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How to Transform Food Waste into a Resource

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"If you can't fly, then run.

if you can't run, then walk,

if you can't walk, then crawl,

but whatever you do,

you have to keep moving forward."

Martin Luther King Jr.

CONTENTS

Abstract

The objective of the project is to propose and implement new solutions to tackle food waste. Based on the principle of circular economy, the strategy of the project is to prevent food losses from turning into waste by working synergistically on different action points. The main goal of the project is to develop an innovative network of expertise, able to implement new food recovery logistics chains.

This study arises out of the need for new strategies to: (i) prevent and reduce the volume of surplus food generated, (ii) implement and harmonize the recovery system for social solidarity purposes, and (iii) enhance the conversion of food waste into safe and sustainable feed products. For this reason, the study is divided in three sections: source reduction, feed hungry people and feed animals.

The section entitled “source reduction” presents two studies: the first study is focused on food packaging, a fundamental aspect related to the extension of the product’s life that helps preventing waste. The second study is an analysis of the correlation between food portion size in school catering and the generation of food waste, which can result when food is not accurately proportioned.

In the section called “feed hungry people” three studies are included. The first identifies critical points with respect to the food recovery chain, while the second study is a Manual of Good Practices for Charitable Organization approved by the Italian Ministry of Health. Finally, at the end of this section an applicative study is presented that was conducted in collaboration with Fondazione Banca Popolare of Lodi and Centro Solidale del Diritto al Cibo of Lodi.

In the final section “Feed Animals”, two scientific works are presented; the first is a qualitative analysis of agri-food waste and by-products in order to estimate their bioactive contents and a possible reuse as functional ingredients in animal feed. The last work examines the European regulatory framework regarding animal feeding in order to evaluate possible new interventions to reuse food waste, not only vegetable matter, in the pet food industry. The project builds on the fact that around 88 million tonnes of food are wasted annually in the European Union, with associated costs estimated at 143 billion euros. Thus, looking for every opportunity to prevent food waste and strengthen sustainability of the food system is one of the most crucial issues of modern societies.

The key output of the project consists of an improvement of the overall sustainability of food chains, from social, environmental and economic perspectives.

Abstract

L'obiettivo del progetto è proporre e attuare nuove soluzioni per affrontare lo spreco alimentare. Tenendo in considerazione il concetto fondamentale di economia circolare, la strategia è quella di evitare che le perdite alimentari si trasformino in rifiuti agendo in sinergia su diversi punti di azione. L'obiettivo principale del progetto è sviluppare una rete innovativa di competenze, in grado di implementare una nuova catena logistica di recupero alimentare.
A partire dallo studio e la messa in atto di nuove strategie volte a (i) prevenire e ridurre il volume delle eccedenze generate, (ii) implementare e armonizzare il sistema di recupero ai fini di solidarietà sociale e (iii) valorizzare lo spreco alimentare attraverso la conversione di quest'ultimo in un nuovo prodotto sicuro dal punto di vista igienico sanitario e sostenibile da utilizzare nell'alimentazione animale.
Per queste ragioni lo studio si articola in tre parti chiamate: "*source reduction*", "*feed hungry people*" e "*feed animals*".
Nella sezione "*source reduction*" sono presentati due studi il primo focalizzato sul "*food packaging*" che riveste un ruolo chiave nel prolungamento della vita dei prodotti contribuendo così alla prevenzione degli sprechi mentre, il secondo studio, valuta la conformità delle grammature nella ristorazione scolastica, che se superiori alle grammature previste possono generare spreco.
Nella sezione "*feed hungry people*" sono stati inseriti tre studi, il primo ha come obbiettivo l'individuazione dei punti critici nella filiera del recupero, il secondo studio è un Manuale di Buone Prassi Operative per le Organizzazioni Caritative approvato dal Ministero della Salute e in fine, a chiusura di questa sezione, è stato presentato uno studio applicativo condotto in collaborazione con la Fondazione Banca Popolare di Lodi e con il Centro Solidale del Diritto al Cibo di Lodi.
In conclusione, nell' ultima sezione "*Feed Animals*", sono presentati due lavori scientifici, il primo ha come obbiettivo l'analisi qualitativa degli scarti ortofrutticoli e dei sotto prodotti al fine di valutare il loro contenuto bioattivo per un possibile riutilizzo come ingredienti funzionali nell'alimentazione animale, nell'ultimo lavoro viene esaminato il quadro normativo europeo sull' alimentazione animale per analizzare possibili nuovi interventi al fine di riutilizzare gli sprechi di cibo, non solo vegetale, nell' industria del *pet food.*
Il progetto pone le sue basi sull'evidenza che circa 88 milioni di tonnellate di cibo vengono sprecate ogni anno nell'Unione Europea, con costi associati stimati a 143 miliardi di euro. Pertanto, la ricerca di ogni opportunità per prevenire lo spreco di cibo e rafforzare la sostenibilità del sistema alimentare è una delle questioni più cruciali nella società moderne. L'output chiave del progetto è un miglioramento della sostenibilità complessiva delle catene alimentari, dal punto di vista sociale, ambientale e economico.

1 | INTRODUCTION

The sustainability topic articulated in its different forms – environmental, economic and social - now represents the real challenge that agri-food systems have been called to face (Kates, 2018; Blackburn, 2012). In this context, the theme is that food waste represents, without doubt, one of the most complex and important problems for which we must find a solution (Garrone et al, 2014).
Roughly one third of the food produced in the world for human consumption gets lost or wasted. Studies commissioned by Food and Agriculture Organization (FAO) in 2013 showed that agricultural production is responsible for the greatest amount of total food wastage volumes, representing 33 percent at the global level. Upstream wastage volumes, including production, post-harvest handling and storage, represent 54 percent of total wastage, while downstream wastage volumes, including processing, distribution and consumption, represent 46 percent. Thus, on average, food wastage is balanced between the upstream and downstream supply chains. (Gustafsson, 2011) In the European Union around 88 million tonnes of food is wasted annually, with associated costs estimated at 143 billion euros (EU FUSIONS, 2016). At the European level the situation is not balanced; indeed, the most recent estimates of food wastage reveal that the greatest amount of food waste (70 percent) arises from the household, food service and retail sectors and the remaining 30 percent contribute to the production and processing sectors (EU FUSIONS, 2016).
The magnitude of the related ethical and economic issues requires the involvement of all actors in the food chain to play a role in preventing and reducing food waste, and scientific literature is increasingly focused on the impact of waste enhancement strategies (Arancon et al., 2013; Thyberg and Tonjes, 2016; Takata et al., 2012; Venkat, 2011; Mirabella et al., 2014). Nevertheless, the magnitude of the global food waste problem is difficult to comprehend (ReFED, 2016).
This amount of waste has far-reaching impacts on food security, resource conservation and climate change, and the need to prevent and reduce food waste, while ensuring the safety of the food and feed chain, is an aim of growing social, economic, environmental and political interest (Vandermeersch et al., 2014). On the other hand, it must be considered that the basis of the decrease in waste generation are multiple, and include: better production planning and resource use, promoting resource-efficient production and processing practices, improving preservation, packing technologies, transportation and logistics management, replacing disposable products with reusable products, and developing shelf life extension technologies (FAO, 2013).
For these reasons, During the last few years, many initiatives have had, as the object of their investigation, this theme connected both to aspects of the managerial nature of the different agri-food chain and sectors and to the efficiency problem associated with the agri-food system overall (Parfitt et al,2010; Lipinski et al, 2013; Stenmarck et al, 2011). In the agri-food chain and other sectors, the management of food waste is related to a series of costs for enterprise, public administration, and citizens (Eriksson et al, 2005; Aschemann-

Witzel et al, 2015). To this field belongs a series of initiatives directed toward decreasing the food destined to be discarded and, subsequently, the recovery of it for human use and other uses as animal feed. At a system level, the most remarkable aspects concern efficiency and in particular, the sustainable use of the natural resources.
In September 2015 the United Nations Organization adopted the 17 Sustainable Development Millennium Goals that reflect wide awareness that the actual global "status quo" is unbearable and that a change is necessary to face the negative global tendencies related to the economic, social and ecological aspects which they can determine: growth, comfort, natural capital and social cohesion (Le Blanc, 2015; Porter et al, 2004).
Therefore, the necessity of change is recognized as a universal challenge. Food waste is a global problem whose importance is destined to grow due to the necessity to feed an increasing population (Alexandratos et al, 2012).
It is certainly possible to make food waste sustainable by pursuing the EU Action Plan for the Circular Economy and paying attention to the actions of prevention, donation, use in animal feeding as shown in figure 1, and by finding practical solutions that can be applied on a small scale to transfer and subsequently spread on a global scale (Papargyropoulou et al, 2014).

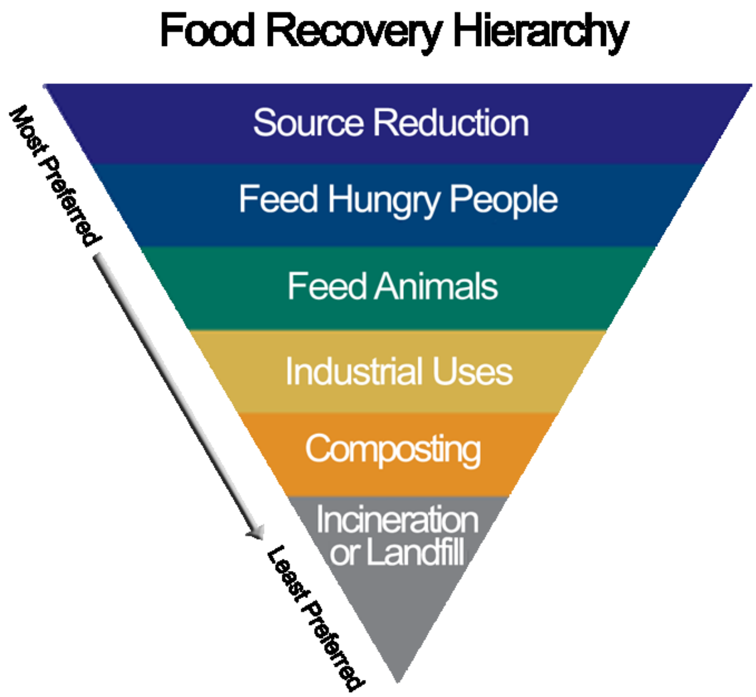

Figure 1. Food Waste Hierarchy.
Source: https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy

1.1. CIRCULAR ECONOMY: EVOLUTION OF THE CONCEPT

According to the definition given by the Ellen MacArthur Foundation, the term circular economy refers to the necessity of reintroducing used products in the circular flux (Ellen MacArthur Foundation, 2014).

The circular economy is, therefore, a planned economic system for the reuse of the materials in the productive cycles, minimizing waste (Ellen MacArthur Foundation, 2014).

The linear economic model "take-make-dispose" is based on the accessibility of a large amount of resources and energy and is increasingly less suitable for the reality in which we operate.

A transition from a linear model to circular model, must take into account all the production phases: from the planning to the production through the consumption (end of life) and as well as catch opportunities to limit the input of the incoming material and energy and to minimize waste, focusing attention on the prevention of the negative environmental impacts and on the creation of new social and territorial values (Ellen MacArthur Foundation, 2014).

