

## Organic and eco-sustainable packaged food products: a possible solution to close the gap between consumer perception and real data

Stefanini R.\*, Vignali G.\*

\* *Dipartimento di Ingegneria e Architettura, Università di Parma, Parco Area delle Scienze 181/A, 43124, Parma*  
(*roberta.stefanini@unipr.it; giuseppe.vignali@unipr.it*)

**Abstract:** Food companies nowadays are investing in the production of organic food, starting from crops and farms based on the use of natural substances and not excessively exploiting natural resources such as soil, water and air. Moreover, they allocate resources looking for environmentally sustainable packaging solutions, often using bio-based or recycled materials. Are consumers aware of these efforts? Taking as a reference the case study of an Italian manufacturer of grated organic cheese, which is looking for new packaging solutions, a questionnaire was created and submitted to a widespread sample of Italian people: 333 questionnaires have been collected from consumers of different age, education and origin, in order to investigate their opinions about organic products and eco-sustainability. Results show that consumers make choices based on food product's quality and price and are unable to distinguish an organic cheese from a traditional one. As far as the packaging solution is concerned, food paper is considered the best material to contain cheese, followed by glass, while plastics are associated with a high environmental impact. Outcomes thus highlight a clear difference between the consumers' perception of packaging and the scientific data of materials' functionality and environmental impact calculated by means of the Life Cycle Assessment (LCA) methodology. It is therefore necessary to close this gap improving the exchange of information between consumers and the scientific sector. To achieve this goal, social networks are not the best option since consumers declare not to show interest in following the company profile. They seem, instead, to appreciate non-traditional labelling, such as RFID (Radio Frequency IDentification) and QR Code, because they give more information about products features and history, ensuring traceability and anti-counterfeiting. Consequently, the digitization of information supporting the food products appears the main way to differentiate the single brand and provide consumers with information necessary to make the right choices.

Keywords: **Food packaging; Organic food; RFID; QR code; LCA**

### 1. Introduction

Today more and more companies are investing in high-quality products, made with natural ingredients and minimally treated, and organic products in particular are becoming numerous on the market (ANSA, 2018). “Organic” is any product of plant or animal origin, obtained by a process that involves the total absence of external elements to those that nature makes available. As a consequence, in the production of organic food, synthetic chemicals and modified organisms are not used. (Feil, et al., 2020). Organic is often associated with healthy and safe food and it seems that a bio diet could have some implications on human health (Mie, et al., 2017).

In Italy, organic foods are currently niche products, but they are increasing on the market (Il fatto alimentare, 2017). Some food companies are investing, for example, in the production of organic Parmigiano Reggiano. To produce this cheese, as well as to complying with the regulations provided by the Disciplinary of Production Consortium (Parmigiano Reggiano D.O.P. s.d.), the procedures of organic agriculture, which concern the feeding of animals, their welfare and the milk processing, must also be respected. The fodder comes exclusively

from organic farming which prohibits the use of chemical fertilizers, herbicides, pesticides, insecticides and are free of genetically modified organisms (GMOs). Moreover, the animals are bred in open spaces, rehoused in spacious and comfortable stables. Organic milk is processed using preservative-free rennet. The processing takes place in boilers and in containers reserved for biological transformation and therefore separated from other production processes (Bioqualità, 2020).

Meanwhile the organic topic increases its relevance among the consumers, some environmental issues are pushing for further changes in the food packaging industry. Today, the plastic litter is well known all over the world because huge quantities of plastic waste are damaging flora and fauna oceans (Mecho, et al., 2020) (Range-Buitrago, et al., 2020). As far as Italy is concerned, 53 thousand tons of plastic pour into the Mediterranean every year: 78% derives from coastal activities, 18% from fishing activities and 4% is transported by rivers. Most of the plastic then remains on the surface or returns on the beaches, while a minimum part settles on the seabed (WWF, 2019). On Italian coasts, plastic waste constitutes 81.2% of the waste found on beaches: 29% comes from food packaging, followed by glass/ceramic (7.3%), metal (3.7%), paper (2.8%), rubber,

textiles or wood. In particular, plastic bottles for drinks, including caps and rings, are the most common disposable plastic product that pollute the coastlines (Legambiente, 2019).

The main issue about plastics is that they do not decompose, but they are shredded into small pieces of less than 5 mm, called microplastics, which are often ingested by marine animals and therefore become part of our food chain (Min, et al., 2020). In Italian seas, plastic concentration is among the greatest in the Mediterranean and reaches up to 20 g/m<sup>3</sup> in the areas of Po, Venice and Adriatic sea (Liubartseva S., 2018).

