/Food\\_hygiene/EU\\_Guidance\\_882.pdf](http://www.fsai.ie/legislation/food/eu_docs/Food_hygiene/EU_Guidance_882.pdf)

**APPENDIX 3**  
**FINAL Questionnaire 07NS2**  
**Microbiological safety of unpasteurised fruit juices, vegetable juices and smoothies**

*Please note: 1) EHO's must complete this questionnaire for all samples, 2) all questions are mandatory and 3) all questionnaires must be returned to the FSAI by 12/10/2007*

**1. General Information:**

\* EHO Name: \_\_\_\_\_

\* EHO Sample Reference Number (i.e. EHO's own personal reference number for the sample) \_\_\_\_\_

\* Laboratory Reference Number (upon receipt of lab report) \_\_\_\_\_

**2. Premises Information** (See section 3 of Protocol):

❖ **Premises type:** Supermarket ; Juice Bar ; Restaurant ; Hotel ; Farmers market ; Leisure centre ; Beauty salon ;  
 Other  Please specify \_\_\_\_\_

**3. Sample information:**

**Type of product:** Unpasteurised fruit juice ; Unpasteurised vegetable juice ; Unpasteurised fruit and vegetable juice ; Unpasteurised smoothie

**Location of preparation:** Was the unpasteurised juice/smoothie prepared on the premises where the product was sampled? Yes  or No   
 If yes, was it prepared at the point of sale  or was it pre-prepared   
 If no, please state the manufacturer/brand name: \_\_\_\_\_

**Labelling information:** Was the product labelled? Yes  or No  If yes, please answer the next 2 questions:

1) Was the product labelled as unpasteurised?: Yes  or No   
 (See section 4 of protocol: EHO's should only sample pre-packaged juices/smoothies if they are sure the products are unpasteurised)

**4. Microbiological results** (see section 8 of protocol):

	Satisfactory	Acceptable	Unsatisfactory
<i>Salmonella</i> spp.	<input type="checkbox"/>	N/A	<input type="checkbox"/>
<i>L. monocytogenes</i>	<input type="checkbox"/>	N/A	<input type="checkbox"/>
<i>E. coli</i> O157	<input type="checkbox"/>	N/A	<input type="checkbox"/>
<i>E. coli</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**5. Follow-up action** (see section 9 of protocol):  
 (Follow-up action is only required for unsatisfactory results. Please tick as many boxes as necessary)

None

Product recall

Product withdrawal

Repeat sample  Lab. ref. no. of repeat sample : \_\_\_\_\_

Other action  Details: \_\_\_\_\_

## Appendix 4

**Number of Samples Submitted from each Health Service Executive (HSE) Region and Area:**

HSE Region	HSE Area	Number of Samples Submitted
HSEDMLR	East Coast Area	43
	Midlands Area	80
	South Western Area	103
HSEWR	Mid-Western Area	70
	North Western Area	59
	Western Area	84
HSEDNER	North Eastern Area	62
	Northern Area	68
HSESR	South Eastern Area	117
	Southern Area	125
<b>Total</b>		<b>811</b>

## Appendix 5

**Number of samples analysed in each Food Microbiology Laboratory:**

Official Food Microbiology Laboratory (OFML)	Number of Samples Analysed
Cherry Orchard *	200
Cork	125
Galway	84
Limerick*	70
Sligo*	59
SPD	156
Waterford*	117
<b>Grand Total</b>	<b>811</b>

\* This OFML's was able to test samples for *E. coli* O157

## Appendix 6

### *Salmonella* results by Health Service Executive (HSE) Region and Area:

HSE Region	HSE Area	Number of Samples		
		<i>Salmonella</i> spp. absent in 25g*	<i>Salmonella</i> spp. present in 25g	Total no.
HSEDMLR	East Coast Area	43	0	43
	Midlands Area	80	0	80
	South Western Area	103	0	103
HSEWR	Mid-Western Area	70	0	70
	North Western Area	59	0	59
	Western Area	84	0	84
HSEDNER	North Eastern Area	62	0	62
	Northern Area	68	0	68
HSES♦	South Eastern Area	117	0	117
	Southern Area	125	0	125
<b>Total</b>		<b>811</b>	<b>0</b>	<b>811</b>

\* Food safety criteria are laid down in Commission Regulation 2073/2005 for *Salmonella* spp. in unpasteurised fruit and vegetables juices (see Appendix 1).

