Fresh-cut salad and shelf life date extension: a segmentation of Italian consumers

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Abstract

Shelf-life estimation has become increasingly important due to the growing consumer interest in fresh and safe food products and the European policy indications to consider it as a key issue for the sustainable management of food waste within the supply chains. To date, no legislation on the shelf life date of the most of food products exists. Several studies demonstrate that logistic management and the technology available in the fresh-cut sector would allow to extend the shelf life date of products without compromising their intrinsic quality attributes and to achieve a more sustainable production by a strong reduction of unsold stock. The aim of the study was to segment consumers on the basis of their attitude towards the extension of the shelf life date in the fresh-cut salad sector. On the basis of the clusters found, the paper discusses if the information concerning such technology is a useful tool to inform consumers on product characteristics or if it entails a risk of information overload.

Keywords: shelf life date extension, fresh-cut sald, consumer, cluster analysis

1. Introduction

During the past decades various technological applications relating to prolonging of the shelf life of food products has been introduced. The reasons associated to the introduction of such technologies are related to several aspects. In addition to the improvement of food processing, the introduction of new technologies has often allowed an enhancing of safety attributes of food products, a reduction of production costs and positive effects on the environment, by a reduction of energy, water and chemicals used, and the production of less waste (Rollin et al., 2011). Although some food technologies, such as food irradiation and genetic modification, capture the interest of public debate, consumer acceptance a consistent part of technologies related to food processing remains undiscussed (Teisl et al., 2009). Nevertheless, insight into consumer acceptance is crucial

for the food industry since process characteristics often determine consumer preferences (Krystallis et al., 2009).

With regard to perishable products, innovative technologies throughout the food supply chain would contribute to improve the shelf life (Parfitt et al., 2010). Perishable products are among the most wasted food items within supply chains and households. Fruits and vegetables usually account for the highest proportion of food waste in many developed countries (Morgan, 2009; European Commission, 2010). Several studies demonstrate that the technology available in the fresh-cut sector would allow to extend the shelf life date of products without compromising their intrinsic quality attributes and to achieve a more sustainable production by a strong reduction of unsold stock (Ignat et al., 2014; Siroli et al., 2015; Manzocco et al., 2013).

With regard to the food category of minimally processed vegetables research focuses mostly on the effects of the introduction of new technologies on microbiological safety, quality, packaging and processing characteristics of such products whereas consumer preferences towards such technologies is still at the core of the scientific debate (Siroli et al., 2014; Ramos et al., 2013; Vandekinderen et al., 2009; Scolari and Vescovo, 2004; Soliva-Fortuny and Martín-Belloso, 2003). The present paper concentrates the attention on consumers acceptance of technology applications related to the shelf life extension of fresh-cut salad. In specific, we used cluster analysis in order to identify different kind of consumers on the basis of their preferences towards such technological advances.

The paper is organized as follows. Section 2 focuses on issues related to the fresh-cut salad sector, Section 3 analyses the existing literature on consumer acceptance of food technologies, Section 4 presents the dataset used for the purpose of the study and the methodology and Section 5 presents the empirical results and final remarks.

2. Background to the research

Legal framework on shelf life of food products

Among the strategies discussed at European level in order to promote food waste reduction, the shelf life date of food products has been recognized as a key issue (European Parliament, 2013). Food waste related to the shelf life of food products within supply chains or within households due to a misunderstanding of the normative labelling system on shelf life date (best before and use by) is considered one of unacceptable causes of food waste in developed countries (FAO, 2011).