In addition, fossil plastic consumes non-renewable resources and contributes to the emission of greenhouse gases during its extraction and production. Someone proposes, as solution to these issues, the abolition of plastic and its replacement with other materials, such as paper or glass. Otherwise, others think that plastic is irreplaceable and the society should focus on other ways to limit these environmental problems (Ragaert, 2019). However, consumers now perceive polymers as negative packaging materials and for this reason, many food companies prefer to look for new packaging alternatives.

At this point, a question arises: are consumers aware of these topics and how do they deal with these changes? In order to answer these questions, in collaboration with an Italian organic Parmigiano Reggiano producer, a questionnaire was created and submitted to Italian consumers. The results of this analysis make it possible to obtain interesting conclusion on the consumers' perception of these changes.

The article is structured as follows: the next paragraph introduces the main relevant research carried out on the presented issues. Then, the structure and characteristics of the questionnaire are illustrated. Subsequently, the results of the analysis are shown and discussed at a descriptive level. Finally, the conclusions of the study are drawn.

## 2. Review of the relevant literature

Packaging is the fundamental tool for extending foods shelf life, protecting them from light, gases, pathogenic and spoilage microorganisms, preserving over time the nutritional properties and quality features such as aroma and taste (Bottani et al., 2011). If the food were not packaged, the amount of waste would be very high, as would the impact generated (WRAP, 2013) (Manfredi, et al., 2015). Moreover, packaging has the function of informing the consumer about the contents, the features, and the origins of the product, apart from containing, preserving and protecting it (Alimentarium, 2020). Although packaging is indispensable in the food sector, today many consumers negatively perceive some packaging materials, especially plastic. This is due to the continuous diffusion by the media of the environmental impact that plastic causes in seas and oceans (Van Rensburg, et al., 2020). Some scientific research show how consumers think that paper and glass are much more

environmentally friendly than plastic containers. An example is given in a study performed in Sweden, where the 62% of interviewees perceive plastic packaging as the lowest environmental friendly if compared to metals (30%), multilayer materials (5%) and finally glass (3%) (Lindh, et al., 2016). The common idea is that the replacement of plastic bottles and containers with glassy material is the solution to environmental problems; it could be important, otherwise, to verify scientifically which is the best solution, not basing the ideas on the hearsay. Life Cycle Assessment (LCA) is a method able to calculate the environmental impact of different products, considering their life cycle, from the raw materials extraction to the final disposal. Thanks to a LCA software, it is possible to compare the impact of different packaging materials, considering their production, transport, distribution and end of life phases (ISO 14044, 2006). Some studies in literature compare glass and plastic packaging and results show that glass is more impactful than plastic. For instance, considering the greenhouse gases emissions and the Global Warming Potential (GWP), soft drinks in glass bottles impact 0.555 kg CO<sub>2</sub> eq/l, and 0.151 kgCO<sub>2</sub> q/l in PET bottles (Amienyo, et al., 2013); contrast media packaged in polymeric vials impact 1.81 kg CO<sub>2</sub> eq/l and 4.01 kg CO<sub>2</sub> eq/l in glass vial (Dhaliwal, et al., 2014); beverages impact 2.57 kg CO<sub>2</sub> eq/l in glass bottles and 0.044 kg CO<sub>2</sub> eq/l in PET bottles (Saleh, 2015). The production of the packaging is the main cause of these results. In fact, in the glass production process, high melting temperature is necessary: furnaces consume a lot of energy and non-renewable fossil fuels; then many greenhouse gases are emitted in the atmosphere and contribute to GWP (Pasqualino, 2011). Numerically speaking, in the production of 0.75l glass bottle for beverages, 414 g CO<sub>2</sub> eq/l are emitted, while the value drops to 74 g CO<sub>2</sub> eq/l for 2l PET bottle. Moreover, in the transport phase, glass weight and volume is very impactful in comparison to others packaging materials (Amienyo D, 2013). Finally, at the end of life, considering recycling, incineration and landfill and the avoided impacts that they involve, glass packaging do not result as the best material according to GWP and Cumulative Energy Demand indicators (Pasqualino et al., 2011; Saleh, 2015). According to literature research, PET packaging has the lowest impact on global warming potential, primary energy demand, abiotic depletion, acidification, fresh water and marine aquatic toxicity, photochemical oxidant creation potentials, even if they have a high value on the eutrophication potential, human toxicity and ozone depletion potential (Amienyo et al., 2013; Dhaliwal, et al., 2014; Saleh, 2015). However, consumers do not seem conscious of these scientific data: a Danish research investigated if the consumers perception of environmental sustainability agrees with the Life Cycle Assessment results (Boesen et al., 2019). They found that consumers assess the environmental sustainability of packaging based on the material type, but they do not consider the production and transport impact. They perceive bio-based materials and glass as the best, and plastic as the worst: for these reasons, it seems that consumers have limited knowledge of scientific data on environmental sustainability (Boesen et al., 2019).