## Appendix 7

### *L. monocytogenes* results by Health Service Executive (HSE) Region and Area:

HSE Region	HSE Area	Number of Samples		
		<i>Listeria monocytogenes</i> ≤100 cfu/g*	<i>Listeria monocytogenes</i> >100 cfu/g	Total no.
HSEDMLR	East Coast Area	43	0	43
	Midlands Area	80	0	80
	South Western Area	103	0	103
HSEWR	Mid-Western Area	70	0	70
	North Western Area	59	0	59
	Western Area	84	0	84
HSEDNER	North Eastern Area	62	0	62
	Northern Area	68	0	68
HSES♦	South Eastern Area	117	0	117
	Southern Area	125	0	125
<b>Total</b>		<b>811</b>	<b>0</b>	<b>811</b>

\* Food safety criteria are laid down in Commission Regulation 2073/2005 for *L. monocytogenes* in all ready-to-eat foods (see Appendix 1).

## Appendix 8

### *E. coli* results by Health Service Executive (HSE) Region and Area:

HSE Region	HSE Area	Number of Samples			Total no.
		<i>E. coli</i> ≤100 cfu/g*	<i>E. coli</i> >100 to ≤1,000 cfu/g	<i>E. coli</i> >1,000 cfu/g	
HSEDMLR	East Coast Area	43	0	0	43
	Midlands Area	80	0	0	80
	South Western Area	103	0	0	103
HSEWR	Mid-Western Area	63	1	2	70
	North Western Area	59	0	0	59
	Western Area	84	0	0	84
HSEDNER	North Eastern Area	62	0	0	62
	Northern Area	68	0	0	68
HSESR♦	South Eastern Area	115	2	0	117
	Southern Area	125	0	0	125
<b>Total</b>		<b>806</b>	<b>3</b>	<b>2</b>	<b>811</b>

\* A process hygiene criterion is laid down in Commission Regulation 2073/2005 for *E. coli* in unpasteurised fruit and vegetable juice (see Appendix 2). This criterion is applicable at the end of the manufacturing process but for the purpose of this survey, the criterion has been amended and will be applied to the products sampled at retail level.