Use of the circular approach includes a review of all the phases of the production, paying attention to the entire supply chain in the productive cycle.

Always, explains the Ellen MacArthur Foundation, the concept of the circular economy has deep roots, but it is impossible to link it to a particular founder or date of birth. Conventionally the idea was born at the end of the seventies, when academicians and businessmen started to talk about it (Ellen MacArthur Foundation, 2014). From there, different schools of thought were born from which came the concept of biomimicry (imitation of life), which is the application of nature in solving human problems. Among the most important principles is the study and emulation of nature, the use of ecological standards to evaluate the sustainability of our innovations, judging nature not based on what can be gained but what can be learned from it (Benyus, 1997).

Moreover, the concept of blue economy initiated by Gunter Pauli, which literally means: “use all the resources available on a cascading system, where the waste of one product becomes the input to produce a new cascade” is important in evaluating and solving the problem of waste, yet it faces the problem of sustainability based on the innovation of productive models (Pauli, 2010).

From this perspective, if we speak of raw material, we can claim that discarded materials or pollution simply do not exist because what is considered a discarded material or waste in its first life can be used as a raw material or an energy source in its second life (Iustin-Emanuel et al, 2014).

The aim of this study is to try to encourage innovative solutions to minimize the wasting of food, protecting human and animal health, and the promotion of social inclusion (Riches, 2002).

In this respect, examples of innovation are simple, and in many cases, they bring to attention the utility of a mapping /rediscovery of technical competencies and creativity. For instance, in product life extension, reuse of materials and products enjoy a second life with a different purpose from that for which they have primarily been created. In conclusion, the concept and the application of the principles of the circular economy appear to be a necessary tool to find competitive strategies for the prevention and reduction of food waste.

1.2. THE THESIS OVERVIEW: OBJECTIVES AND APPROACH

The aim of this scientific study was to experiment and to provide sustainable and applicable solutions for the reduction of discarded food focusing attention on the concept of prevention, donation, and reuse of the excess.
In analyzing the "*degree of recoverability*"[1] of surplus food, it has been possible to find solutions that allow for correct management and consequent transformation of food surplus and waste into a resource, and, paradoxically, sustainable in relationship to the three categories of reuse represented in the Food Waste Hierarchy.
The general aim has been to provide innovative solutions able to prevent and reduce food waste though the development and dissemination of competitive and reproducible models in EU and extra EU territories.
The project focused on three different fields, as follows:
1. To prevent the formation of food waste through sustainable packaging and the application of correct food portions in the school meal chain;
2. To favor the recovery and donation of food products for social solidarity purposes;
3. To help limit negative impacts to the environment and natural resources through actions directed to reduce the production of food waste and to promote reuse and recycling to extend the life cycle of the products.
The research was designed into 3 parts described into the figure 2:
I: Source Reduction;
II: Feed Hungry People;
III: Feed Animals.

1.2.1. SOURCE REDUCTION

The practice of food waste prevention is based on a multidisciplinary approach. For these reasons, in this step, the focus is placed in two areas.

1. First study was conducted on new packaging that extends the shelf life of food, preventing food wastage.
2. Second study was an investigation of school catering services, in order to determine the variables that influence food waste in school meals.

1.2.2. FEED HUNGRY PEOPLE

The aim of this research has been the simplification, harmonization and encouragement of a "recovery system", with the purpose to individualize and introduce uniform and clear procedures for the management of the food surplus (in the quantification, categorization, traceability and hygienic aspects), that can consequently help expand and maximize the recovery for charitable purposes.

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[1] The term "degree recoverability" has been defined by Garrone et al, 2014.
(Garrone, P., Melacini, M., & Perego, A. (2014). Opening the black box of food waste reduction. Food policy, 46, 129-139.)

It is important that access to food is guaranteed, but it is even more important to ensure recovered food preserves and protects human health. In this context, the system of the food rescue today effectively and efficiently addresses the urgency of the expressed needs and the available resources, but, certainly, these systems can be improved from sanitation, organizational, managerial and hygienic points of view.

1.2.3. FEED ANIMALS

Food waste that is no longer reusable for human feed has a high value because of its high quality and the nutritional profile of raw materials. This type of waste is considered waste because it is discarded or destined to be discarded, however, once subjected to chemical treatment to extract the bioactive and heat treatment compounds to assure stability and conformity from a hygienic point of view, may be reused as animal feed. These materials not only represent an important resource due to its nutritional value, but also in terms of ownership of technologies, functionality and, finally, in terms of biosecurity.

Chapter 1
Introduction

SOURCE REDUCTION Chapter 2 **Reduce the Volume of Surplus Food Generated**	**Feasibility of Biodegradable Based Packaging Used for Red Meat Storage During Shelf-Life: A Pilot Study**. *Food Chemistry*, 2018, 249: 22-29. **Improving the Overall Sustainability of the School Meal Chain: The Role of Portion Sizes.** *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*, 2018, 1-10.
FEED HUNGRY Chapter 3 **Donate Extra Food to Food Bank**	**Risk Assessment in the Recovery of Food for Social Solidarity Purposes: Preliminary Data**. *Italian Journal of Food Safety*, 2016, 5.4. **Recovery, Collection and Redistribution of Food for charitable purposes: Manual of Good Practices for Charitable Organizations. In accordance with Article 8 of Regulation (EC) 852/2004**. *Italian Ministry of Health* **Applicative Study** **Development and Sustainability: Management of Food Surplus in a Local Context**
FEED ANIMALS Chapter 4 **Divert Food Scrap to Animal Feed**	**Total Phenolic Content And Antioxidant Activity Of Agri-Food Waste And By-Products.** *Italian Journal of Animal Science* (2018): 1-6 **Pet Food as the Most Concrete Strategy for Using Food Waste as Feedstuff within the European Context: A Feasibility Study.** *Sustainability*, 2018, 10.6: 2035.

Chapter 5
Conclusions

Figure 2. An overview of the chapters discussed in the thesis

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SOURCE REDUCTION

2 | REDUCE THE VOLUME OF SURPLUS FOOD GENERATED

Brief Introduction to the Scientific Works

Food waste reduction has become one of the most urgent goals to be achieved on a global level. Public institutions and governments are facing challenges relating to financing studies for the identification of strategies to tackle food waste reduction and, in some cases, the implementation of the policy intervention. In this section my scientific studies focus on food waste prevention.
The section is divided into two scientific paper:

- In the first study I evaluate a new type of packaging with the aim of considering the possibility of extending shelf life expectancy of perishable food.
- The second study investigates a school catering service, to determine the variables that influence food waste in school meals.

Feasibility of Biodegradable Based Packaging Used for Red Meat Storage During Shelf-Life: A Pilot Study

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Feasibility of Biodegradable Based Packaging Used for Red Meat Storage During Shelf-Life: A Pilot Study

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Abstract

This study was designated to ascertain the effectiveness of a polylactic acid (PLA)-based packaging solution to store fresh red meat during its refrigerated shelf-life. Recently the attention in the packaging industry regarding the use of bioplastics has been shifting from compostable/biodegradable materials toward biobased materials.

Steaks obtained from semi-membranous muscle of Piemontese beef were packaged in PLA trays closed with a lid made of PLA film, and for comparison purposes in conventional reference packaging consisting of an amorphous polyethylene terephthalate/polyethylene (APET/PET) tray and wrapped in plastic film of polyvinyl chloride (PVC).

The packaging under modified atmosphere MAP was carried out by using a gas mixture of 66% O_2, 25% CO_2 and 9%N_2. By using PLA packaging combination, it was possible to maintain an optimum red colour together with a reduced content of volatile compounds associated with off-flavours of meat samples particularly related to the oxidation phenomena.

1. Introduction

The purpose of food packaging is to preserve the quality and safety of the food it contains from the time of manufacture to the time it is used by the consumer. An equally important function of packaging is to protect the product from physical, chemical, or biological damage (De Azeredo, 2009). This last function of packaging represents a crucial role for perishable food like fresh meats. The most well-known packaging materials that meet these criteria are polyethylene or co-polymer based materials, which have been in use by the food industry for over 50 years (Mahalik & Nambiar, 2010). The largest part of materials used in packaging industries is produced from fossil fuels and are practically non-degradable. Recently the attention in the packaging industry regarding the use of bioplastics has been shifting from compostable/biodegradable materials toward biobased materials (Nampoothiri, Nair, & John, 2010). Moreover, due to concerns about the env
ironment and health, consumers are avoiding the use of petroleum-based conventional packaging, which takes hundreds of years to decompose, and food products containing synthetic additives or preservatives (Nampoothiri et al., 2010).

PLA (polylactide) is a family of biodegradable thermoplastic polyester made from renewable resources which is nowadays seen as one of the most promising polymers for commercial use. It is produced through the conversion of corn, or other carbohydrate sources, into dextrose, followed by fermentation into lactic acid. PLA exhibits tensile strength comparable to other commercially available polymers (Peelman et al., 2013). In addition to its strength, biodegradability, and compostability, PLA polymers also are resistant to oil-based products, are sealable at lower temperatures and can act as flavour or odour barriers for foodstuffs (Sorrentino, Gorrasi, & Vittoria, 2007). This material provides a good barrier to odours, however, the most important limitation associated with the use of PLA for food application packaging is its moderate barrier to gases and vapours and the brittleness properties (Gronman et al., 2013; Jamshidian et al., 2012).

Moreover, considering that PLA is also classified as GRAS (Generally Recognized as Safe) by the American Food and Drug Administration (FDA) and is authorized by the European Commission (Commission Regulation No 10/2011), this polymer might be used in contact with food (Bishai, De, Adhikari, & Banerjee, 2014). It is important to underline that while some bio-based packaging materials may be biodegradable,
not all biodegradable materials are bio-based (Abdulkhani, Hosseinzadeh, Ashori, Dadashi, & Takzare, 2014). In consideration to the above-mentioned reasons, PLA represent an excellent candidate for producing commercial compostable packaging materials. These materials can be used to control the deterioration of perishable food products, to maintain food quality and to extend the shelf life of foods as well (Detzel & Krüger, 2006). Meat represents one of the most perishable foods in commerce and its safety and organoleptic properties may be altered during storage. These alterations may be due to different reactions such as microbial spoilage or oxidation processes that decrease food value or produce unsafe food (Bastarrachea, Denis-Rohr, & Goddard, 2015). Generally, with the aim of preserving chilled meat from possible contamination during storage, it is packaged in amorphous polyethylene terephthalate in combination with polyethylene (APET-PET) trays and wrapped in plastic film of polyvinyl chloride (PVC) under modified atmosphere (MA) conditions (Fonseca et al., 2015; McMillin, 2008; Smiddy, Papkovsky, & Kerry, 2002; Weng, van Niekerk, Neethirajan, & Warriner, 2016; Zhao, Lian, & Yue, 2013). With increasing consumer awareness and demand for fresh, safe, nutritious and healthy meat products, meat processors are continually investigating new and innovative food preservation technologies for potential commercial application among which the bio-base packaging represent today an important investment field (Gao et al., 2017; Rizzolo et al., 2016).

Commercially available biopolymers in packaging have so far mainly been used for fruit and vegetable due to their relatively short shelf-life and respiration and humidity requirements. (Otoni, Espitia, Avena-Bustillos, & McHugh, 2016).