Based on these premises, the article aims at investigating which is the consumers’ opinion in Italy about these topics. A recent journal article found that, according to Italian consumers, organic products are associated with the main expression of eco-sustainability (Manuelli, 2020). However, which are their perceptions of sustainable packaging and organic products? There is a gap between their thoughts and the mentioned scientific data? Eventually, how is it possible to solve it?

### 3. Methods




A company located in Emilia Romagna has been concerned for decades with producing organic Parmigiano Reggiano. Everything starts from the earth: their fields ripen with sun and rain, without artificial irrigation. Their cows eat autochthonous and nutrient-rich fodder and live in large open spaces. Consequently, healthy and happy cows, produce high quality organic milk, that is the starting point of Parmigiano Reggiano production. Currently, they package their grated and flaked organic cheese in a multi-material plastic bag with Modified Atmosphere Packaging (MAP). This solution allows the cheese to have a shelf life up to three months. However, fearing that plastics are no longer well perceived by consumers, the company is looking for an alternative packaging that can meet their customers’ expectations. Knowing that the market perceives glass packaging more environmentally friendly than plastic, the company intends to experiment the use of a glass jar with an aluminium cap for containing the grated or flaky product. However, this solution would not allow to obtain a shelf life as the currently ensured by multilayer plastic. Therefore, the packaging research centre located at the University of Parma (CIPACK, s.d.), suggested the company to use an oxygen absorber in the aluminium cap and place under vacuum the glass jar. Oxygen absorber consists in a small sachet or sticker that contains an iron material which oxidizes absorbing the trapped oxygen in the packaging. The oxygen removal protects food against spoilage, mould growth, colour changes, rancidity, loss of nutritive values and quality (O2zero Oxygen Absorber, s.d.). Therefore, this packaging solution could seem functional to the Parmigiano Reggiano preservation but it is important to understand which is the consumers’ opinion about it.

It was thus in collaboration with this company that a questionnaire was created. The goal of the article is to understand if Italian perceive correctly the meaning of organic and eco-sustainability and what their thoughts are regarding the alternative packaging solution proposed for organic Parmigiano Reggiano. The results of the study are aimed at both consumers, to be aware of their possible lack of knowledge, and producers, in order to understand their limits and lack of communication to their reference market.

21 questions (Table 1) were created in collaboration with the company, following their experts opinion, and were divided into three fields: the first one collects the characteristics of the respondents such as age, Italian region of origin and education level. The second part

includes some questions to investigate the perception of organic and eco-sustainable packaging and finally some questions analyse consumers’ preferences about new alternatives to package the organic Parmigiano Reggiano. The compilation time was approximately 4 minutes. Google Forms was used in order to share the questionnaire via link: it was published on several communication channels, as LinkedIn, Instagram, WhatsApp, Email, so that consumers could participate freely. After 3 weeks the questionnaire was closed and answers were not collected anymore.

**Table 1: The 21 questions of the interview**

Questions		Closed-questions
1	How old are you?	- Under 26 years old - Between the ages of 26 and 50 - Over 50 years old
2	What is your highest academic qualification?	- Elementary school diploma - Middle school certificate - High school diploma - Bachelor or Master degree - Ph.D.
3	Where are you from?	Possibility to choose the Italian region
4	Do you usually consume Parmigiano Reggiano (grated or slivers) and are you able to recognize it at restaurant or canteen?	- I recognize it: I usually eat it - I recognize it: I eat it sometimes - I recognize it: I don't eat it often - I eat cheese almost every day but I can't recognize the type - I don't eat cheese
5	Do you buy organic Parmigiano Reggiano?	- Yes, often - Sometimes - Almost never - I don't know: I can't recognize the difference with a non-organic Parmigiano Reggiano
6	When you choose a product at the supermarket, from 1 to 4, how much you take into account the following characteristics during the food production:	- price - quality - respect of animal welfare - low environmental impact
7	In your opinion, the wording "organic Parmigiano Reggiano" implies that	- The product was created from organic farming for the cows feeding and there are only natural substances in the milk - The packaging respects the environment - The product and the packaging are naturally respectful of the environment and animals
8	In your opinion, should an organic product be packaged in eco-sustainable packaging?	- Yes - It is preferable - Not necessarily - No
9	Judging from the aesthetics of the following packaging, which of these three slices of Parmigiano Reggiano do you consider organic?	a.  b.  c. 
10	The colour of an eco-friendly package containing an organic product should be predominantly	- White - Transparent - Green - Light blue