## Appendix 9

### *E. coli* O157 results by Health Service Executive (HSE) Region and Area:

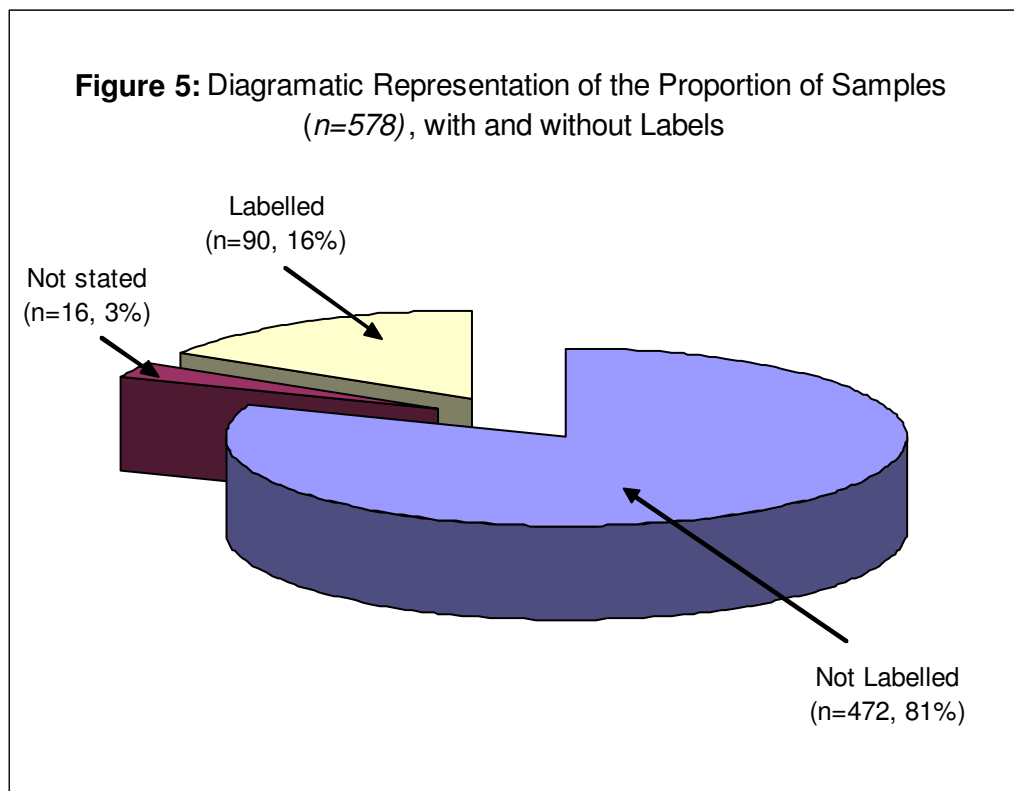
HSE Region	HSE Area	Number of Samples		Total no.
		<i>E. coli</i> O157 absent in 25g*	<i>E. coli</i> O157 present in 25g	
HSEDMLR	East Coast Area	9	0	9
	Midlands Area	0	0	0
	South Western Area	81	0	81
HSEWR	Mid-Western Area	70	0	70
	North Western Area	59	0	59
	Western Area	0	0	0
HSEDNER	North Eastern Area	62	0	62
	Northern Area	48	0	48
HSESR	South Eastern Area	107	0	107
	Southern Area	0	0	0
<b>Total</b>		<b>436</b>	<b>0</b>	<b>436</b>

\* There are no microbiological criteria for Verocytotoxigenic *E. coli* (VTEC) in RTE foods, however positive isolation of *E. coli* O157 is legislated for under Article 14 (Food Safety Requirements) of Commission Regulation 178/2002.