Currently, very little research exists to address the application of PLA to maintain the quality of muscle foods. Some studies have investigated the effect of PLA, alone or in combination with other antimicrobials to inhibit microorganisms on fresh or further processed meat products (Chen & Brody, 2013; Rizzolo et al., 2016; Coma, 2008; Cutter, 2006; Kerry, O'Grady, & Hogan, 2006). In addition, the synergistic effect of 2% low molecular weight polylactic acid alone or in combination with lactic acid or nisin against *Escherichia coli* O157:H7 was demonstrated on raw beef during irradiation and during refrigerated storage (Chen & Brody, 2013; Coma, 2008). Considering the scarce scarcity of literature concerning the use of whole PLA packaging for meat storage, the purpose of this preliminary research was to investigate the feasibility of replacing APET/PE trays in combination to PVC film with biodegradable polymers PLA tray and film in order to preserve the quality of red meat as well as to control the microbial contamination during the refrigerated shelf-life.

2. Material and Methods

2.1. Sampling and Storage Conditions

Sliced fresh top round beef, comprising the Semi-membranous of Piemontese beef, were obtained from a local distribution store. Piemontese is the most important double-muscle Italian autochthonous beef breed from the region of Piedmont, in northwest Italy. Its main attributes are a higher lean-to-fat ratio, a less marbled with less connective tissue red meat than other breeds, and high tenderness. The Semi-membranous muscle was chosen as representing muscle of greatest mass and for its economic value, and steaks used for the present study were cut (1 cm thick, 100 g weight). The pilot study was carried out at meat retail to simulate real working conditions in order to obtain a real evaluation of performances in the context of actual use of PLA material as a solution applicable to the packaging of red meat in a protective atmosphere.

The steaks were packaged in thermoformed, transparent PLA trays with film thickness of 500 μm, closed with a lid made of 500 μm PLA film (ISAP Packaging Verona, Italy). PLA material characteristic was: elongation break (7.2%), tensile strength (36.4 MPa), decomposition temperature (200 °C) and half-life in 37 °C normal saline (4–6 months).

For comparison purposes a conventional reference package consisting of a 420 μm amorphous polyethylene terephthalate/polyethylene (APET/PET) trays wrapped in plastic film of 120 μm polyvinyl chloride (PVC) were used (ISAP Packaging Verona, Italy). The dimensions of all trays were 17.5×8×2.5 cm. The packaging under modified atmosphere MAP was carried out using a heat sealer Lari3/Pn Cavec T-VG-R-SKIN (Caveco, Milano, Italy). The gas mixture used to package all samples was composed by 66% O_2, 25% CO_2 and 9% N_2 (Aligal 49, Siad, Bergamo, Italy). All packs were stored at 4 ± 1 °C in order to simulate the retail conditions in a refrigerated chamber during the entire declared shelf-life (8 ± 1 days). Also for this purpose, this chamber was illuminated by a standard supermarket fluorescent lamp also. Two packages, with three samples each, were taken after 0, 2, 4, 6 and 8 days of storage for physico-chemical and microbiological analyses as well.

2.2. Microbiological Analyses

Microbiological analyses were performed for evaluating food safety parameters and hygiene process indicator microorganisms. In particular, enumeration of Mesophilic aerobic bacteria, enumeration of *Enterobacteriaceae*, enumeration of coagulase-positive Staphylococci (CPS), enumeration of *Escherichia coli*, and the research of *Salmonella* spp. and *Listeria monocytogenes* were investigated. Furthermore, for monitoring of shelf life was evaluated using the following parameters: total viable psychrophilic counts, *Pseudomonas* spp. counts and Total viable counts of *Lactobacillus* species.

The microbiological characteristics of a 10 g sample were obtained after homogenization in 90 mL of sterile diluent solution (0.85% NaCl and 0.1% peptone) and homogenized in a stomacher (Star Blender Digital- EUplug 710-0958) for 1 min at room temperature and then serial 10-fold dilutions were prepared in a sterile saline solution.

Mesophilic aerobic plate counts (APC) and Enterobacteriaceae plate counts were enumerated using a Petrifilm Aerobic Count (3M, St. Paul, Minnesota, USA), following the: AFNOR 3M 01/1-09/89 and AFNOR 3M 01/06-09/97 respectively. Petrifilm_ plates were also used to determine *E. coli* (EC), and CPS, in accordance with the following methods: AFNOR 3M 01/08-06/01 and AFNOR 3M 01/9-04/03 A, respectively.

Salmonella spp. detection (analytical unit: 25 g) was carried out using UNI EN ISO 6579: 2008 and the presence was confirmed by an API 20E system (Biomerieux, Marcy l'Etoile, France). The detection of *L. monocytogenes* (analytical unit: 25 g) was performed according to AFNOR BRD 07/4-09/98 (AFNOR, 2010a) and the presence was confirmed according to the AOAC N.060402 (MID 67), 2010 method.

Total viable psychrophilic counts were evaluated by plating aliquots into plate count agar (PCA, OXOID Ltd., Basingstoke, and Hampshire, UK) the inoculated plates were incubated at 10 °C for 7 days. *Pseudomonas* spp. counts were determined using Cephaloridine-Fucidin-Cetrimide selective medium (CFC, OXOID, Basingstoke, Hampshire, UK) and were incubated at 25° ± 1°C for 2 days. The presence was confirmed according to the ISO 13,720:2010 method.

Total viable counts of *Lactobacillus* species were determined using Man, Rogosa, and Sharpe (MRS, OXOID, Basingstoke, Hampshire, UK) agar and incubated at 30 °C ± 1 °C for 72 ± 3 h, according to the ISO 15,214:1998 method.

All results were expressed as log10 cfu g−1 and performed in duplicate.

2.3. Physicochemical Analyses

2.3.1. pH

The pH value of steaks was measured directly on the beef slices using a membrane glass probe type electrode (Crisolyt A, Crison PH meter GLP 22, Barcelona, ES).

2.3.2. Headspace Gas Composition and Oxygen Transmission Rate (OTR) of the Packages

Analyses of CO_2 and O_2, expressed as percentage, within the packages were monitored by using a CheckMate 9000 gas analyser (PBI Dansensor, Ringsted, Denmark). The gas samples were taken with a needle inserted through a septum placed on the packages and measured in duplicate. The OTR of the empty packages were measured on sealed trays (APET and PLA) by the Ambient Oxygen Ingress Rate Method. The test conditions were 6°/80% relative humidity (HR), both dry (0% internal humidity) and wet gas (100% internal humidity) inside the packages. Wet gas was obtained by adding 10 mL water to the packages.

Results were calculated as mL/package (mean values of four samples).

2.3.3. Colour Measurements

The colour evolution of the individual meat samples stored in the two different packages was determined on the basis of the values of the CIELab system of coordinates immediately following the performance of sensory assessment. The measuring procedure was according to O'Sullivan & Kerry, 2013. The parameters of the color space $L*$ –lightness, $a*$ – redness and $b*$ – yellowness were measured six times for each sample by the reflectance method using a Konica Minolta CM-5 Spectrophotometer (Konica Minolta Sensing, Inc., Japan). The Hue angle was calculated as $Tan^{-1}(b*/a*)$. The instrument was calibrated to white and a setting with D65 light source and measurement slit of 8mm was used. Colour measurements were performed directly after opening the package since consumers buying case-ready packaged beef evaluate its colour at the point of sale, with no blooming.

2.4. Volatile Compounds Analysis

2.4.1. HS-SPME Extraction of Volatile Compounds

The volatile compounds investigated in the preset study were selected primarily on the basis of their impact to the senses as well as chemical oxidation phenomena occurring during the shelf-life of red meat as already investigated and observed in our previous studies as well (hexanal, 3-hidroxy-2-propanone and acetic acid) (Chiesa, Soncin, Biondi, Cattaneo, & Cantoni, 2006; Panseri, Chiesa, Zecconi, Soncini, & De Noni, 2014; Soncin, Chiesa, Cantoni, & Biondi, 2007).

10 g minced meat samples and 10 µl of internal standard solution (4- methyl-2-pentanone; 20 µg mL-1) were weighed into 20 mL headspace vials and sealed with polytetrafluoroethylene (PTFE)-coated silicone rubber septa (20mm diameter) (Supelco, Bellefonte, PA, USA). The vials were kept at 7 ± 1 °C for at least 1 h to allow the volatile compounds in the headspace above the sample to reach equilibrium. At the end of the sample equilibration time, a conditioned (1.5 h at 280 °C) 85 µm Carboxen/polydimethylsiloxane (CAR/PDMS) StableFlex fibre (Supelco, Bellefonte, PA, USA) was exposed to the headspace of the sample for volatile compounds extraction (90 min at 25 ± 2 °C) by CombiPAL system injector autosampler (CTC Analytics, Zwingen, Switzerland). These conditions have already been reported (Chiesa et al., 2006).

2.4.2. GC/MS Conditions

Analyses were performed with a TraceGC (Ultra gas chromatograph (Thermo Fisher Scientific, Rodano, Italy) equipped with a Rtx-WAX column (30m×0.25mm i.d., 0.25 µm film thickness; Superchrom, Milan, Italy) and coupled to a TraceDSQII mass spectrometer (Thermo Fisher Scientific) with source and transfer line temperatures kept at 250 and 200 °C respectively. The column temperature was set initially at 35 °C for 8 min, then increased to 60 °C at 4 °C min−1, to 160 °C at 6 °C min−1 and finally to 200 °C at 20 °C min−1 and held for 15 min. Helium was used as the carrier gas at flow rate of 1 mL min−1. The injector temperature was set at 220 °C. The splitless mode was used for injection, with a purge time of 8 min. The fibre was maintained in the injection port for 8 min. Electron ionization masses were recorded at 70 eV in the mass range between m/z 35 and 350. After each analysis the fibre was routinely desorbed at 250 °C for 15 min in order to eliminate high-boiling-point contaminants. The identification of the volatile compounds was carried out by comparing their mass spectra with those of standard compounds when available, or by comparing their mass spectra with those stored in the National Institute of Standards and Technology (NIST) US Government Library and with Wiley spectral databases. Analyses were performed in triplicate. Results were expressed as ng g−1 internal standard equivalents.

2.5. Consumers Sensory Evaluation

Consumer panelists were utilized to detect differences in the sensory attributes of beef stored in the two different packaging (colour, odour and overall acceptability). The consumers' panel was constituted by 10 elements from the staff of the Veterinary Institute of Milan food safety laboratory (aged between 19 and 64 years old) with previous training during two sessions evaluating the sensory attributes as well. Each sensory attribute was rated on a continuous linear scale ranging from 0 (no perception of the descriptor) to 9 (very intense). The testers were asked to test the samples for the following characteristics: colour intensity, acid odour. The panelists were also asked to express their preference (overall acceptability) by scoring the samples with a 0–9 scale, on which 0 corresponded to “dislike very much” and 9 corresponded to “like very much”. In particular, odour panels were conducted on packages removed from the case at each sampling intervals.

The packages were opened in a random order and panelist were allowed to smell the patties without touching them. Off-odours were assessed within 30 s of package opening also. During the evaluation, the panelists had free access to water and unsalted bread.

2.6. Statistical Analysis

Analysis of variance (ANOVA) was performed to assess differences between the investigated VOCs, microbiological and chemical parameters of meat samples stored in the two different packaging. $p < .05$ was considered to be significant. Statistical analysis was conducted with SPSS software (version 17.0, SPSS, Chicago, ILL).