- 11 In your opinion, which of these materials is the right compromise between sustainability, functionality and suitability for contact with Parmigiano Reggiano?
- Plastic
  - Glass
  - Aluminium
  - Food paper
- 12 Which of these packaging alternatives would you buy in order to respect the environment?
- Standard plastic packaging
  - Packaging that is not plastic
  - Recycled plastic package
  - 100% recyclable plastic package
  - I don't know
- 13 How much would you be willing to pay more for one kg of organic Parmigiano Reggiano in environmentally sustainable packaging?
- 0 €/kg
  - 0,50 €/kg – 1 €/kg
  - 1 €/kg – 2 €/kg
  - 2 €/kg – 3 €/kg
  - I don't know
- 14 Choosing a product on supermarket shelves, how do you take into account the environmental impact of the packaging?
- I choose products in recyclable, compostable or biodegradable packaging
  - I try to limit the purchase of plastic packaging
  - I buy bulk products whenever possible
  - I still buy plastic packaging because they are the best solution
  - I do not believe that my choice contributes to environmental problems
- 15 Which of these solutions does it seem more organic for the packaging of slivers or grated organic Parmigiano Reggiano?
- a. Mono-material plastic tray
  - b. Glass jar with aluminium cap
  - c. Multi-material plastic bag
- 16 Instead of the traditional plastic packaging for slivers or grated organic Parmigiano Reggiano, a glass jar could be used. From 1 to 4, how do you rate this choice with regard to
- environmental friendliness
  - aesthetically pleasing
  - practicality
- 17 From 1 to 4 how much do you know the meaning of "oxygen absorber"?
- 1
  - 2
  - 3
  - 4
- 18 Oxygen absorbers are labels or pouches that extend the shelf life of foods without negatively affect the food suitability. What is your opinion about them?
- Their presence would not negatively condition my choice
  - I would prefer the label: it is not in contact with the product
  - I'd rather not buy the product if there is any kind of absorber
  - I'd love it, I would prefer it on Instagram
  - I'd love it, I would prefer it on Facebook
  - I'd love it, I would prefer it on LinkedIn or Twitter
  - It would be interesting, but I don't think I would follow the page
  - I don't think it would be useful: I choose what to buy directly at the supermarket
- 19 If a brand of organic Parmigiano Reggiano creates an internet profile by publishing its activities, products and events:
- I would often use this mode
  - I don't know if I would use it
  - I would not consider it very useful
  - I would like it and I would feel
- 20 From 1 to 4 how much do you know the meaning and use of RFID tags and QR-Codes in labelling?
- 1
  - 2
  - 3
  - 4
- 21 If placing your smartphone next to the label of organic Parmigiano Reggiano you
- I would often use this mode
  - I don't know if I would use it
  - I would not consider it very useful
  - I would like it and I would feel

can read information on the production chain, biological measures adopted, traceability and originality of the product purchased: more confident about the features of the product I purchased

#### 4. Results

333 responses were collected from Italian consumers. The 51% of respondents is between 26 and 50 years old, 30% is under 26 and 19% over 50 years old. The highest school qualification is a master or bachelor degree for the 55% of interviewees, followed by high school diploma (33%), and finally a middle school diploma (6%) or a Ph.D. (6%). The 51% comes from Emilia Romagna, while the others come from Lombardy (27%), Lazio (6%), Sicily (6%), Puglia, Tuscany. Nobody lives in Campania, Liguria, Trentino-Alto Adige or Umbria. Responses from 1 or 2 candidates were registered from the others regions.