## Appendix 10

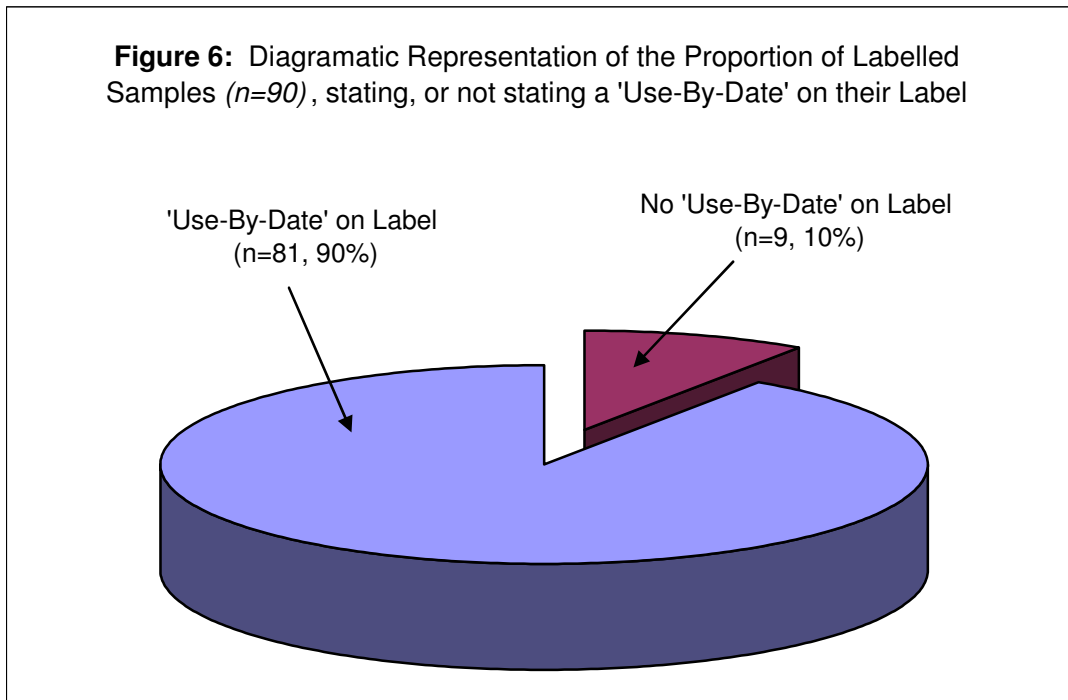
### 10.1 Number of Samples Labelled

Of the samples returned with a questionnaire ( $n=578$ ), 16% ( $n=90$ ) were reported to be labelled, while 81% ( $n=472$ ) of samples were reported to carry no labelling. This information was not provided for 3% ( $n=16$ ) of samples (Figure 5).



## 10.2 'Use-by-date' on the Sample Label

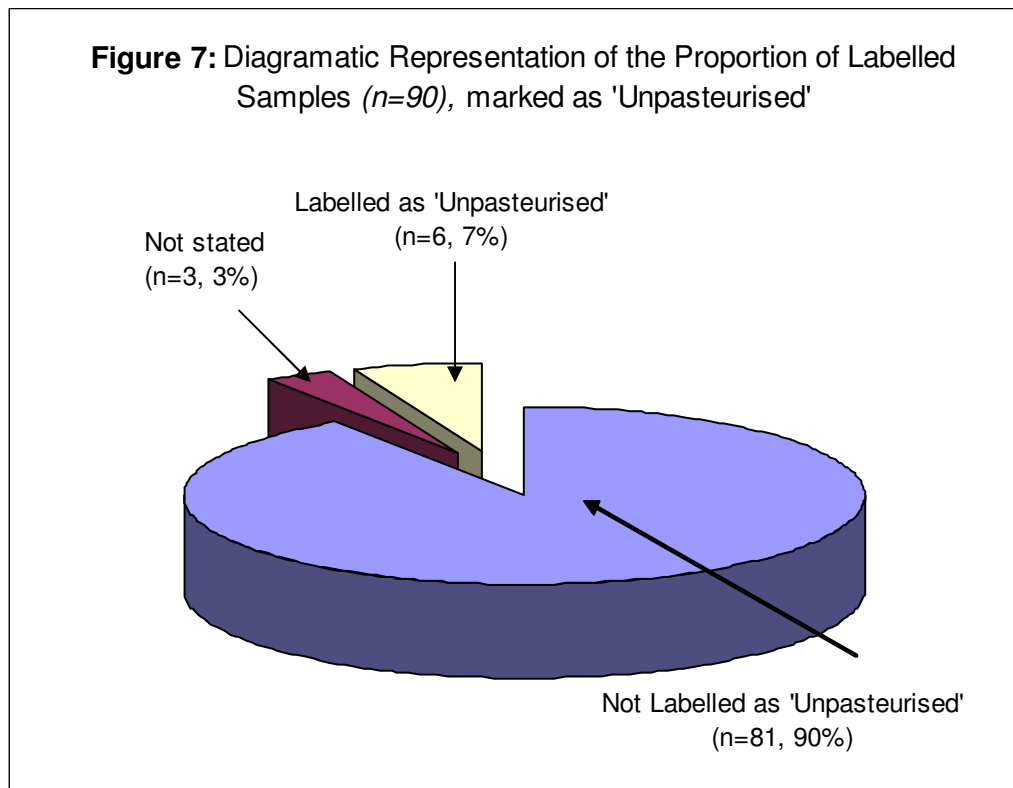
Of the 90 samples (16% of the total) which were reported to be labelled (Figure 5), 90% (n=81) were reported to be labelled with a 'use-by-date' while 10% (n=9) were reported to carry no 'use-by-date' (Figure6).