European legislation refers to legal responsibility of manufacturers to determine the shelf life period of food products. One of the main pillars of the EU Regulation 178/2002 is that the primary responsibility for food safety lies with the manufacturer. Hence, Directive EC 2000/13 on the labelling, presentation and advertising of foodstuffs and Regulation EC 1169/2011 on the provision of food information to consumers do not specify any rules for the determination of the shelf life date of food products. The decision by the food company on the shelf life date to apply in order to obtain a safe and market acceptable product depends on the food processing applied by the manufacturer and the intrinsic (e.g. pH) and extrinsic properties of the food (e.g. temperature, packaging) (Beaufort, 2011). In Italy the only law in force is the DM n ° 3746 of 06/20/2014 that makes no

specific reference to the expiration date, but only to some microbiological parameters (Listeria, E. coli, Salmonella) and the limits of the temperature at which the salad to be stored during the distribution (T <8 ° C). Hence, food firms and retailers can set their own limits to the expiration date. Actually in Italy an expiration date of 6 days and of 7 days for "adult salad", is used for baby leaf with industrial brand. Fresh-cut salads with private label have to follow more stringent limits (usually 5 days).

Technologies applications to prolong the shelf life for fresh-cut salad

The efficient management of food waste along the supply chains is receiving a lot of attention by institutions (Boxstael et al., 2014). Estimates of food wasted vary by region and product type; however, figures usually indicate that between 20 and 30% of all food produced is wasted in the supply chain (Mena et al., 2014).

Perishable products are among the most wasted food items within supply chains and households. Fruits and vegetables usually account for the highest proportion of food waste in many developed countries (Morgan, 2009). Industrial waste resulting from the process of weeding are delivered to biogas farms linked to the production phase. Moreover, the product that is no longer sellable, as exceeds the orders, must be opened and the packaging, a plastic film, is thrown, increasing the amount of waste. Finally, in the distribution phase, if salad exceeds the expiration date, is no longer sellable and also in this case must be discarded. In facts, all this strictness does not improve the quality of the salad for consumers, but greatly increases the amount of waste.

Currently at industrial level there are specific technology applications which may prolong the shelf life of the fresh-cut salad. The temperature of the water that comes in contact with the product during the production line, the type of packaging used (controlled atmosphere, type of film used, mixture of gases) are only some examples of the existing technological tecniques which can contribute to the sustainability of such products.

The fresh-cut salad sector in Italy

The fresh-cut salad in Italy has started from the mid-80s. During the last thirty years, this sector has become a successful example of innovation and development opportunities. The Italian industry of fresh-cut salad represents one of the leading industries in Europe with a production of 110,000 tonn. and a turnover of € 770 million in 2012 (source: Nielsen, 2014).

In 2010 the 70% of the Italian cultivated area for fresh-cut salad refers to products grown in greenhouse. The supply chain for fresh-cut salad is composed by 600 agricultural farms and about 120 firms (AOP UnoLombardia, 2011). Most of these firms are concentrated in few Italian provinces, namely Lombardy, Campania, Emilia Romagna and Piemonte.

The demand towards fresh-cut salad is increasing, in spite of the slump of the last years (source: Nielsen, 2013). The reasons are different. First, growing surfaces of the main discounts have been dedicated to fresh fruits and vegetables. Second, also the increasing attention of the private labels towards fresh-cut fruits and vegetables has played an important role. Third, minimally processed food are gaining consumer interest and satisfy their preferences in terms of 'helthy eating' and convenience attributes. From 2001 to 2010 the consumption of fresh-cut salad increased of 280%, with a market penetration of 74,4% (source: Ismea, 2010). The consumption of fresh-cut salad is concentrated in the North of Italy and the 63% of sales belongs to the 20% of Italian

consumers (source: Nielsen, 2014). This means that the market of fresh-cut salad in Italy has still a good margin of growth.

3. Information and consumer acceptance of new food technologies and processes

Consumers' product preferences have become more dependent on the way in which food is being produced (de Barcellos et al. 2010; Krystallis et al., 2009). Despite the fact that the scientific community has recognized the safety of many food processes, most of them have received significant consumer resistance. Consumer attitudes are central, as consumer rejection can prevent application of a technology in practice or lead to a failure of product innovation (Haugaard et al., 2014; Olsen et al., 2010).

