



## Consumer attitudes towards the application of smart packaging technologies to cheese products



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### ABSTRACT

The survey conducted set out to explore consumer knowledge and attitudes pertaining to cheese shelf life expectation, advanced packaging technologies (smart, active and intelligent packaging and nanotechnology). Also, the willingness of a consumer to pay more for the extension of shelf life using the above technologies was assessed. Nanotechnology derived the highest level of awareness, with the other technologies receiving lower levels of recognition. Consumer acceptance of technologies varied depending on technology type and cheese application. Willingness to pay more for products containing these technologies was deemed unacceptable; however, willingness increased after participants received information about the value of using such technologies. Results indicate that provided product recipients are sufficiently educated, the future is optimistic for the employment of smart technologies to cheese products.

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### 1. Introduction

Smart packaging technologies are steadily becoming the solution to satisfying the response to consumer demands and industry trends. Within the smart technologies market, food packaging represents a very small fraction, which is almost totally concentrated in Japan, (Dainelli, Gontard, Spyropoulos, Zondervan van den Beuken, & Tobbback, 2008). Smart packaging systems can generate an enhanced product by utilizing non-traditional packaging functions to provide safer and securer, more nutritious or appealing food products, whilst being environmentally friendly. They can also contribute informatively; yielding improved logistical efficiency and optimised product recall. In addition, smart packaging technologies can be further optimised by the incorporation of nanotechnology, which can be utilised actively or intelligently, to enhance or extend package function.

Despite the numerous benefits bestowed by smart packaging, there are several barriers to full-scale adoption and application of such technologies to food products, including; complete scientific knowledge pertaining to the operating systems, full contact material compliance, implications of such technologies on the environment, unclear regulatory guidelines, and critically,

acceptance by retailers and consumers (Coles & Frewer, 2013; Frewer et al., 2011). Retailer and consumer attitudes towards food technologies are critical as they can ultimately lead to market success or widespread failure. However, consumers can be too conservative when it comes to accepting innovative concepts (Heiskanen et al., 2007). The opinion of the public towards a new technology can be heterogeneous and attitudes may vary dependent on the characteristics of the technology, the level of technology neophobia or consumer's associations with other technologies (Frewer et al., 2011). Therefore different technologies can provoke different responses.

The success of an innovation also depends on the product to which the technology is applied (Murray & Delahunty, 2000). Cheese, like many food product types, is suitably disposed to the application of smart packaging technologies and nanotechnology. This is because, firstly, it is widely consumed and consumption is growing globally (Sheehan, 2013) and secondly, due to its perishable nature, particularly when opened, spoilage occurs mainly at the product surface. However, besides barcodes and quick response codes, very few commercial examples of smart packaging technologies applied to cheese products are currently employed. In order to determine the reasoning behind this lack of employment, and to also avoid alienating the consumer and ensure an opportunity for adoption success, consumer reactions towards these technologies and potential obstacles such as

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resistance to cheese as a product application of these packaging technologies should be considered prior to introduction.

Research in the area of advanced packaging technologies and cheese is limited. [Almli et al. \(2011\)](#) determined consumer acceptance of different innovations, including packaging, on cheese. The packaging innovations evaluated were singular examples of convenience- (odour containment) and market-based packages. [Pilone, De Lucia, Del Nobile, and Contó \(2015\)](#) concentrated on consumer acceptance of environmental and shelf life extension innovations on Italian cheese, but did not discuss the specific technologies employed to achieve these functions.

This investigation was carried out to evaluate opinions on the shelf life offered by current cheese packaging formats and assess knowledge and attitudes towards the incorporation of novel packaging technologies within these formats in order to further extend product shelf life or communicate information with respect to product quality, with a particular focus on willingness to purchase if the price was increased.

## 2. Materials and methods

### 2.1. Research questions and survey distribution

The survey was composed of 16 questions (available in supplementary material). Prior to beginning the questionnaire, participants were informed that its purpose was to 'evaluate consumer attitudes towards the shelf life of retail cheese products and to assess knowledge and opinions of the incorporation of additional packaging technologies within conventional cheese packaging formats'. It was also specified in this initial introduction, that ideally, the survey participant should be a consumer of cheese. In order to recruit participants, the survey was distributed online through use of the university's survey mailing lists and social media websites.