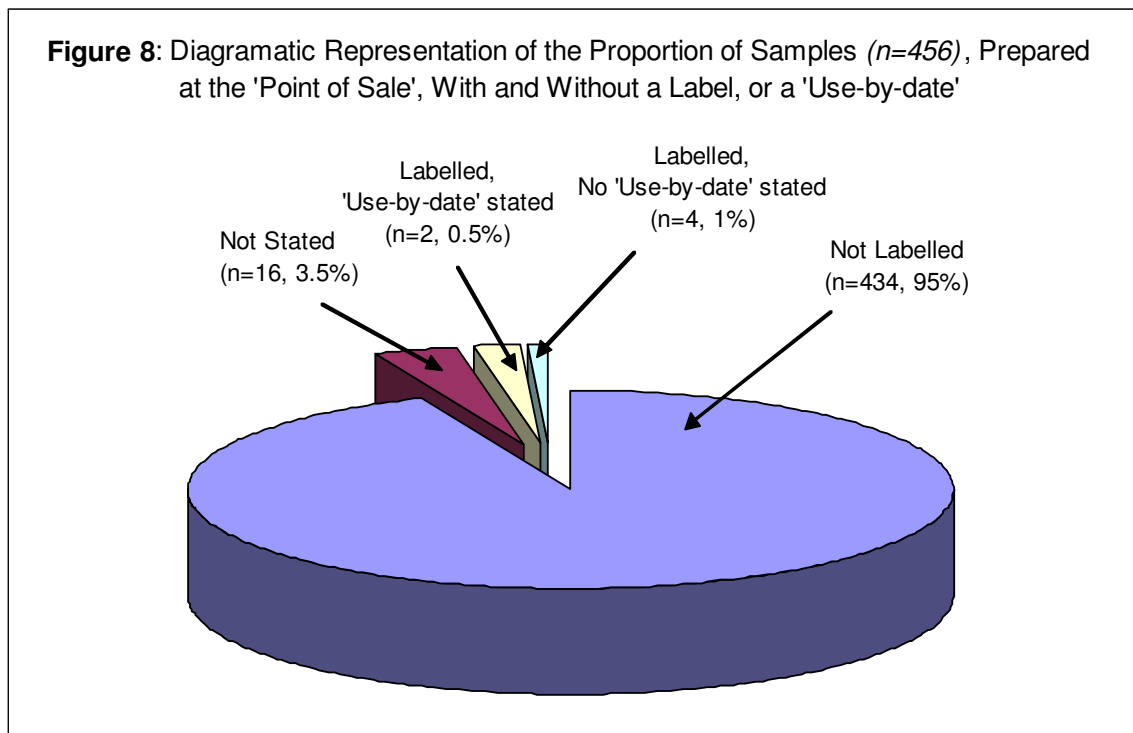
### 10.3 Samples Labelled as 'Unpasteurised'

Of the 90 samples (16% of the total) which were reported to be labelled (Figure 5), 7% (n=6) were reported to be labelled as 'unpasteurised' while 90% (n=81) were reported not to carry this information on their label. This information was not provided for 3% (n=3) of samples (Figure 7).