Although technology has become an important part of the everyday life, the reaction of consumers to new technological applications in the food sector is ambiguous. Most of them often appear skeptical about new technologies in the food sector (Abrams et al. 2010). Among the reasons associated to this consumer attitude the low public confidence in food safety systems after repeated food scares and scandals plays an important role (Curtis et al., 2004).

The focus group conducted by De Barcellos et al. (2010) reported various perceived advantages and disadvantages of beef technologies by consumers. Not all technologies were considered to be favorable. In particular, invasive technologies were rejected whereas more traditional and familiar technologies were easily accepted. Van Wezemael et al. (2011) showed that the majority of consumers accepted the application of beef technologies related to the enhancing of food safety at various stages of the beef chain. However, consumers expressed some reserve towards technological interventions during the processing stage due to low trust in processing industries.

Several studies have stressed the correlation between information and consumer attitudes towards new food technologies and processes applications, even if the effects of information on technology acceptance are still discussed in the literature. Johansson et al. (1999) investigated the effects of information on preferences for organic versus conventionally grown tomatoes. Results showed that information about processing methods influenced positively consumer perception of the vegetables. Deliza et al. (2003) investigated the impact of the information about high pressure technology on consumer perception of pineapple juice. Also this study showed that labelled information about technology appears to influence positively consumer product acceptance, especially for those products not very familiar to consumers. Caporale and Monteleone (2004) studied the effect of information concerning manufacturing processes, e.g. organic, genetically modified and traditional technology, on beer acceptability. ANOVA results confirmed that information on processes has a significant effect on product acceptability and it can modify the actual liking of product.

On the contrary, other authors stressed the negative or ambiguous impact of information on technology acceptability. Di Monaco et al. (2007) observed no significant effects of information on consumer acceptability of soup stabilization technology, whereas Altintzoglou et al. (2012) found negative effects of labelled information about chilling technology for cod fillets. Moreover, Cerjak et al. (2011) showed that information have an impact on consumer preferences but not univocally for all process methods. Their study on pig breed

used in sausages demostrate that information affects positively consumer preferences toward traditional breed and negatively towards modern breed.

A number of studies highlighted the correlation between the acceptance of food technology depends and the way technology is communicated. The disclosure of benefits associate to a new technology or process seems to have an impact on consumer acceptance. More precisely, consumer-oriented benefits related to the implementation of a technology, such taste or healthy characteristics, lead to an enhancement of consumer acceptance (Cardello, 2003). Also the study of Nayga et al. (2005) on food irradiation confirmed that that information about the nature and benefits of that technology leads to positive changes in consumers' perceptions and buying decisions. However, in the paper of Van Wezemael et al. (2012) the positive association between information and technology acceptance was not confirmed for all the technologies investigated. On the opposite, recent studies on the acceptance of new technologies revealed that even new technologies with clear benefits may not be appealing to all consumers (Chen et al., 2013; de Barcellos et al., 2010). A lower degree of acceptance seems to be associated to those technologies with producer-oriented benefits or indirect benefits, like for example, environmental or ethical benefits (Cox et al., 2007).

It is clear from different results across studies that the discussion on the provision of information related food technology to consumer is still at the core of scientific debate (Fernqvist and Ekelund, 2014). Food processing firms which have adopted sustainable process methods along the supply chain in order to prolong the shelf life of minimally processed vegetables face two possibilities. On the one hand, they could preserve the information asymmetry between producers and consumers without communicating about technical procedures that could possibly produce a negative attitude of consumers towards such products. On the other hand, food firms could decrease the information asymmetry among producers and consumers by giving more precise information on the technologies and production techniques adopted along the supply chain to prolong the shelf life of fresh cut salad.