3. Results and Discussion

The quality of fresh meat depends on several quality indices, which can be clustered in two main groups: chemical-sensory and microbiological. Meat colour or its appearance is one of the most important attributes for red meat whereas the microbiological indices account for its safety. The results are summarized in the following paragraphs.

3.1. Gas-composition Trend

The headspace gas composition of a fresh meat package changes dynamically as the dominant gases, oxygen and carbon dioxide can be produced or removed through respiration, oxidation, solubilization and permeation processes as well. These phenomena are a function of the packaged food and can be influenced by the packaging materials also (Gao et al., 2017).

The measured percentages of O_2 and CO_2 associated with the two types of packaging solutions investigated during the refrigerated shelf-life of red meat samples were shown in Fig. 1. With respect to the storage times we observed a general decrease of CO_2 percentage. A general drop in CO_2 content is expected because of CO_2 adsorption into the meat samples and also due to the packaging material transmission of CO_2 as reported by other authors (Chen & Brody, 2013; Rizzolo et al., 2016). For the traditional material the minimum level was reached at eight days with very little variation during the shelf-life in contrast with PLA packaging system in which a considerably large decreasing was observed reaching the minimum at day eight. The two materials clearly and statistically differ in CO_2 loss this last higher for the PLA packages than the reference material as well. Generally, carbon dioxide is generated through respiration and reduced when being dissolved in the meat or when permeating through the packaging material to the external atmosphere.

This decline cannot be monitored by reason of microbial growth. Regarding O_2 percentages, statistical differences were also noted for the two packages with opposite behavior. In meat stored in PLA packages an increasing of O_2 was evident during the entire shelf-life. The higher rate of oxygen permeation for PLA must be attributed to the higher OTR of this type of packaging compared to the reference (Table 1). In general, this high rate of oxygen accumulation in the PLA packages could represent a limit and not compatible with the desired MA has a low concentration of oxygen (i.e. for cheese storage) in which low oxygen concentration is generally used (Coma, 2008; Zhao et al., 2013). The barrier properties of plastic materials use for packaging play a major role in determining the shelf-life of packaged foodstuffs. In particular, polymeric films, controlling the rate at which small molecular weight compounds permeate in or out of the package, can slow down the detrimental phenomena responsible for the unacceptability of the packaged foods (Jamshidian et al., 2012; Sorrentino et al., 2007).

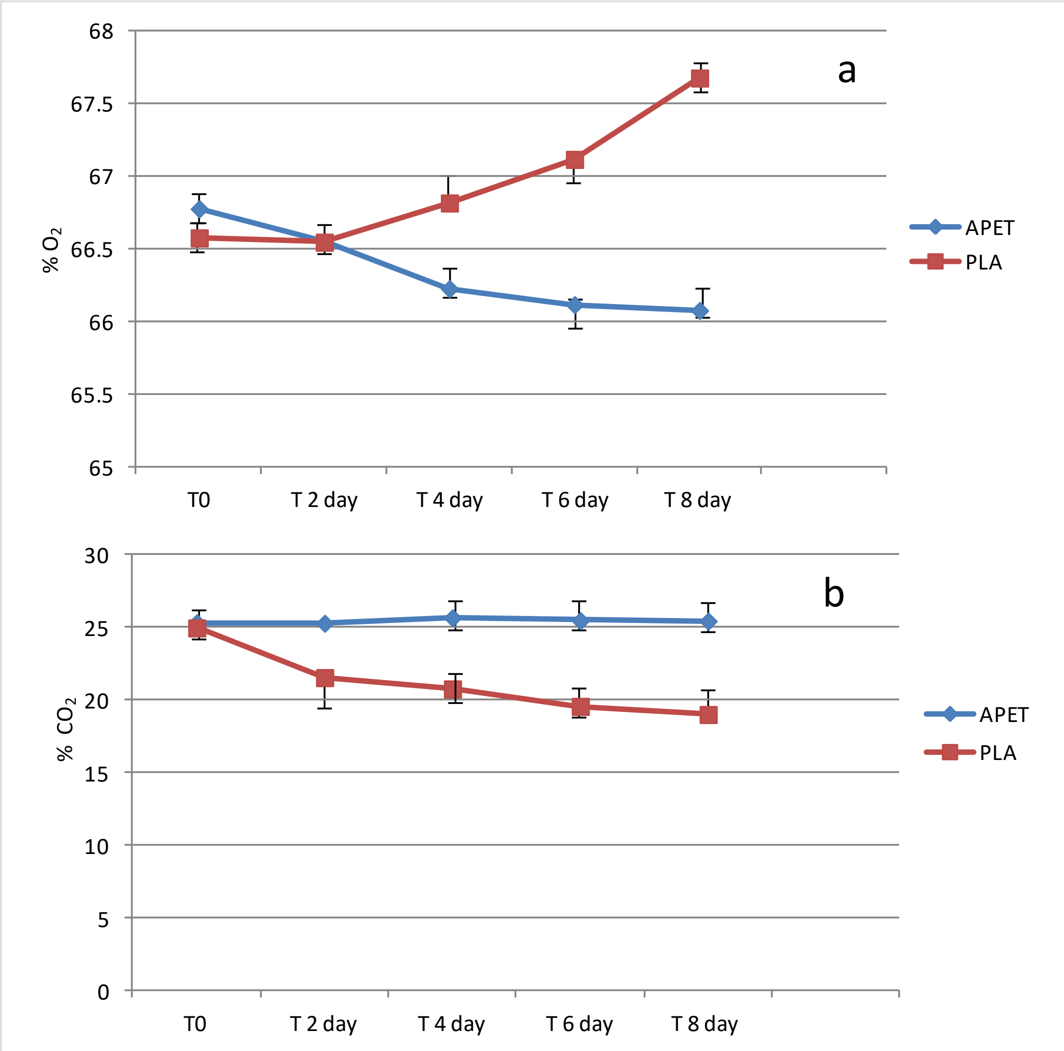

Fig. 1. Evolution of O_2 (a) and CO_2 (b) percentage during the refrigerated shelf-life of meat samples stored in two packaging typologies (APET and PLA).

Table 1. Oxygen transmission rate (OTR) in amorphous polyethylene terephthalate/polyethylene (APET/PET) trays wrapped with polyvinyl chloride (PVC) film and PLA trays wrapped with PLA top film.

Material	6°C/80% Wet internal gas	6°C/80% Dry internal gas
APET/PE package	0.050 ± 0.019	0.031 ± 0.007
PLA-based package	7.418 ± 3.097	4.075 ± 1.005

3.2. Microbiological Results

The microbiological results are presented in Table 2. The data for both samples (meat in PLA package and meat in PET/PE package) are expressed in relation to the evaluation after 0, 2, 4, 6 and 8 days of storage at 4 °C ± 1 °C.

The results expressed as Log CFU/g, while for the *Salmonella* spp. and *Listeria monocytogenes* parameters the absence of which are expressed in 25 g samples.

The results show that there are not significant variations in the value of all microbiological parameters investigated, during the refrigerated storage in both samples, as shown in Figs. 2 and 3.

Table 2: Results of microbiological analyses.

Sample	Parameters	Units	Storage period (days)				
PLA			0	2	4	6	8
	Aerobic plate counts	Log CFU/g	4,3	4,6	5	5	5,9
	Enterobacteriaceae	Log CFU/g	*2,8*	2,1	2	2	2,7
	Coagulase-positive *Staphylococci*	Log CFU/g	<1	<1	<1	<1	<1
	Escherichia coli	Log CFU/g	2,8	2	2,7	2	2,7
	Salmonella spp.	Org/25g	Negative	Negative	Negative	Negative	Negative
	L. monocytogenes	Org/25g	Negative	Negative	Negative	Negative	Negative
	Psychrophilic aerobic counts	Log CFU/g	3,6	3,6	4,1	4,9	5,7
	Pseudomonas spp.	Log CFU/g	<1	<1	<1	<1	<1
	Lactobacillus spp.	Log CFU/g	4,3	3,6	5	4,6	4,6
APET/ PET							
	Aerobic plate counts	Log CFU/g	4,1	4,5	5,4	5,6	5,4
	Enterobacteriaceae	Log CFU/g	*2,9*	2,6	2,7	2,3	2,5
	Coagulase-positive *Staphylococci*	Log CFU/g	<1	<1	<1	<1	<1
	Escherichia coli	Log CFU/g	*2,9*	*2,6*	2,6	*2,3*	*2,3*
	Salmonella spp.	Org/25g	Negative	Negative	Negative	Negative	Negative
	L. monocytogenes	Org/25g	Negative	Negative	Negative	Negative	Negative
	Psychrophilic aerobic counts	Log CFU/g	3,2	4,4	4,2	5,6	5,2
	Pseudomonas spp.	Log CFU/g	<1	<1	<1	<1	<1
	Lactobacillus spp.	Log CFU/g	4,3	3,6	5,2	4,6	4,5

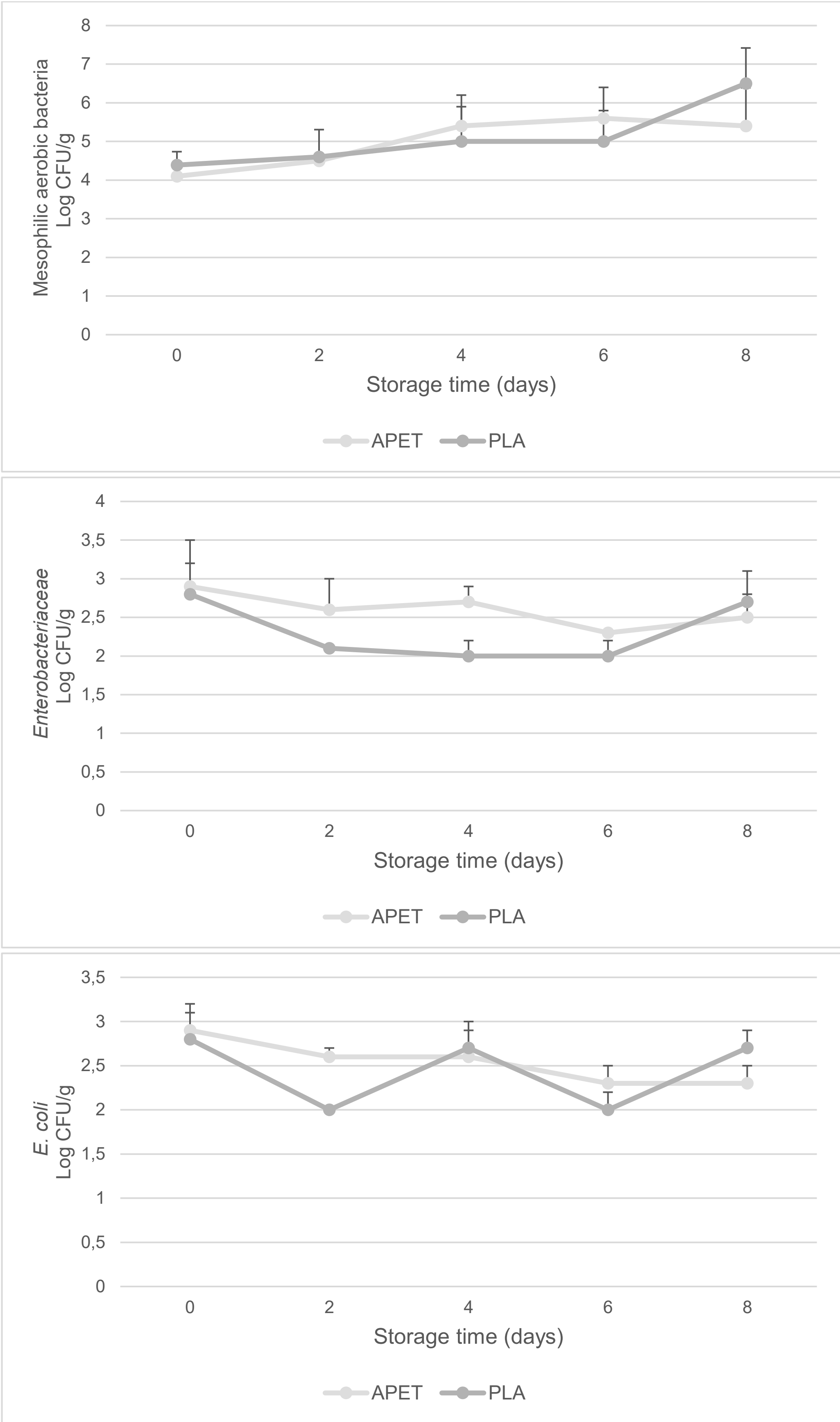

Fig. 2. Count of Mesophilic aerobic, *Enterobacteriaceae* and *E. coli* during the refrigerated shelf-life of meat samples stored in two packaging typologies (APET and PLA).