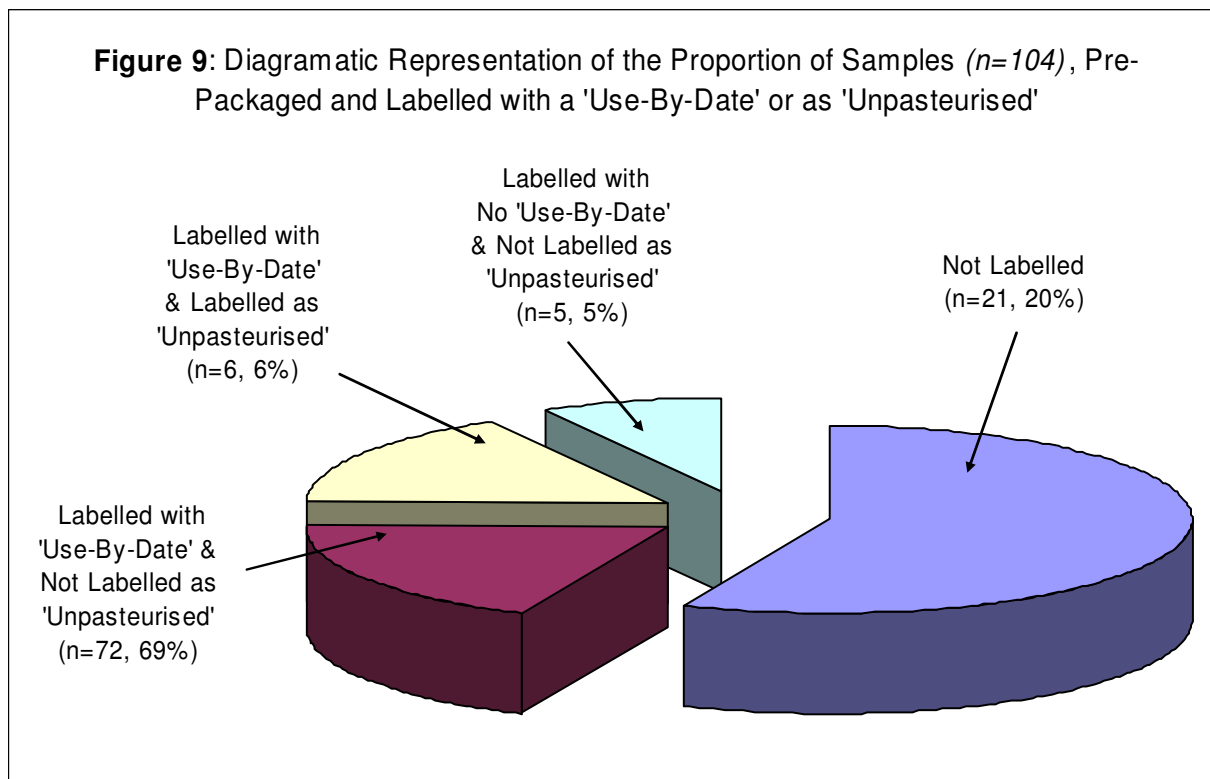
#### 10.4 Samples Prepared at the 'Point of Sale'

Only 6 out of 456 samples (1.5%), prepared at the point of sale were reported to be labelled. Two of these 6 samples were reported to be labelled with a 'use-by-date' while no sample was reported to be labelled as 'unpasteurised'. This information was not provided for 16 (3.5%) of samples (Figure 8). Since these products were reported to be prepared at the point of sale, there is no legal requirement for labelling (S.I. No. 483 of 2002).



### 10.5 Samples Pre-Packaged

Only 83 (80%) out of 104 pre-packaged samples were reported to be labelled. Seventy eight of these samples were reported to be labelled with a 'use-by-date' (six of these were also labelled as unpasteurised) while five samples were reported not to be labelled with a 'use-by-date' (these samples were reported not to be labelled as unpasteurised). Finally, 21 (20%) pre-packaged samples were reported to have no labelling at all (Figure 9). Legal requirements for labelling of pre-packaged products (S.I. No. 483 of 2002), depends on whether the product is prepared on the same establishment, as the one it is sold on (see section 4.2.11).