The start of the survey, pages 2 and 3, contained questions (1–7) regarding some basic background information, such as; age, gender, nationality and education level. Education level responses are defined in [Table 1](#). Data was also collected from each respondent with respect to cheese consumption, type of cheese product consumed (soft, hard or both), and varieties purchased most frequently. Questions 8–16—on page 4 of the survey, participants were asked to estimate what they thought the shelf life of cheese to be, their satisfaction with current cheese shelf life, and the point at which they ceased consuming a cheese product. Page 5 determined consumer opinion on the application of safe technologies to further extend cheese storage capabilities and their willingness to pay more for this enhancement. Page 6 of the survey asked participants about their knowledge of the following packaging or related terms; Smart packaging, Active packaging, Intelligent packaging and Nanotechnology. If respondents had heard of the term they were also asked to comment on the circumstance in which they had been introduced to the term (Q14). The final page of the survey (page 7) provided the participants with a description of each of the terms ([Kerry & Bulter, 2008](#)), which were presented as follows;

**Smart packaging** – A package that provides the consumer with an extra function beyond the basic purpose of the package (protection, containment and communication). The extra function is usually mechanical, chemical, electrical or electronic.

**Active packaging** – This is a form of smart packaging. An active package contains constituents incorporated into the packaging material or within the packaging container that deliberately alters the condition of the package to either enhance sensorial

properties, maintain quality, or to extend the shelf life of the packaged product.

**Intelligent packaging** – This is a form of smart packaging. An intelligent package contains a device, positioned internally or externally to the package, which can monitor the condition of the product, package or packaging environment. The device can provide information on these aspects, but does not alter the condition of the package or product.

**Nanotechnology** – This is the use of materials on a nanometre scale, between 1 nm and 100 nm in size ([Duncan, 2011](#)), (1 nm = 1 millionth of a millimetre). Nanoparticles can expand the performance range of existing packaging materials. Particles at this size exhibit novel properties such as improved activity, mechanical, thermal and barrier function.

Acceptance was determined by asking consumers whether they would purchase a cheese product whose packaging contained one or more of these technologies. The final question repeated the query regarding paying more for the use of such technologies in retail packs of cheese products. Questions 8–16, with the exception of Q14, and their respective responses are presented in [Tables 2, 3 and 5](#).

### 2.2. Statistical evaluation of the questionnaire

Completed questionnaires were coded into a Microsoft<sup>®</sup> Excel worksheet and transferred into SPSS Statistics 20 (IBM, Armonk, NY, USA) to perform statistical analysis. Data was summarized as frequencies for each question and presented in contingency tables. Significance was determined using Chi-square analysis, and where these statistical differences existed, were identified using Chi-square post-hoc tests ([Beasley & Schumacker, 1995](#)). A significance level of  $P \leq 0.05$  was set and this was adjusted to control the type I error rate. The adjusted  $P$  value =  $0.05/\text{Number of analyses performed}$ . Only values which were found to be significant display superscripts in tables to indicate where in a group (age, gender, etc.) significance lies. A paired  $t$ -test was employed to establish if there was a significant difference ( $P \leq 0.05$ ) between responses for questions 12 and 16.

## 3. Results and discussion

### 3.1. Participant demographic

A total of 814 complete responses were collected from the survey. Respondent demographic characteristics are presented in [Table 1](#). Respondents were mostly aged between 18 to 34 (87.96%) and the majority of respondents (39.43%) had completed a PS level of education, both of which are unsurprising since the survey was distributed via university channels. This can also explain the increased number of female responses, 67.08% females compared to 32.92% males, as the [IUA \(2013\)](#) reported that in the academic year 2009/2010, more females than males were enrolled in Irish universities. Despite being circulated within an Irish university environment, 33 nationalities responded, with Ireland, the United Kingdom (inclusive of England, Scotland, Wales and Northern Ireland), Germany, the United States, Malaysia and Canada, contributing the bulk of responses. Most participants consumed cheese regularly (daily or weekly), with more than half (64%) eating both hard and soft cheese. Respondents were also asked to provide the names of the varieties of cheese they consumed most often. In total, 70 cheese varieties were mentioned, with the most popular cheese types being (those noted over 50 times); Cheddar, Mozzarella, Parmigiano-Reggiano/Parmesan, Cream cheese, Brie, Blue cheese (Stilton, Cashel blue or Gorgonzola), Goats cheese,

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