Both these possibilities can have negative effects on consumer preferences. The non-disclosure of information could lead consumer to inferring negative attitudes toward the extension of the shelf life period. Once the attitude towards a technology is known, it can then be interpreted as a product attribute that contributes to overall evaluation of products created with the technology (Lusk et al., 2005). The disclosure of information could not lead to a reduction of information asymmetry between consumers and producers. Several studies found that many consumers often fail to read or process all the information available on products during food purchase, even though such information is free. Firstly, because the opportunity costs of acquiring all the provided information would be too high (McCluskey and Swinnen, 2004; Verbeke, 2005). Second, purchasing decisions are often influenced by consumers risk perception towards certain quality and safety attributes of food products. The introduction of a food processed by a new technology with direct effects on consumers may create concern among them (Bieberstein et al., 2013; Onwezen and Bartels, 2011). A wide range of studies on consumer acceptance of novel technology in relation to risk perceptions has been conducted. These studies refer for example to the acceptance of irradiation (Fox, 2002; Nayga et al., 2005), high pressure processing (Siegrist et al., 2008) and genetic modification (Frewer et al. 2013).

The present paper investigates consumer acceptance of process techniques leading to an extension of shelf life of minimally processed products on consumers' willingness to purchase fresh cut salads. Most studies have concentrated the attention on sensory and analytical methodologies for the estimation of shelf life of minimally processed products with the application of such technologies (Gimenez et al., 2012). No known study has valuated the effect of such information on consumer preferences.

4. Methodology

We carried out a survey among 350 consumers living in Lombardy, one of the Italian regions where the consumption of fresh-cut salad is high and evolved. Following literature we developed a questionnaire including socio-demographic variables, attitude towards information about shelf life extension and towards quality, economic variables, frequency of purchase, and so on. The sample is representative of Italian population. It was obtained first stratifying consumer by different areas (large urban centres, small urban centres, mountain area), by age and by gender, according to the structure of the Italian population. Then for each stratum we used random face to face contacts. Sample size was identify assuming an error of 5% considering a proportion of the consumers interested in fresh-cut salad not exceeding 75% (penetration rate).

Descriptive analysis of socio-economic characteristics and of questionnaire answers were carried out to have an overview of the sample.

Principal component factor analysis with *varimax* rotation was used to discover latent variables from the information of questionnaire. Six factors with eigenvalue > 1 were emerged and accounted for a total of 65% of the variance. These factors were used in a two-step clustering to reveal consumers with similar attitude toward information about shelf life extension. This is an exploratory tool that has several desirable features that differentiate it from traditional clustering techniques, that is the ability to create clusters based on both categorical and continuous variables, the automatic selection of the number of clusters and the ability to analyse large data files efficiently. Two-steps cluster method is a scalable cluster analysis algorithm using a hierarchical clustering method. In a first step, the consumers are pre-clustered into many small sub-clusters; in a second step, these sub-clusters are clustered into the final number of cluster.

5. Results and discussion

The sample analysed includes 52.7% of women and is distributed between the ages according to Italian population. The level of education is medium-high: 43.9% of respondents have a high school diploma and 18.20% hold a university degree. Descriptive results show that almost 31% live in big urban centre and 61% have a low-middle income.

By factor analysis we found six factors identified in table 1.

Table1. Factor analysis

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Positive attitude toward shelf life extension (SLE)	0.505	0.077	-0.051	-0.001	-0.041	-0.022
WTP for frwsh-cut salad SLE	0.512	0.084	-0.072	0.039	-0.054	0.000
Age	0.035	0.483	-0.022	0.030	0.195	-0.042
Education	-0.132	-0.445	0.088	0.120	0.035	0.009
Food shopping frequency	-0.134	0.294	0.389	0.289	-0.264	0.095
Freshness of fresh-cut salads	-0.044	-0.014	0.545	-0.138	-0.083	-0.048
Consumption frequency	0.019	-0.004	0.386	0.097	0.137	0.052
Price	-0.009	0.019	0.019	-0.566	-0.016	0.103
Income	0.024	0.021	-0.075	0.511	0.020	0.079
Residence	0.040	0.063	-0.156	0.017	-0.550	0.145
Healty life attitude	-0.030	0.139	-0.125	0.046	0.598	0.077
Trust	-0.143	-0.089	0.238	-0.208	0.022	0.423
Safety of prodoct	0.050	-0.159	-0.248	0.056	0.085	0.510
Shelf life date control	0.016	0.152	0.042	0.069	-0.134	0.565