## **10.6 Pre-Packaged samples according to location of preparation**

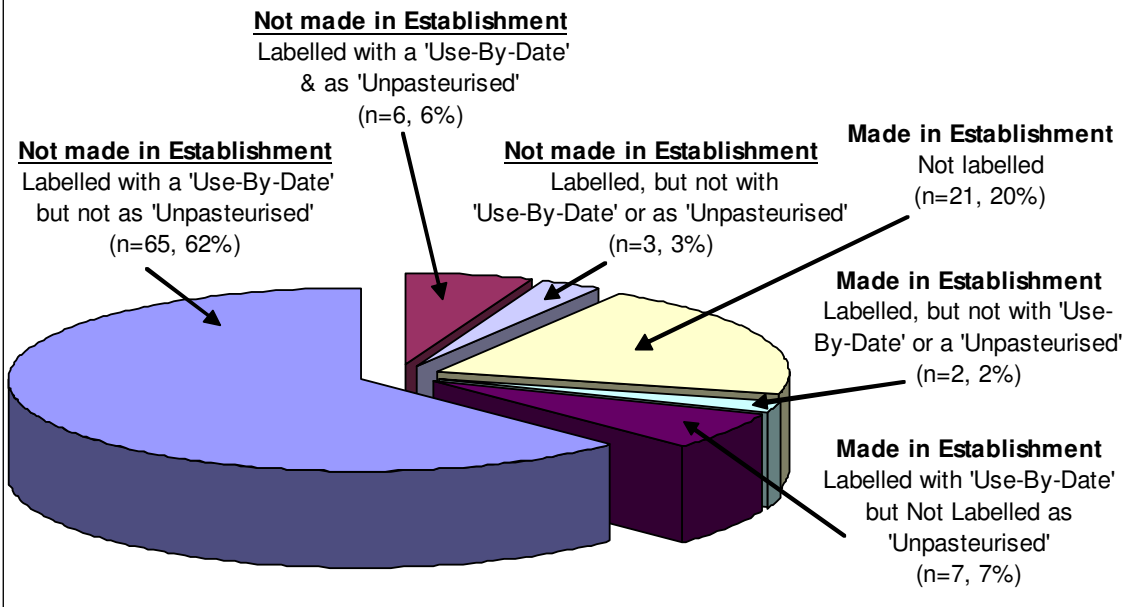
### **Pre-packaged samples prepared on the establishment where sampling took place:**

A total of 30 out of 104 pre-packaged samples (29%) were reported to be prepared on the establishment where sampling took place. Nine of these 30 samples were reported to be labelled; however only seven of these samples were reported to be labelled with a 'use-by-date'. No sample was reported to be labelled as 'unpasteurised'. However, since these 30 samples were reported to be pre-packaged on the retail establishment from which they were sold, there are no legal labelling obligations (S.I. No. 483 of 2002) for these products.

### **Pre-packaged samples prepared on an establishment other than the establishment where sampling took place:**

Seventy four out of the 104 pre-packaged samples (71%) were reported to be prepared on an establishment other than the establishment where sampling took place. These 74 samples were reported to be labelled. Seventy one of these samples were reported to be labelled with a use-by date (six of which were also reported to be labelled as unpasteurised), while three samples were reported not to be labelled with a 'use-by-date' (it was also reported that these samples were not labelled as 'unpasteurised'). These three samples are in breach of the labelling requirements of Council Directive 2000/13/EC (enforced under S.I. No. 483 of 2002), which states that durability in this case 'use-by-date' is a legal requirement.

**Figure 10:** Diagrammatic Representation of the Proportion of Pre-packaged Samples ( $n=104$ ), Prepared on the Establishment and Labeled with a 'Use-By-Date' and as 'Unpasteurised'



## Appendix 11

### Information on Labelling of Pre-Packaged Juice and Smoothie Products

- **FSAI**, Food Safety Authority of Ireland. Leaflet: Know Your Juice. Available at: <http://www.fsai.ie/assets/0/86/204/dad25195-f8fa-46d4-984a-abd4960d7f75.pdf>
- **FSAI**, Food Safety Authority of Ireland, (2006). Survey on Fruit Juices to Determine Compliance with Labelling Requirements and to Examine 'Made from Concentrate' Declarations. pp 1-23. Available at: [http://www.fsai.ie/uploadedFiles/Monitoring\\_and\\_Enforcement/FruitJuicesReport.pdf](http://www.fsai.ie/uploadedFiles/Monitoring_and_Enforcement/FruitJuicesReport.pdf)
- **Directive 2000/13EC of the European Parliament and of the Council** of the 20th of March 2000 on the approximation of the laws of the Member States relating to Labelling, Presentation and Advertising of Foodstuffs. Available at: [http://www.fsai.ie/uploadedFiles/Consol\\_Dir2000\\_13.pdf](http://www.fsai.ie/uploadedFiles/Consol_Dir2000_13.pdf)