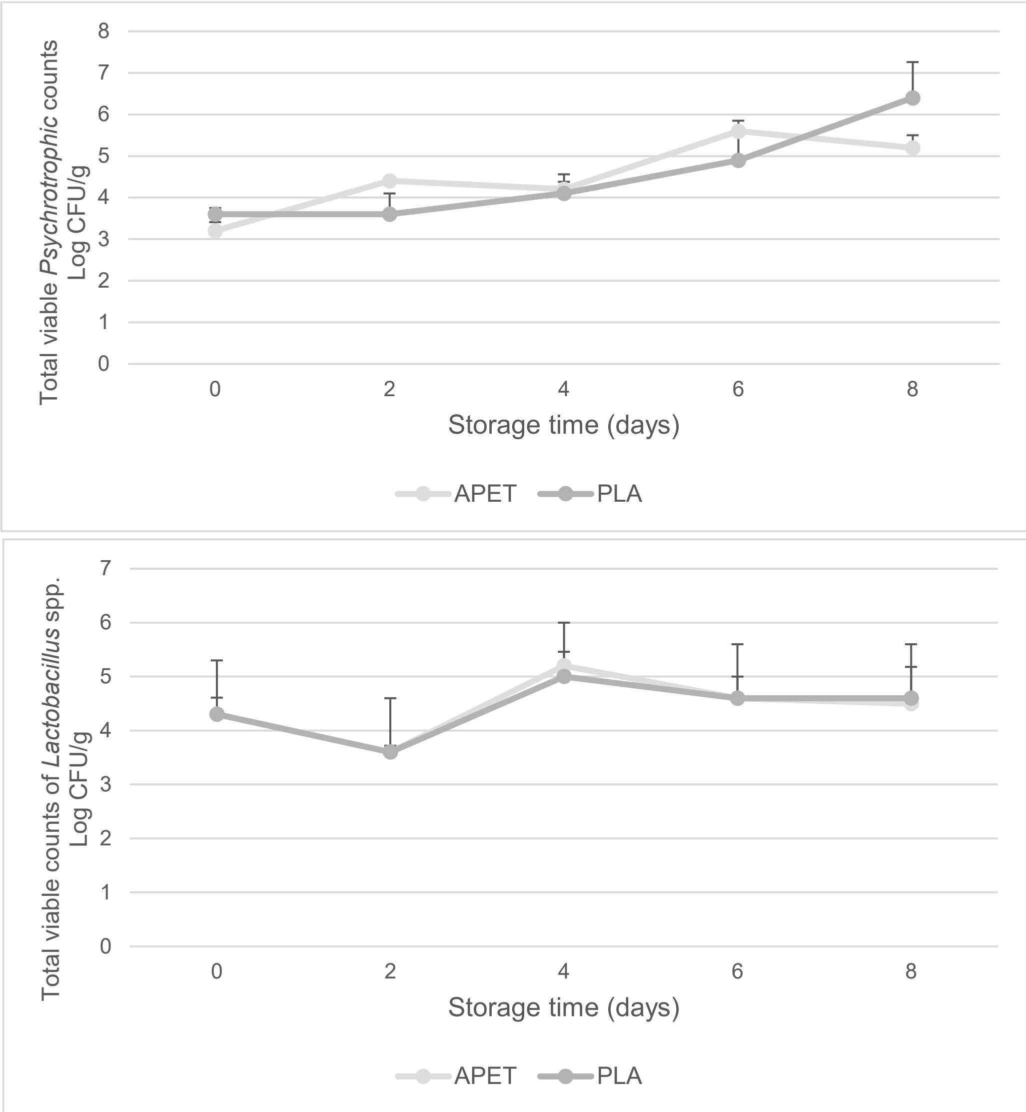

Fig. 3. Count of total viable psychrophilic and *Lactobacillus* spp. during the refrigerated shelf-life of meat samples stored in two packaging typologies (APET and PLA).

3.3. pH trend

The evolution of pH values with respect to time and type of packaging is shown in Fig. 4. We observed no statically difference during the shelf life and examining the two packaging solutions adopted for red meat storage.

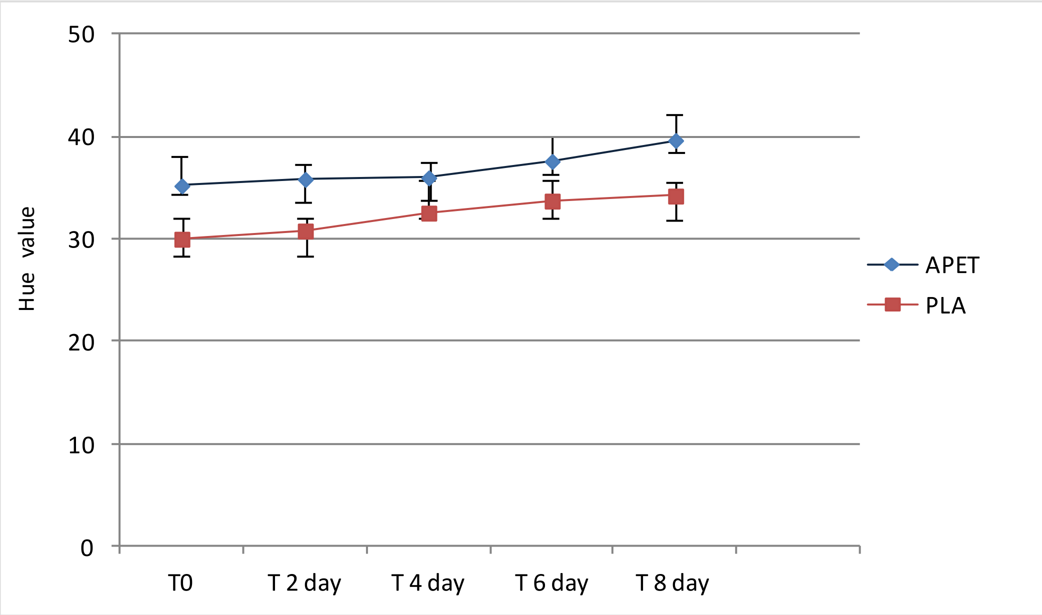

Fig. 4. pH trend during the refrigerated shelf-life of meat samples stored in two packaging typologies (APET and PLA).

3.4. Instrumental Colour Analysis

The cherry red colour in meat is one of the most important qualities influencing the consumer's decision to purchase (McMillin, 2008). The colour of meat depends on many factors, such as the concentration and chemical state of heme pigments, particularly myoglobin; the physical characteristics of the meat; and the pH (McMillin, 2008). Discoloration results from the conversion of oxymyoglobin to metmyoglobin, which produces an unattractive brown color (Coma, 2008). Also packaging materials as well as mixture gas composition in MA are critical factors influencing the color of red meat during the shelf-life (Coma, 2008). Lightness (L $*$), redness (a $*$) and yellowness (b $*$) were measured and then used to calculate the Hue index. Hue value (low value indicates red color, whereas high values indicate yellow color) measured during the shelf-life is presented in Fig. 5. Generally, an increase in Hue value during the shelf-life was observed in the two different packaging systems during the shelf life. The increase of this parameter depends on the storage temperature and time as reported by other authors and it could be explained by the gradual oxidation of myoglobin and accumulation of metmyoglobin with time. As reported in Fig. 5 we observed a statistical difference between red meat samples stored in the reference packaging and PLA, the latter with lower value suggesting the hue variations during storage are dependent on the nature of the packaging. These results confirmed the PLA based packaging as suitable material to maintain the red cherry color in refrigerated red meat during it’s the entire shelf-life as well.

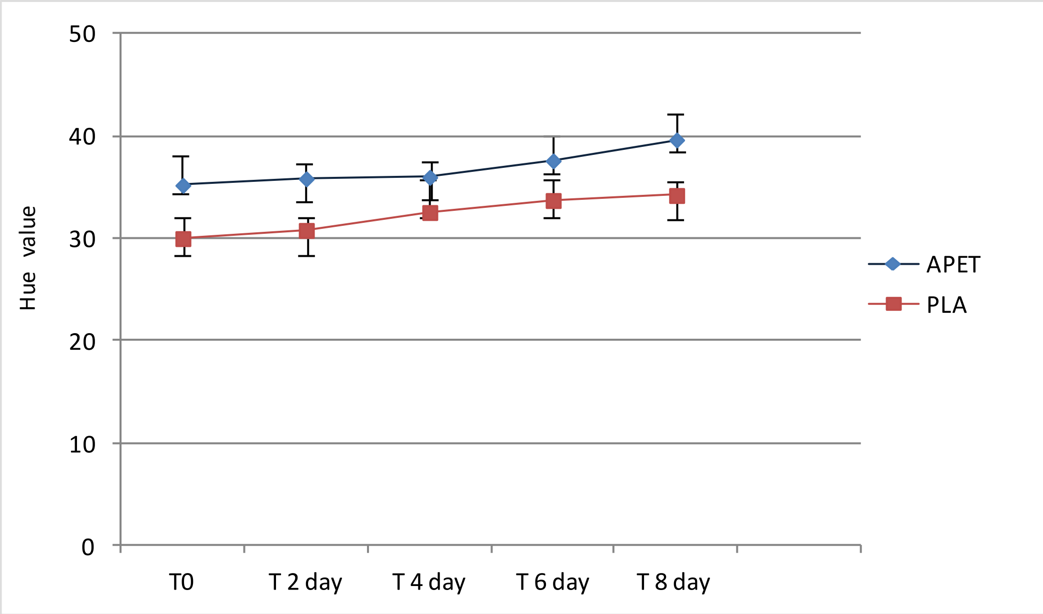

Fig. 5. Hue angle modification during the refrigerated shelf-life of meat samples stored in two packaging typologies (APET and PLA).