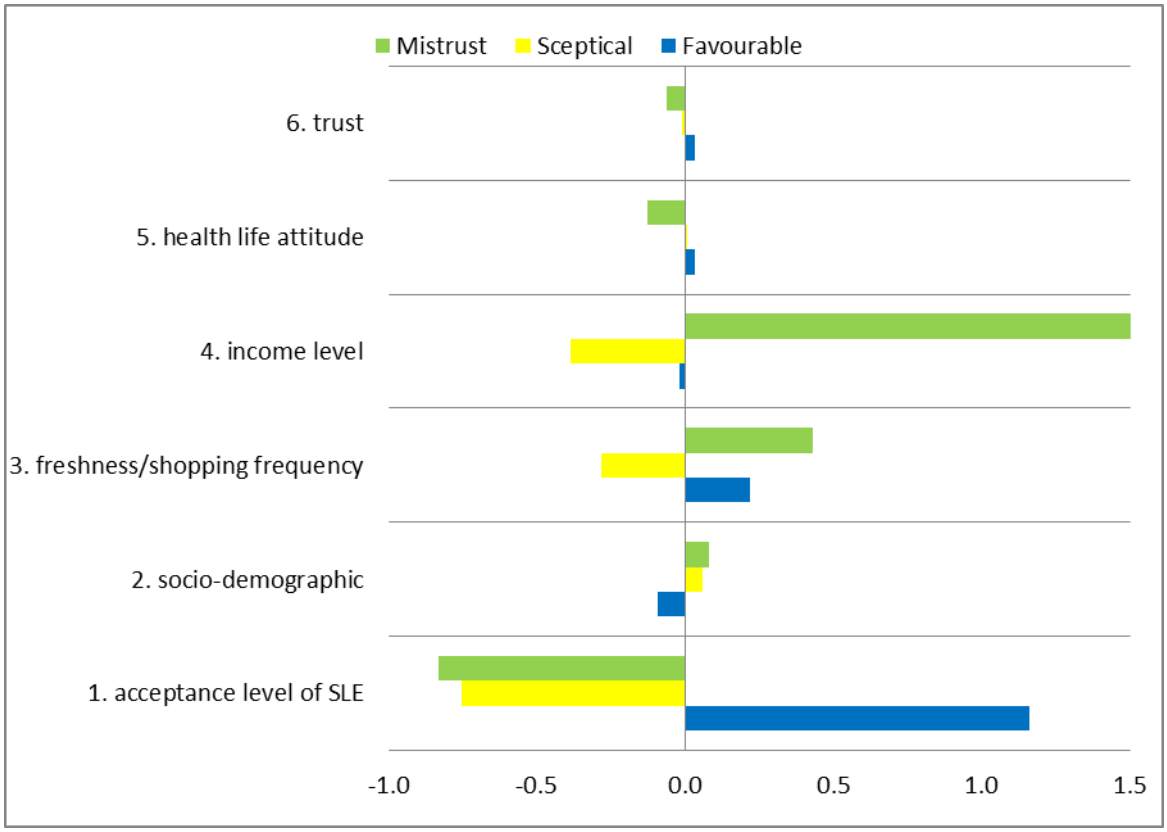
Factor 1 related to “positive response to the information about the shelf life extension”. Factor 2 related to socio-demographic variables. Factor 3 distinguished shopping frequency and reputation of freshness of salad fresh cut. Factor 4 represents economic variables, Factor 5 characterized geographic areas, and finally Factor 6 related to interest to expiration date and trust in the brand.