According to results, it is possible to affirm that the vast majority of consumers is able to distinguish Parmigiano Reggiano from other similar cheese in situations such as canteen or at the restaurant, and they consume it almost every day or very often. However, a great difficulty was found in distinguishing the traditional one from the organic Parmigiano Reggiano, which is still a type of cheese rarely purchased. In fact, the 37% of the interviewees cannot say if they buy organic Parmesan cheese or not, since they are not able to recognize it (Figure 1). Interesting results are found about organic food packaging. Most of interviewees (55%) says that an organic product must be packaged in environmentally sustainable packaging, followed by 40% who considers that it is preferable, but not necessary. Moreover, responses to question 13 state that consumers are willing to spend only a few euros more per kg for an organic product packaged in eco-sustainable packaging (39.6%: 0,50 €/kg – 1 €/kg; 22.8% 1 €/kg – 2 €/kg; 22.2%: I don't know) : from their point of view, this feature is intrinsic in the organic definition.

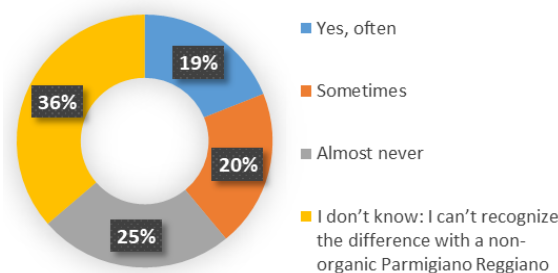


Figure 1: Question 4's results: "Do you buy organic Parmigiano Reggiano?"

When choosing a product at the supermarket, food quality is clearly taken into consideration, followed by the product's price. Instead, less importance is attributed to respect for animal welfare during production and low environmental impact (Figure 2).

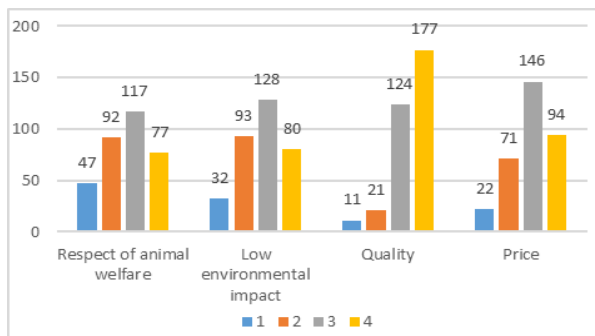


Figure 2: Characteristics that consumers consider (from 1 to 4) when choosing a product at the supermarket

However, plastic is considered the most environmental impactful material and therefore consumers (52%) try to limit its purchase. In order to respect the environment, they chose recyclable, compostable or biodegradable packaging (17%), or buy bulk products when it is possible (20%). In particular, recyclable plastic packaging are perceived as the most ecological solution (53%) compared to non-plastic (32%), recycled (10%) or standard plastic packaging (0%).

Results show how consumers associate a green coloured packaging to an organic product. However, also a transparent package is appreciated. As regards to packaging of organic Parmigiano Reggiano, 54% of consumers shows a preference for the proposed new solution: the glass jar with the aluminium cap. Afterwards, 30% votes for the multilayer plastic bag and 16% for the single-material plastic tray (Figure 3).



Figure 3: Comparison between three solutions for grated cheese: mono-material plastic tray, glass jar, multilayer bag

The glass jar is considered not only ecological, but also very aesthetically pleasing. However, it is not seen as a user-friendly solution (Figure 4).

Despite the vast majority of consumers do not know the meaning and the advantages of oxygen scavengers, they affirm (65%) that their presence would not negatively condition their choices at the supermarket. However, someone (22%) prefers the sticker format, because it is not in contact with the food product. Only 12% would not buy the product with an oxygen scavenger in the packaging.

Finally, two question were added. The topic concerns the best way the consumers prefer to receive more information about the purchased product. In particular, two options were envisaged. The first one is a proposal of an internet profile in which the food company could share news and information about their products. Results show that many consumers (46%) think that the page could be interesting, but they will not follow the page, and some people affirm to choose what to buy directly at the supermarket (20%).

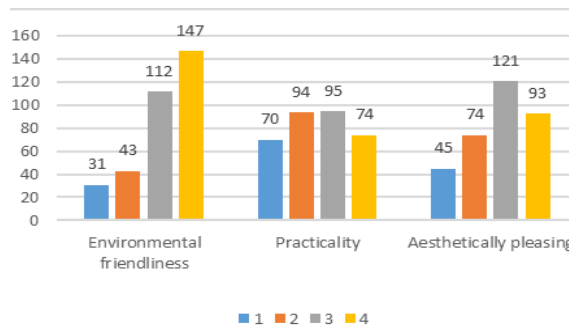


Figure 4: Consumers opinions about alternative packaging solution for organic Parmigiano Reggiano

However, someone would find interesting to follow the food company’s account on Instagram (24%), Facebook (16%) or LinkedIn/Twitter (4%) (Figure 5).