3.5. Volatile Compounds Analysis

The trend of the investigated volatile compound during the shelf-life of meat sample stored in different packaging is presented in Fig. 6. A statistical difference was observed after 6 days of storage along with an increase of volatile compounds associated with the oxidation phenomena (hexanal and hidroxy-2-butanone-acetoin) in the samples stored in the reference packaging. Moreover, only some volatile compounds, defined as aroma compounds, are important for the characterization of a product's aroma; indeed, some compounds with a very low odour threshold have an important impact on the formation of the "aromatic fingerprint" of the product in particular for meats. Usually the development of oxidative off-flavour (rancidity) has long been recognized as a serious problem during the storage of meat products.

Hexanal is mainly formed during the oxidation of linoleic acid via the 13-hydroperoxide. It has an odour described as "grassy" which contributes to off-flavour, due to the low odour threshold in water: (4,5 μg kg^{-1}) (Bianchi et al., 2007; Turchini et al., 2005).

In addition, high O_2 atmosphere concentration tends to favor lipid oxidation of red meat. The use of high concentration of O_2 usually up of 70% is however necessary in order to transform myoglobin, purple in color, to its oxygenated form of oxymyolobin, bright red in color. In our experiment we observed a different trend of hexanal which was developed in minor concentration in red meat samples packaged in bio based PLA packaging. A similar trend was shown for acetoin with minor concentration detected in meat stored in PLA trays. Acetoin together with acetic acid are derived entirely from the catabolism carbohydrates.

Under aerobic conditions, microorganisms such as B. thermosphacta produces acetoin; acetic, and other volatile compounds among which acetoin is the volatile compounds strictly related to the sour-sweet offensive odour. Oxygen and carbon dioxide mainly affected glucose metabolism (Chen & Brody, 2013). Under aerobic conditions, this organism produces acetoin from diacetyl, which comes from pyruvate via -acetolactate, yielding one molecule of acetoin per molecule of glucose, while under anaerobic conditions it transforms glucose mainly into lactic acid, yielding two molecules of lactic acid per molecule of glucose as well (Chen & Brody, 2013).

No significantly, differences were shown for acetic acid concentration's trend in the meat sample stored in the two investigated packaging this also supported from a constant trend of pH during the entire shelf life.

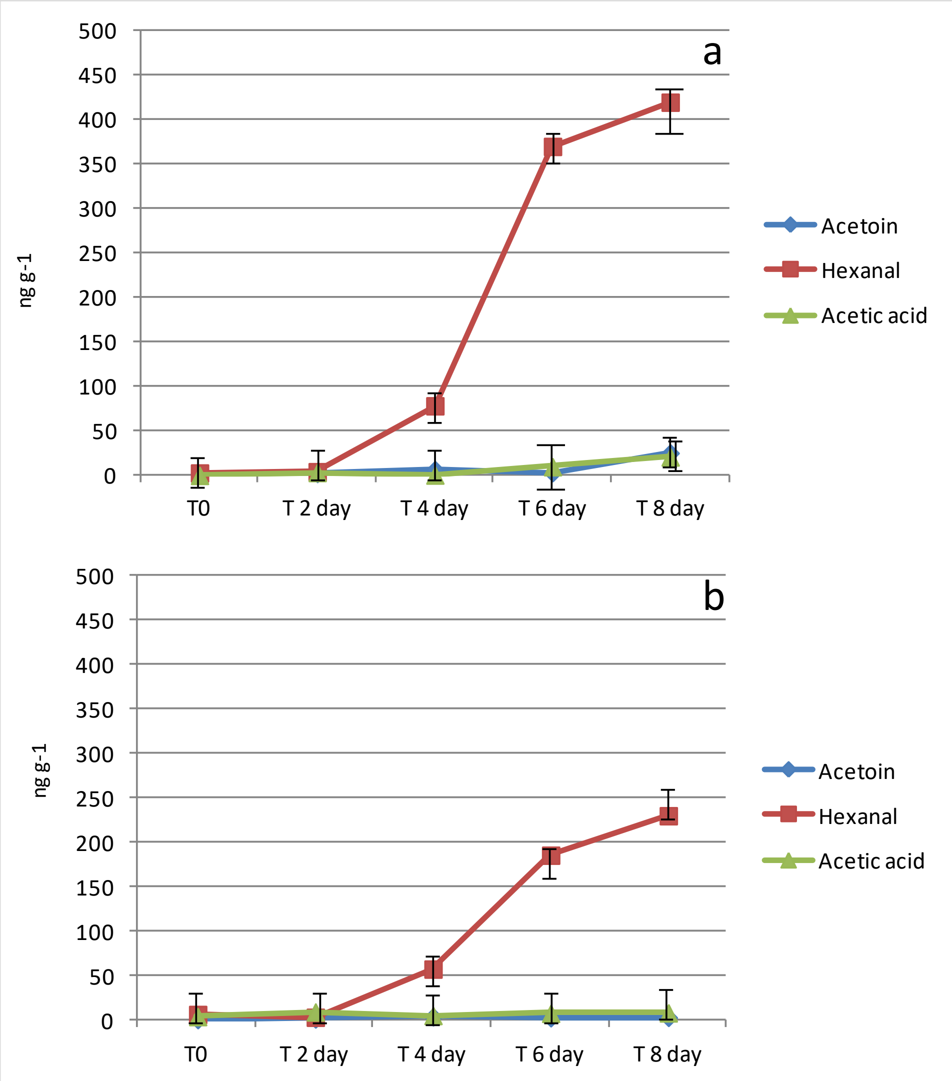

Fig. 6. Evolution of Volatile compounds associated to oxidation phenomena during the refrigerated shelf-life of meat samples stored APET (a) and PLA (b) typologies.

3.6. Sensory Changes

Sensory properties concerning the evaluation of red colour, acidity and overall acceptability are shown in Fig. 7. Based on data displayed in Fig. 7b is evident that the meat samples stored in PLA packaging maintained a red colour longer than meat stored in reference packaging material. In addition, acidity scores were judged lower in meat packaged in PLA (Fig. 7a). As consequence, the overall acceptability of meat in PLA tray was defined as sufficient at day 9 of the shelf-life in contrast with meat stored in reference material reaching the sufficient value at day 7. This is important evidence that could allow and lead to the proposal of an extension shelf-life of about two days. These results are in accordance with Pettersen, Bardet, Nilsen, & Fredriksen, 2011 who investigated the use of PLA material to store fresh salmon compared with APE/PET packaging. The author found significantly higher score values concerning colour intensity and acceptability in fillet stored in PLA packaging for the entire shelf-life.

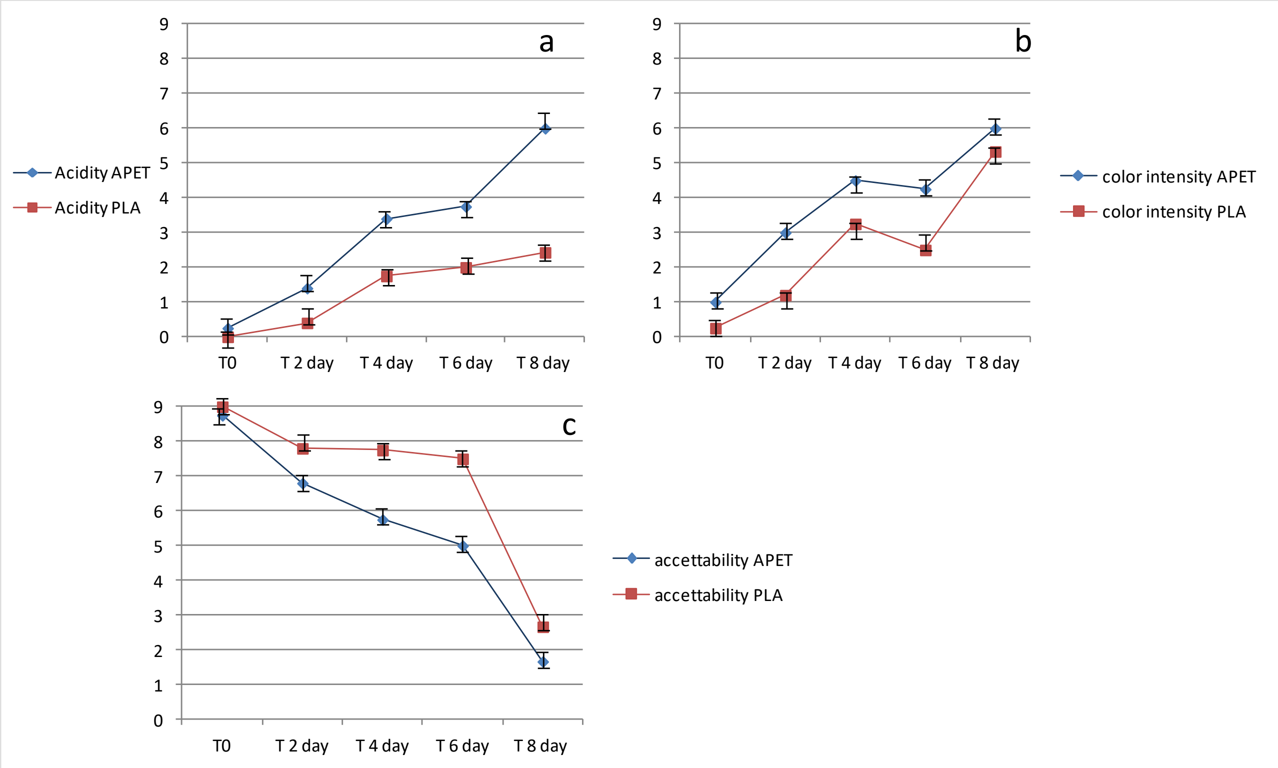

Fig. 7. Evolution of sensory parameters during the refrigerated shelf-life of meat samples stored in two packaging typologies (APET and PLA).

4. Conclusions

In the present pilot study two different options for beef steak packaging is evaluated on the basis of their ability to preserve and maintain quality of meat along shelf-life. The studied options were bio-based polylactic acid packaging and fossil based amorphous polyethylene terephthalate/polyethylene+PVC combination. Different parameters were investigated to obtain information toward the feasibility of potential use of PLA to preserve the quality of red meat.

This represents the first study that involves the use of a packaging solution in which both tray and film are made of PLA. The quality of fresh meat depends on several quality indices, which can be clustered in two main groups: chemical-sensory and microbiological.

Microbiological analyses in particular as they relate to the shelf-life of total viable psychrophilic counts, *Pseudomonas* spp. counts and total viable counts of *Lactobacillus* species showed the same behavior in meat packaged in PLA compared to meat stored in conventional packaging system. Examining the evaluation of colour, which represents a crucial parameter conditioning the consumer, statically differences existed between red meat samples stored in the reference packaging and PLA, these last with lower Hue value. These results confirmed the PLA based packaging as suitable material to preserve the red cherry color in refrigerated red meat during its the entire shelf-life as well.

These results are then in accordance with consumer evaluations that revealed meat samples stored in PLA packaging maintained a red colour longer than meat stored in reference packaging material. Also, acidity scores were judged lower in meat packaged in PLA. It is important to underscore how new high-performance materials, energy efficient production technologies, protective solutions for preservation and insulation are just a few of the current technological challenges in food waste avoidance. Bio-based packaging represents an integrated approach, from design to communication to disposal, which takes into account all the steps of a product generation process, making the most of each of them and of all the parties involved, especially in view of implementing a circular economy. The results obtained from the present pilot study on the feasibility of potential use of bio-based packaging material PLA for red meat storage along the declared shelf-life confirms the efficacy of this material for red meat storage.