Afterwards we identify 3 clusters characterized by our interpretation of which variables were more significant in each cluster (figure 1). Only one of the three clusters is represented by consumers with a positive attitude towards the introduction of an extension of the shelf life date, whereas the other two clusters identify consumers with a negative attitude towards such information. In this cluster consumers consider the fresh-cut salad to have a good degree of freshness and safety and they purchase it frequently. They are between 40 and 60 years old and with a medium level of education. Most of them live in big cities and pay attention to healthy eating. Price is not an important factor for them. The other two clusters identify consumers who give a negative connotation to the extension of the shelf life date of fresh-cut salad. The first one identifies consumers with low income level and who consider price to be an important search attribute. They perceive the fresh-cut salad with a low level of freshness and a low degree of safety and purchase it less than once a week. They are usually young and with high level of education. The last cluster represents consumers with high income level. Most of them live in big cities and they pay attention to healthy eating. They consider fresh-cut salad to have a high level of freshness, but they are worried about safety attributes of fresh cut salad.

The three different groups of consumers described above confirm that not all consumers will accept the introduction of technology applications aimed at prolonging the shelf life of fresh-cut salad products. The analysis reported above confirms what is discussed in the literature about the misinterpretation of new product attributes related to product processing. Even if information is important to reduce market inefficiencies, cluster results show that the 60% of interviewed have a negative attitude towards shelf life extension. This can be related to several reasons: consumers do not believe that a prolonged expiration date

corresponds to an equal level of quality; otherwise they prefer to avoid the purchase because they don't know technologies and strategies that allow to get a salad that lasts longer and don't find useful information in label.

Figure 1. Sample segmentation



Firms producing fresh-cut salad should have the possibility to introduce several technologies and good practices to extend shelf life maintaining high quality as well as retail chains could reorganize their logistic management for the same aim. All these measures could lead positive effects on the economic and environmental sustainability of supply chain and reduce waste problems.

From cluster results managerial implication can be drawn. First of all, the introduction of new technology applications concerning the extension of shelf life of fresh-cut salad could decrease production costs in terms of waste management and production management. Moreover, these applications would allow firms to differentiate their product in terms of environmental characteristics and to gain market recognition. However, most of consumers misinterpret the information associated to new technologies. This entails a risk of product failure. Within this context, firms have two possibilities. The first one concerns the transformation of the shelf life extension in search attribute through a deep and clear communication strategy. The other consists in maintaining the technology as credence attribute without informing consumers.

References

Abrams, K.M., C.A. Meyers, and T.A. Irani. 2010. Naturally confused: Consumers' perceptions of all-natural and organic pork products. Agriculture and Human Values 27: 365–374.

Altintzoglou, T., Nøstvold, B. H., Carlehög, M., Heide, M., Østli, J., & Egeness, F.A. (2012). The influence of labelling on consumers' evaluations of fresh and thawed cod fillets in England. British Food Journal 114, 1558-1570.

Beaufort, A. (2011). The determination of ready-to-eat foods into Listeria monocytogenes growth and no growth categories by challenge tests. Food Control, 22, 1498-1502.

Bieberstein, A., Roosen J., Marette S., Blanchemanche, S., and Vandermoere F. (2013). Consumer choices for nano-food and nano-packaging in France and Germany. European Review of Agricultural Economics 40(1): 73-94.

Boxstael, S.Van, Devlieghere, F., Berkvens, D., Vermeulen, A., Uyttendaele, M. (2014). Understanding and attitude regarding the shelf life labels and dates on pre-packed food products by Belgian consumers. *Food Control* 37: 85-92.

Caporale, G. Monteleone, E. (2004). Influence of information about manufacturing process on beer acceptability. Food Quality and Preference 15, 271–278.

Cardello, A. V. (2003). Consumer concerns and expectations about novel food processing technologies: Effects on product liking. Appetite, 40(3), 217–233.

Cerjak, M., Karoly,i D., Kovacic, D. (2011). Effect of information about pig breed on consumers' acceptability of dry sausage. Journal of Sensory Studies 26(2), 128-134.