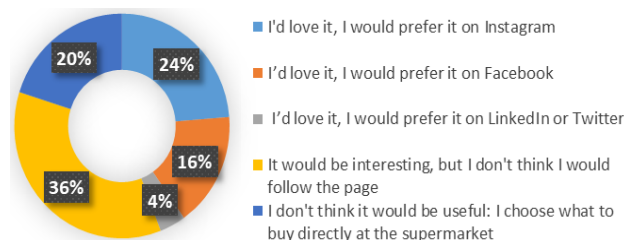


Figure 5: Consumers opinions about the company internet profile

The second option of communication is the use of non-traditional labelling, such as RFID (Radio Frequency Identification) and QR (Quick Response) code. Both of them are systems for conveying large amount of data in a small format. They are used in different fields but now are spreading also in food packaging thanks to their advantages (Bottani, et al., 2014). QR codes are similar to barcodes, but they can be read through a smartphone and are connected to links, web sites, images, that give more information about the product. RFID uses radio frequency signal to communicate to a reader. A tag could contain a lot of information about products features and history, ensuring its traceability and anti-counterfeiting (Covey, 2017). Even if the consumer knowledge about QR code and RFID is homogeneously distributed from “1 = I do not know them” to “4 = I know them well”, they seem well disposed towards their use. Thanks to non-traditional labelling, 36% would feel more confident about the features of the purchased product and 34% would often use this mode. Only 26% do not know if they will use it, and 4% do not consider it very useful (Figure 6).

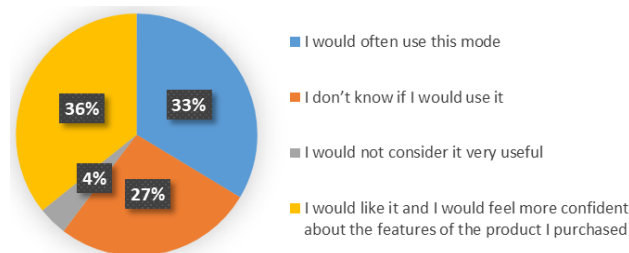


Figure 6: Consumers opinions about the use of non-traditional labelling as RFID or QR code

## 5. Discussion

Starting from the results, some considerations could be done. First of all, confirming the recent Italian research (Manuelli, 2020), it is clear that interviewees associate the meanings of organic and low environmental impact packaging as an expression of sustainability. However, since consumers find difficult to recognize whether a product falls into the organic category, this is obviously inconvenient for companies, which invest time and resources to differentiate a product that is then not distinguished. To solve this problem a packaging that aesthetically recalls organic could be used: it is convenient to invest on green coloured packaging, mainly associated with organic, or on a transparent one, which perhaps gives an image of greater naturalness.

It is clear that, Italian consumers believe that glass is the most environmentally sustainable packaging. Consequently, the glass jar solution, proposed as an alternative packaging of organic Parmigiano Reggiano, has been very successful, although the high weight and volume make it not very user-friendly.

However, from the LCA results presented in the Literature Analysis, it turns out that glass is actually more impactful than plastic packaging during all phases of the life cycle. There is obviously a difference between consumer's perception and scientific data of environmental sustainability. This is may be justified by the fact that interviewees do not take into account the packaging production, transport and distribution phases, but they focus only on their disposal. Probably, thinking about media reports of plastic litter, they are convinced that glass can solve the problem, thanks to its reuse. In reality, data show that if plastics are correctly disposed, they contribute less than glass to environmental problems even if glass is reused for the maximum number of cycles allowed before breakage (Amienyo, et al., 2013).

Therefore, it would be necessary to sensitize the population on these issues, in order to direct their choices towards recyclable or recycled materials, and not towards the abolition of plastics. In this way, it is possible to create a circular economy in the plastic sector (Basso, 2020). Furthermore, costs must be considered, but are not studied in depth in this study. In fact, the glass packaging production is significantly more expensive than plastic and its substitution would lead to an increase in the price of the product: based on the questionnaire's result, consumers do not seem willing to pay it.

Among other things, it is clear that consumers are not informed about the materials functionality and suitability for contact with food products. In fact, 80% of respondents think that food paper is the most suitable packaging for containing cheese. However, it is not able to guarantee the same shelf life of vacuum-sealed plastic packaging, which keeps the product for months.