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Improving the Overall Sustainability of the School Meal Chain: The Role of Portion Sizes

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Improving the Overall Sustainability of the School Meal Chain: The Role of Portion Sizes

Balzaretti C.M., Ventura V., Ratti S., Ferrazzi G., Spallina A., Carruba M.O., **Castrica M.**

Abstract

Purpose

This work analyses the meal supply in primary schools in Italy in order to highlight new areas of inefficiency upstream of the food chain, regarding the size of the food portions specified in public tenders. A lack of conformity of food portions can potentially lead to a double negative externality affecting the sustainability of school meals: overweight children and food waste.

Method

Based on the data contained in the contract between municipalities and school catering services, the analysis was performed on the portion sizes (in grams) of the main food products included in the school menu for each regional capital (RC) in Italy. Data analysis regarded two main aspects: consistency of food portions within regions and adherence to national standards for children.

Results

The results revealed great discrepancies amongst regions and in several cases, portion sizes significantly larger than the reference values of standard portions for school catering. The study also profiles RC on the basis of portion sizes, school meal attendance, and childhood obesity rates.

Conclusions

Potential exists to educate the next generation through school meals that encourage healthy eating habits, therefore playing a leading role in obesity prevention in children. Similarly, the educational role of eating at school can contribute to raising children's awareness about one of the most urgent environmental challenges - food waste - by introducing the best strategies for waste reduction, reuse and recycling. Results have economic, social, health and environmental implications and highlight the need to revisit policies in order to introduce new solutions for more sustainable and healthy school canteens in Italy.

1. Introduction

1.1 School Catering Services

Food and nutrition play a crucial role in health promotion and disease prevention. At the global level, the development of school menus is based on specific dietary guidelines that reflect the current body of nutrition science, in order to help health professionals and policy makers to set up healthy and balanced food programs for school meals. With regard to public food procurement in Italy, the national guidelines for school catering were released in 2010 by the Italian Ministry of Health [1]. These guidelines outline how to organize and manage the catering services, to define the contracts with caterers, and provide appropriate meals to meet the needs of different age groups. More specifically, the National Reference Energy and Nutrient Intake Levels (hereafter LARN, the Italian acronym for reference levels of nutrient and energy intake for the Italian population), developed by the Italian Society of Human Nutrition is the official source for nutritional standard [2]. The provisions for primary school meals state that lunch must contribute to approximately 35% of the daily energy requirements. The daily menu should provide about 15% of protein, 30% of fat, and 55% of carbohydrates.

School catering is a significant part of the procurement budget for local governments in Italy. On average 440 million meals are provided each year, with an annual value of approximately two billion euros [3], although with differing school meal attendance rates from region to region.

In some municipalities measures aimed at making catering services more sustainable have already been implemented with the dual aim of reducing food waste and increasing the nutritional profile of school meals. These include purchasing energy-efficient appliances for schools, the use of tap water, transportation using vehicles with a low environmental impact, and a significant reduction in packaging. Additional criteria used to lessen other sustainability impacts associated with catering contracts include the use of ecological cleaning products and awarding points for bidders that offer a wider range of organic or fair-trade products [4-5]. Nevertheless, these measures cannot be considered to be sufficient for the achievement of an increased global sustainability in school meals chain, since a great number of variables can contribute to create more sustainable school settings. This work analyses the role of food portion size for its relationship with the issue of children overweight as part of the social sustainability of school meals, along with the topic of food waste and its implication in the environmental sustainability of food chains.

1.2 The Sustainability of School Meals: Tackling Children Overweight

The improvement of the sustainability of school meals is strictly associated with the acquirement of healthier communities, through the access to fresh and nutritious food. Growing concerns about the social implications of sustainability derive from the fact that food systems are faced with the challenge of finding innovative solutions to the increasing overweight/obesity rates in children [6].

Within the EU around one in three 11 year-old children are overweight or obese, according to country data Italy is at the top of the list for obesity and overweight rates (9.3% and 21.3%, respectively) in 8-9 year-old children [6-7]. Childhood obesity in Italy is not-equally distributed across the country, with a high prevalence in regions in the south [8]. Amongst the wide range of possible interventions, nutritional education at school appears to be one of the most important strategies to prevent obesity [9-10]. Due to the specific features of the environment, schools provide an unparalleled opportunity to reach the vast majority of children and positively influence their behaviour through specific interventions: promotion of physical activity [11], positive change in attitude towards fruit and vegetable consumption [12] and more generally, increased awareness of the importance of a healthy lifestyle [13].

Several studies have demonstrated that healthy school meals can effectively contribute to improve children's well-being [14] and educational outcomes [15], and portion size is one of the key elements of a balanced diet, since increasing the portion size of food meals results in increased consumption, which may contribute to weight gain [9, 16-18]. Consequently, the provision of larger portion sizes of school meals can also play a role in generating over nutrition and obesity in children.

1.3 The Sustainability of School Meals: Reducing Food Waste

Food loss and waste have negative environmental impacts because of the water, land, energy and other natural resources used to produce the wasted food. Thus, reducing food waste will help increase sustainability and reduce the environmental impact of the food system.

Studies commissioned by the European Commission have estimated that annual food waste in the EU is around 88 million tonnes (EU 28) [19], with the food services sector contributing 12% (10.5 million tons), corresponding to 21 kg of per capita waste production.

Public institutions and governments have financed studies on the strategies needed to tackle food waste reduction and, in some cases, have implemented policies. In March 2017, the European Parliament voted to introduce farm-to-fork targets to reduce the EU’s food waste by 30% by 2025 and 50% by 2030, and prevention has been recognized as the first strategic tool to tackle the challenge of food chain efficiencies [20].

In parallel with the institutional interventions, scholars have been investigating the causes of food waste, the methodologies for its quantification, and the actions needed to reduce it [21-25].

Most studies have focused on household food waste, while school meals have been scarcely investigated despite the fact that schools play a special role in providing nutritious, well-balanced meals for students and in educating the next generation about environmental issues through the reduction and recycling of waste [26-29]. Among the little data available, a French report [30] estimates the average quantity of per capita food waste in primary schools as 70 grams/per day.

Moreover, the UK Wrap study [31] suggests that over a school year, a total of 55,408 tonnes of food waste is generated by primary schools in England and 24,974 tonnes by secondary schools, with a total food waste weight of 80,382 tonnes: more specifically, producing 72 grams per pupil per day and secondary schools 42 grams per pupil per day. Within the food categories, fruit and vegetables accounted for almost half of the food waste (by weight) [31].

In Italy, Falasconi et al. [32] estimated that unserved food amounts to 15-16% of the total amount of food processed in the school meals considered in their study. A further study in Italy [33] quantified an average of 107 g of avoidable plate waste produced daily by each participant.

An additional issue is that irrespective of the food environment considered (household/school), investigations into the causes of food waste frequently focus on the final step in the food chain, namely when the food is consumed [34-36]. A more comprehensive evaluation needs to take into account the whole food supply chain and reduce inefficiencies at each point at which the waste arises. In that regard, the formulation of food portion sizes to be served in school catering can have a relevant role in food waste prevention [24, 28, 37-38], based on the assumption that school meals, when not completely consumed, generate food waste.

The aim of this work is to evaluate the meal supply in primary schools in Italy in order to analyse possible points of inefficiency upstream of the food chain, originating in the provisions contained in the contract between municipalities and catering services. More specifically, the analysis focuses on food meal portions in primary schools and their compliance with the standard portions established by National Reference Energy and Nutrient Intake Levels (LARNs) [2]. Compliance with food portions in school canteens is key in terms of its main impact, namely the potential modification of the nutritional and caloric intake of the menu consumed during lunch at school. A secondary impact relates to the generation of food waste at the end of the chain due to inadequate food portions, ending in unconsumed food and consequently increased waste.

2. Methods

Data on food portion sizes contained in the public tenders for school catering were collected between April and June 2017 from the municipality website of each regional capital (hereafter RC) of the 20 Italian regions (Appendix 1), representing a sample of roughly 500.000 primary school students. Note that Italy is divided into 20 administrative 'regions' each with a regional capital (hereafter RC, e.g. Rome in Lazio, Florence in Tuscany), which are further subdivided into 'provinces' and 'municipalities'. Municipalities (i.e. local councils) are responsible for contracting out school meals to caterers.

In practical terms, each municipality selects a catering company (via a tender) with whom it signs a public contract. The information on the catering tender is public and available on the website of each municipality. This document contains specific provisions on the food product characteristics, portion sizes and frequency of consumption. From the information available in the documents regarding the tendering process for primary school meal provision, data on the portions (in grams) of the most representative categories were extracted and classified. The following food categories were included in the analysis:

- **Cereals:** pasta, rice and bread;
- **Dried pulses**;
- **Food of animal origin:** meat, fish, cooked and raw ham;
- **Food of plant origin:** cooked and raw vegetables and fruit.

In terms of food of animal origin, the analysis did not consider eggs, because of its standard portion (one egg, 50 g average) or cheese due to the great variety available with high differences in terms of caloric intake and relative portion size.

To evaluate the degree of homogeneity amongst different regions, the average, minimum and maximum values, standard deviations and relative standard deviations of each individual food category were estimated.

Secondly, the estimation of the adequacy of food portion disposition retrieved in tender documents has been performed by comparing them with standard food portions. The specific benchmarks for the evaluation of meal portion sizes were calculated based on the National Reference Energy and Nutrient Intake Levels (LARNs). The official document of the Italian Society of Human Nutrition (SINU) contains the reference tables for the average daily energy intake for adults and children, and standard portions for adults only. Standard portions are defined as the quantity assumed as reference value by operators and consumers, consistent with cultural tradition and reasonable in size, in line with consumers' expectations. Though the size of standard portion cannot be considered a measure of nutritional adequacy, it has been used as reference since tender documents do not contain specific information on caloric intake of the recipes proposed in school menus.

Due to the lack of data on reference food portions for primary school, SINU's estimation was based on the difference in energy intake for adults (1550 Kcal/die on average) and children (aged 6-10 year: 1100 Kcal/die on average), which resulted in a 30% reduction. Thus, the standard food portions for children was established by reducing the adult food portions proposed by SINU by 30% (Table 2). To test the adherence to standard portions, a one-way analysis of variance (ANOVA) was performed for multiple comparisons combined with Duncan's multiple range test, with significance set at a p value< 0.05.

Table 1. Food Portion. Source: National Reference Energy and Nutrient Intake Levels.

Food Category	Standard Portion Adult (g)	Standard Portion Children 6-10 years (g) (-30% standard portion adult)
Cereals		
Pasta, rice	80	56
Bread	50	35
Pulses		
Dried Pulses	50	35
Food of Animal Origin		
Red meat	100	70
Poultry meat	100	70
Fish	150	105
Cured Meat (Ham)	50	35
Food of Plant Origin		
Cooked vegetables	200	140
Raw vegetables	200	140
Fresh fruits	150	105

In addition, for each RC the *total size* (in grams) was calculated as the sum of all food categories, as well as the *total std size* portion (in grams), as the sum of the reference children's portion of all food categories. The *delta portion size* variable was then estimated from the difference between *total size* and *total std size*.