Chen, Q., Anders, S. and An, H. (2013). Measuring consumer resistance to a new food technology: A choice experiment in meat packaging. Food Quality and Preference 28: 419–428.

Cox, D. N., Evans, G., & Lease, H. J. (2007). The influence of information and beliefs about technology on the acceptance of novel food technologies: A conjoint study of farmed prawn concepts. Food Quality and Preference 18, 813–823.

Curtis, K. R., McCluskey, J. J., & Wahl, T. I. (2004). Consumer acceptance of genetically modified food products in the developing world. AgBioForum, 7(1&2), 70e75.

de Barcellos, M.D., Kügler, J.O., Grunert, K.G., Van Wezemael, L., Perez-Cueto, F.J.A., Ueland, Ø. and Verbeke, W. (2010). European consumers' acceptance of beef processing technologies: a focus group study. Innovative Food Science and Emerging Technologies, 11, 721-732.

Deliza, R., Rosenthal, A. and Silva, A.L.S. (2003). "Consumer attitude towards information on non conventional technology." Trends in Food Science & Technology, 14(1/2), 43-49.

Di Monaco, R., Cavella, S., Torrieri, E., Masi, P. (2007). Consumer acceptability of vegetable soups. Journal of sensory studies, 22(1), 81-98.

European Commission (2010). Preparatory study on food waste across Eu. Technical Report 2010-54, 1-213.

European Parliament (2013). Technology options for feeding 10 billion people. Options for Cutting Food Waste. Institute for Technology Assessment and System Analysis, Karlsruhe Institute of Technology.

FAO (2011). Global food losses and food waste – Extent, causes and prevention. Rome.

Fernqvist, F., Ekelund, L. (2014). Credence and the effect on consumer liking of food. A review. Food Quality and Preference 32 Part C, 340-353.

Fox, J.A. (2002). Influences on Purchase of Irradiated Foods. Food Technology 56(11), 34-37.

Frewer, L. J., van der Lans, I. A., Fischer, A. R., Reinders, M. J., Menozzi, D., Zhang, X., Zimmermann, K.L. (2013). Public perceptions of agri-food applications of genetic modification–a systematic review and meta-analysis. Trends in Food Science & Technology, 30(2), 142-152.

Giménez, A., Ares, F., & Ares, G. (2012). Sensory shelf-life estimation: A review of current methodological approaches. Food Research International, 49(1), 311-325.

Haugaard, P., Flemming, H., Jensen, M., Grunert, K.G. (2014). Consumer attitudes toward new technique for preserving organic meat using herbs and berries. Meat Science 96, 126-135.

Ignat, A., Manzocco, L., Bartolomeoli, I., Maifreni, M., Nicoli, M.C. (2014). Minimisation of water consumption ion fresh-cut salad washing by UV-C light. Food Control 50, 491-496.

Johansson, L. Haglund, A., Berglund, L., Lea, P. Risvik, E. (1999). Preference for tomatoes, a□ected by sensory attributes and information about growth conditions. Food Quality and Preference 10, 289-298.

Krystallis, A., de Barcellos, M.D., Kügler, J.O., Verbeke, W. and Grunert, K.G. (2009). Attitudes of European citizens towards pig production systems. Livestock Science, 126 (1): 46-56.

Lusk, J. L., Jamal, M., Kurlander, L., Roucan, M., & Taulman, L. (2005). A meta-analysis of genetically modified food valuation studies. Journal of Agricultural and Resource Economics, 30(1), 28-44.

Manzocco, L., Panozzo A., Nicoli M.C. (2013). Inactivation of polyphenoloxidase by pulsed light. Journal of Food Science, 78, 8, 1183-1187.

McCluskey, J.J., Swinnen, J.F.M. (2004). Political economy of the media and consumer perceptions of biotechnology. American Journal of Agricultural Economics 86: 1230-1237.