## 5. Conclusion

Italian consumers do not have a correct perception of organic food and eco-sustainable packaging, even if many

food companies are investing in these fields. How can these gaps be solved? It is necessary to help consumers to distinguish organic products from traditional ones and to increase their knowledge about sustainability issues. Digitalization may be the right way forwards. It is recommended that companies create their own websites, where they can thoroughly describe their product, origin, history, ingredients, all accompanied by images, videos and certifications. Furthermore, in order to make immediate the communication to consumers at the supermarket, investing in unconventional labelling, such as QR code and RFID, seems a good solution. A consumer, by bringing his or her smartphone closer to the product packaging, could directly acquire more information about it. He or she would be more confident about the originality, quality, bio-characteristics and eco-sustainability of the packaged products purchased. Moreover, disseminating the scientific LCA results and the packaging material conservation capacity, the functionality and suitability for contact with food, it will be possible to raise the awareness of this topics among consumers. All these measures would therefore allow companies to enhance their products, and consumers to make more informed choices.

## Acknowledgments

This work was funded by the research project entitled “Analisi di impatto ambientale e studio packaging innovativo per progetto OltreBio – Filiera etica del Parmigiano Reggiano biologico” which is supported by the “Piano OltreBIO – Filiera etica del Parmigiano - Reggiano biologico” - PSR 2014-2020 – Tipo di operazione 16.2.01 “Supporto per progetti pilota e per lo sviluppo di nuovi prodotti, pratiche, processi e tecnologie nel settore agricolo e agroindustriale. Avviso pubblico regionale 2017 – Approccio di sistema”

## References

- Alimentarium, 2020. *Packaging information*. [Online] Available at: <https://www.alimentarium.org/en/knowledge/packaging-%E2%80%93-information> [2020].
- Amienyo, D., Guiba, H., Stichnothe, H. & Azapagic, A., 2013. Life cycle environmental impacts of carbonated soft drink. *International Journal of Life Cycle Assessment*, 18(1), pp. 77-92.
- ANSA, 2018. *Bio, un'avanzata da 400mila ettari l'anno in Europa*. [Online] Available at: [https://www.ansa.it/europa/notizie/agricoltura/biologico/2018/01/23/bio-unavanzata-da-400mila-ettari-l'anno\\_2d3b6212-1865-40e9-b7fa-0c8950c6030f.html](https://www.ansa.it/europa/notizie/agricoltura/biologico/2018/01/23/bio-unavanzata-da-400mila-ettari-l'anno_2d3b6212-1865-40e9-b7fa-0c8950c6030f.html) [May 2020].
- Basso, F., 2020. *Corriere della sera*. [Online] Available at: [https://www.corriere.it/economia/consumi/20\\_marzo\\_0](https://www.corriere.it/economia/consumi/20_marzo_0)

[5/italia-entra-patto-europeo-la-plastica-spinta-riuso-riciclo-0635e33c-5f1d-11ea-bf24-0daffe9dc780.shtml](https://www.italia-entra-patto-europeo-la-plastica-spinta-riuso-riciclo-0635e33c-5f1d-11ea-bf24-0daffe9dc780.shtml) [2020].

Bioqualità, 2020. *La normativa del biologico*. [Online] Available at: [https://www.bioqualita.eu/wp-content/uploads/2020/01/BQ\\_NormativaBIO\\_Testo\\_2\\_2gen20.pdf](https://www.bioqualita.eu/wp-content/uploads/2020/01/BQ_NormativaBIO_Testo_2_2gen20.pdf) [March 2020].

Boesen, S., Bey, N. & Niero, M., 2019. Environmental sustainability of liquid food packaging: Is there a gap between Danish consumers' perception and learnings from life cycle assessment?. *Journal of Cleaner Production*, Volume 210, pp. 1193-1206.

Bottani, E., Manfredi, M., Vignali, G. & Volpi, A., 2014. Life cycle assessment of RFID implementation in the fresh food supply chain. *International Journal of RF Technologies*, Volume 6, pp. 51-71.

CIPACK, s.d. *Centro Interdipartimentale per il Packaging CIPACK*. [Online] Available at: <http://www.centritecnopolo.unipr.it/cipack/> [March 2020].

Covey, M., 2017. *Taking Anti-Counterfeiting Action with Item-Level RFID*. [Online] Available at: <https://risnews.com/taking-anti-counterfeiting-action-item-level-rfid> [2020].

Dhaliwal, H. et al., 2014. A life cycle assessment of packaging options for contrast media delivery: comparing polymer bottle vs. glass bottle.. *Int J Life Cycle Assess*, Volume 19, p. 1965–1973.