Mena, C., Terry, L.A., William,s A. Ellram, L. (2014). Causes of waste across multi-tier supply networks: Cases in the UK food sector. Int. J. Production Economics 152, 144–158.

Morgan, E. (2009). Fruit and vegetable consumption and waste in Australa. Victoria, Australia.State Governement of Victoria. Health Promotion Foundation.

Nayga, R:M. Jr., Aiew, W., Nichols, J.P. (2005). Information Effects on Consumers' Willingness to Purchase Irradiated Food Products, Review of Agricultural Economics, 27(1), 37-48

Olsen, N. V., Grunert, K. G., & Sonne, A. -M. (2010). Consumer acceptance of high-pressure processing and pulsed-electric-field: A review. Trends in Food Science and Technology, 21(9), 464–472.

Onwezen, M.C., Bartels, J. (2011). Which perceived characteristics make product innovations appealing to the consumer? A study on the acceptance of fruit innovations using cross-cultural consumer segmentation. *Appetite* 57: 50–58.

Parfitt, J., Barthel, M., Macnaughton S. (2010). Food waste within food supply chains: quantification and potential for change to 2050. Philosophical Transactions of the Royal Society B-Biological Sciences 365, 3065-3081.

Ramos, B., Miller, F.A., Brandao, T.R.S., Teixeira, P., Silva, C.L.M.. (2013). Fresh fruits and vegetables . An overview on applied methodologies to improve its quality and safety. Innov. Food Sci. Emerg. Technol. 20, 1-15.

Rollin, F., Kennedy J. and Wills J. (2011). Consumers and new food technologies. Trends in Food Science & Technology 22(2-3): 99-111.

Scolari, G., Vescovo, M.. (2004). Microbial antagonism of Lactobacillus casei added to fresh vegetables. Ital. J. Food Sci. 16, 465.

Siegrist, M., Stampfli, N., Kastenholz, H., & Keller, C. (2008). Perceived risks and perceived benefits of different nanotechnology foods and nanotechnology food packaging. Appetite, 51(2), 283-290.

Siroli, L., Patrignani, F., Serrazanetti, D. Tabanelli, G., Montanari C., Tappi, S., Rocculi, P., Gardini, F., Lanciotti, R. (2014). Efficacy of natural antimicrobials to prolong the shelf-life of minimally processed apples packaged in modified atmosphere. Food Control, 46, 403-411.

Siroli, L, Patrignani, F., Serrazanett,i DI., Tabanelli, G., Montanari, C., Gardini, F., Lanciotti, R. (2015). Lactic acid bacteria and natural antimicrobials to improve the safety and shelf-life of minimally processed sliced apples and lamb's lettuce. Food Microbiology 47, 74-84.

Soliva-Fortuny, R.C., Martín-Belloso, O. (2003). New advances in extending the shelflife of fresh-cut fruits: a review. Trends Food Sci. Tech. 14, 341-353.

Teisl, M.F., Fein, S.B. and Levy, A.S. (2009). Information effects on consumer attitudes toward three food technologies: organic production, biotechnology, and irradiation. Food Quality and Preference, 20: 586-596.

Van Wezemael, L., Verbeke, W., Kügler, J.O., and Scholderer, J.(2011). European consumer acceptance of safety-improving interventions in the beef chain' Food Control 22: 1776-1784.

Van Wezemael, L., Ueland, Ø., Rødbotten, R., De Smet, S., Scholderer, J., and Verbeke, W. (2012), Relationships between sensory evaluations of beef tenderness, shear force measurements and consumer characteristics. Meat Science 97, 310–315.

Vandekinderen, I., Devlieghere, F., De Meulenaer, B., Ragaert, P., Van Camp, J. (2009). Decontamination strategies for fresh-cut produce. Stewart Posthar 5, 1-8.

Verbeke, W. (2005). Agriculture and the food industry in the information age. European Review of Agricultural Economics 32(3): 347-368.