Feil, A. A. et al., 2020. Profiles of sustainable food consumption: Consumer behavior toward organic food in southern region of Brazil. *Journal of Cleaner Production*, Volume 258, p. 120690.

Il fatto alimentare, 2017. *Biologico in Italia: aumenta la produzione e anche il consumo. Tutti i dati su alimenti, motivazioni e canali di vendita*. [Online] Available at: <https://ilfattoalimentare.it/biologico-italia-aumento-sana.html> [May 2020].

Legambiente, 2019. [Online] Available at: [https://www.legambiente.it/wp-content/uploads/dossier\\_beachlitter2019.pdf](https://www.legambiente.it/wp-content/uploads/dossier_beachlitter2019.pdf)

Lindh, H., Olsson, A. & Williams, H., 2016. Consumer Perceptions of Food Packaging: Contributing to or Counteracting Environmentally Sustainable Development?. *Packaging Technology And Science*, Volume 29, pp. 3-23.

Liubartseva, S., Coppini, G., Lecci, R. & Clementi, E., 2018. Tracking plastics in the Mediterranean: 2D Lagrangian model. *Mar Pollut Bull*, Volume 129, pp. 151-162.

Manfredi, M., Fantin, V., Vignali, G. & Gavara, R., 2015. Environmental assessment of antimicrobial coatings for packaged fresh milk. *Journal of Cleaner Production*, Volume 95, pp. 291-300.

Manuelli, M. T., 2020. *Sole24ore*. [Online] Available at: <https://www.ilsole24ore.com/art/il->

[43percento-italiani-acquista-food-base-impatto-ambientale-packaging-ACdxOZLB](https://www.43percento-italiani-acquista-food-base-impatto-ambientale-packaging-ACdxOZLB) [March 2020].

Mecho, A. et al., 2020. Deep-sea litter in the Gulf of Cadiz (Northeastern Atlantic, Spain). *Marine Pollution Bulletin*, Volume 153, p. 110969.

Mie, A. et al., 2017. Human health implications of organic food and organic agriculture: a comprehensive review. *Environmental Health*, Volume 16, p. 111.

Min, K., Cuiffi, J. & Mathers, R., 2020. Ranking environmental degradation trends of plastic marine debris based on physical properties and molecular structure. *Nat Commun*, 11(1), p. art. no. 727.

O2zero Oxygen Absorber, s.d. *O20*. [Online] Available at: <https://www.o2zero.com/about-us> [2020].

Parmigiano Reggiano D.O.P, s.d. *Parmigiano Reggiano: disciplinare e normative*. [Online] Available at: <https://www.parmigianoreggiano.com/it/consorzio-disciplinare-normative/> [March 2020].

Pasqualino, J., Meneses, M. & Castells, F., 2011. The carbon foot print and energy consumption of beverage packaging selection and disposal. *Journal of Food Engineering*, 4(103), pp. 357-365.

Ragaert, K., 2019. *TEDx*. [Online] Available at: [https://www.youtube.com/watch?v=l1BaOIEJ\\_eE&trk=public-post\\_share-video-embed\\_share-article\\_title](https://www.youtube.com/watch?v=l1BaOIEJ_eE&trk=public-post_share-video-embed_share-article_title)

Range-Buitrago, N., Williams, A., Costa, M. F. & De Jonge, V., 2020. Curbing the inexorable rising in marine litter: An overview. *Ocean and Coastal Management*, Volume 188, p. 105-133.

Saleh, Y., 2015. Comparative life cycle assessment of beverages packages in Palestine. *Journal of Cleaner Production*, Volume 131, pp. 28-42.

Van Rensburg, M. L., Nkomo, S. L. & Dube, T., 2020. The ‘plastic waste era’; social perceptions towards single-use plastic consumption and impacts on the marine environment in Durban, South Africa. *Applied geography*, Volume 114, p. 102-132.

WRAP, 2013. [Online] Available at: [http://www.wrap.org.uk/sites/files/wrap/Report%20-%20Consumer%20attitudes%20to%20food%20waste%20and%20packaging\\_0.pdf](http://www.wrap.org.uk/sites/files/wrap/Report%20-%20Consumer%20attitudes%20to%20food%20waste%20and%20packaging_0.pdf) [March 2020].

WWF, 2019. *Report WWF: fermiamo l'inquinamento da plastica*. [Online] Available at: <https://d24qi7hsckwe9l.cloudfront.net/downloads/fermi-amo-inquinamentoplastica-giu2019-con-logo-def.pdf> [March 2020].