In order to profile RCs and to verify the existence of different groups based on the variables t*otal size*, *delta portion size*, school meal attendance and obesity rate, a k-means cluster analysis [39], was estimated. All reported analyses were conducted using IBM SPSS Statistics. The occurrence of obesity in children for each Italian region was provided by the National Institute of Health (ISS) [7]. Data on the attendance rate of school meals was retrieved from of the Italian Ministry of Education, Universities and Research [40].

3. Results

3.1. Food Portion Sizes

Table 3 presents the descriptive statistics (means, min and max values and standard deviation) of data regarding the portion sizes of each food category. The results show a great variability of food portions amongst the RCs analysed.

Table 2. Descriptive statistics of variables.
[1] **RSD (relative standard deviation) =** Std Dev/Mean**.** [2]**Av.Delta Portion=** Mean – std portion.

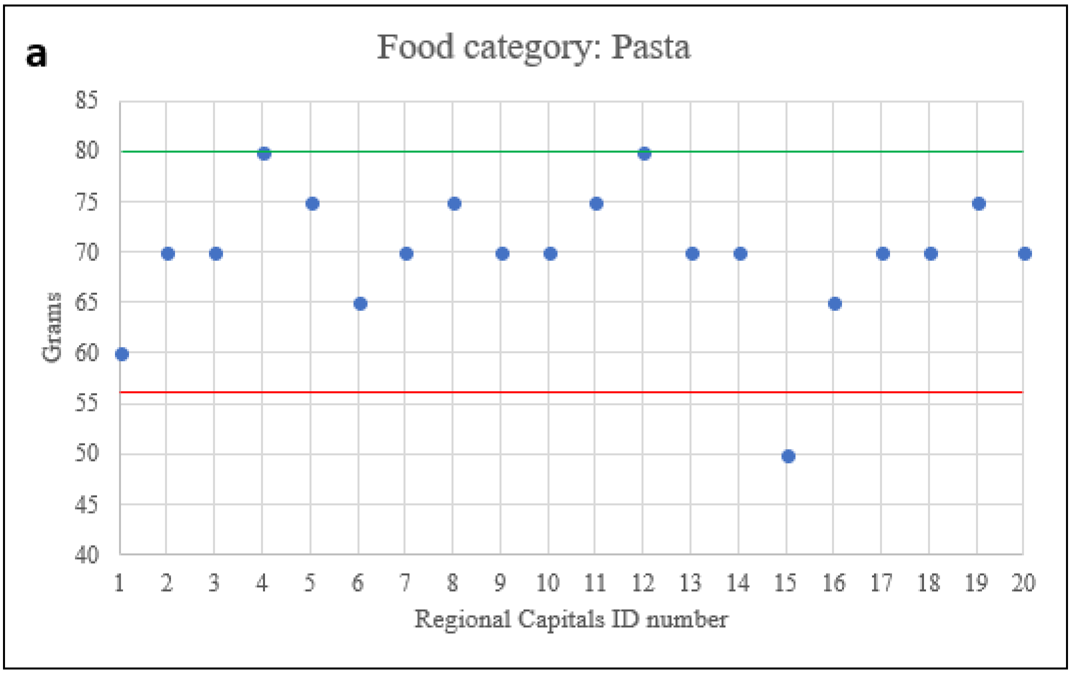
Food Category	Mean (g)	Std Dev	RSD[1] (relative standard deviation)	Min	Max	STD portion (g)	Av.Delta Portion[2]
Pasta	70	6.7	0.10	50	80	56	14
Rice	69.5	8.9	0.13	50	80	56	13.5
Bread	55.8	14.1	0.25	40	100	35	20.8
Dried pulses	34.3	9.9	0.29	21	60	35	-0.7
Meat	84.5	18.1	0.21	60	120	70	14.5
Fish	98.5	22.2	0.23	60	120	115	-16.5
Cooked / raw ham	52.3	10.1	0.19	35	75	35	17.3
Cooked vegetables	127.9	37.5	0.29	75	235	140	-12.1
Raw vegetables	101	35.5	0.35	35	150	140	-39
Fresh fruit	150.5	18.5	0.12	130	200	105	45.5

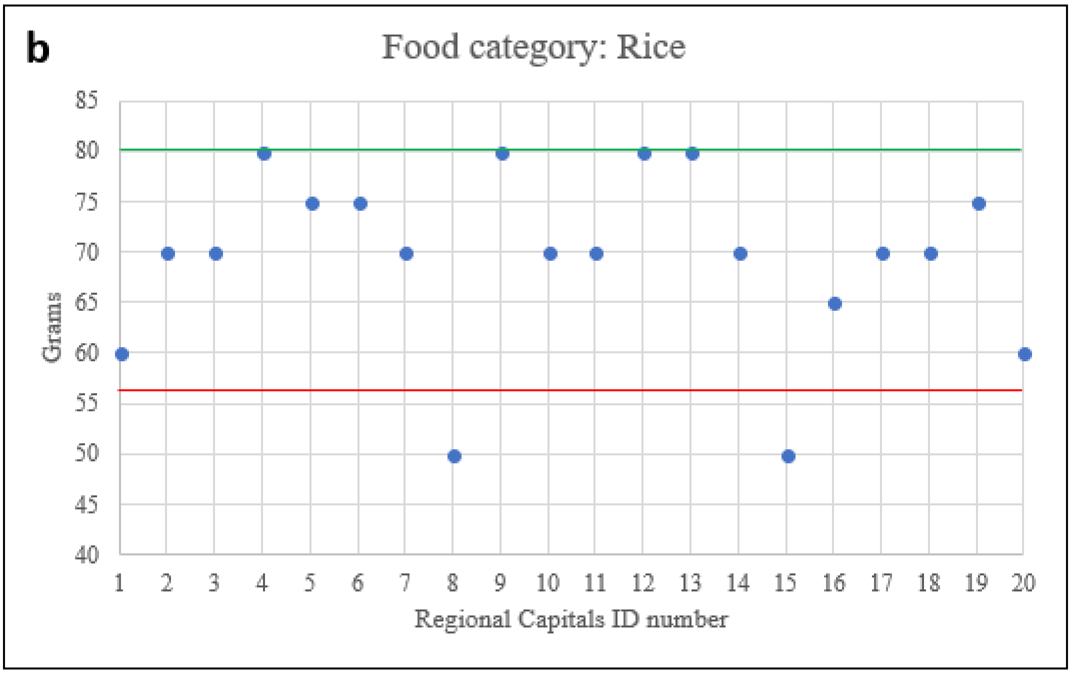
Food categories with highest RSD values (relative standard deviations) were cooked and raw vegetables (0.29 and 0.35 respectively) indicating great levels of heterogeneity in food portions amongst Italian regions. Conversely, pasta and rice portions were more uniform (0.1 and 0.13), although on average bigger than the standard portion. The only food categories characterised by a smaller mean portion are fish, raw vegetables and cooked vegetables, the food categories that mostly contribute to healthy food consumption, whereas calorie-dense food categories (carbohydrates) often exceed the reference portion size.

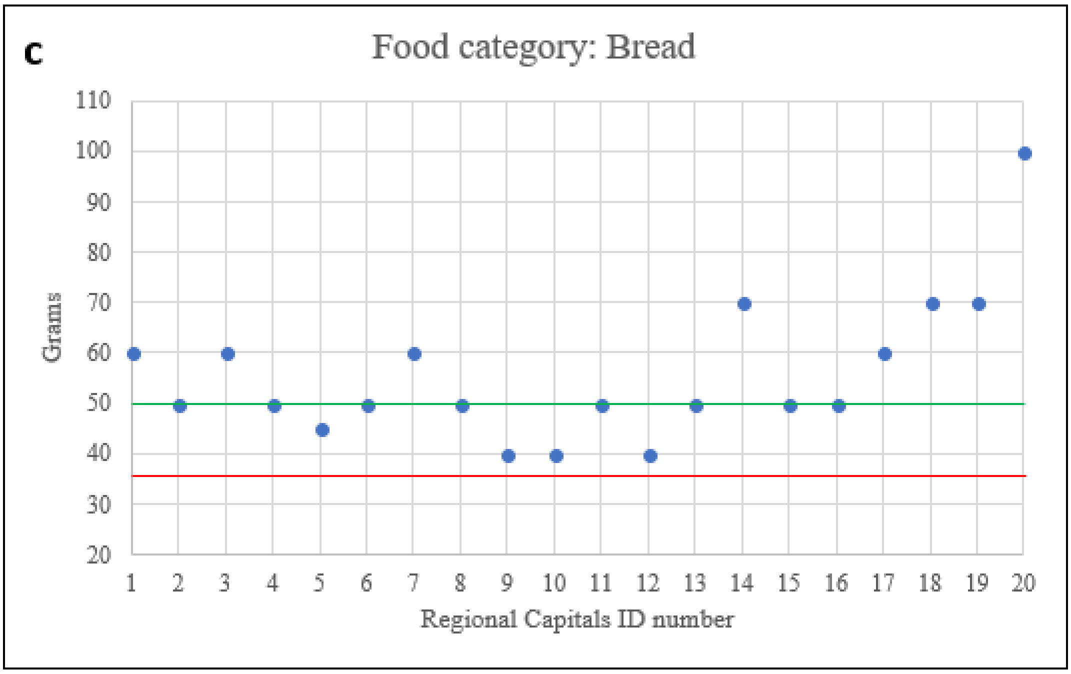
Cereals and Pulses

Figure 1 shows the results for the cereals: pasta (a), rice (b) bread (c) and pulses (d) for each RC. Regarding pasta, the results highlighted statistically significant differences ($F = 2.18$, $P < 0.05$) amongst the RCs and the std portion (adults and children). In 16 cases (IDs: 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 19, and 20) the average portion of pasta showed values that outweighed the children's std portion ranging from 70 grams (ID 2, 3, 4, 7, 9, 10 13, 18 and 20) to 80 grams (IDs 4 and 12), which corresponds to adult standard. Similar values were found for rice portions, which showed statistically significant differences ($F = 3.40$, $P < 0.001$) between the data collected and the reference std portion (both adult and children). Only in five RCs (IDs: 1, 8, 15, 16 and 20) the average values were in line with the children's std portion (56 grams). The remaining RCs showed higher average values with a minimum of 70 grams (ID 2, 3, 7, 10, 11, 14, 17 and 18) to a maximum of 80 grams (IDs 4, 8, 12 and 13), which corresponds to the adult std portion (80 grams). Finally, with respect to bread, the cities with the IDs: 1, 3, 7, 17 and 20, had higher average values than children's std portion, with a minimum value of 60 grams (IDs 1, 3, 7 and 17) and a maximum value of 100 grams (ID 20), which was two-fold higher than the adult portion (50 grams). In addition, in this case the differences between the RCs and the LARNs were statistically significant ($F = 7.99$, $P < 0.001$).

As regards dried pulses (F = 100.563, P <0.001), only six RCs (IDs: 8, 9, 16, 18, 19 and 20) were in line with the children's portion size (35g), and most RCs (IDs 1, 2, 3, 7, 10, 13, 14 and 18) remained below the reference value, with only one region (ID 11) highlighted by having far exceeded even the adult std portion (50g).







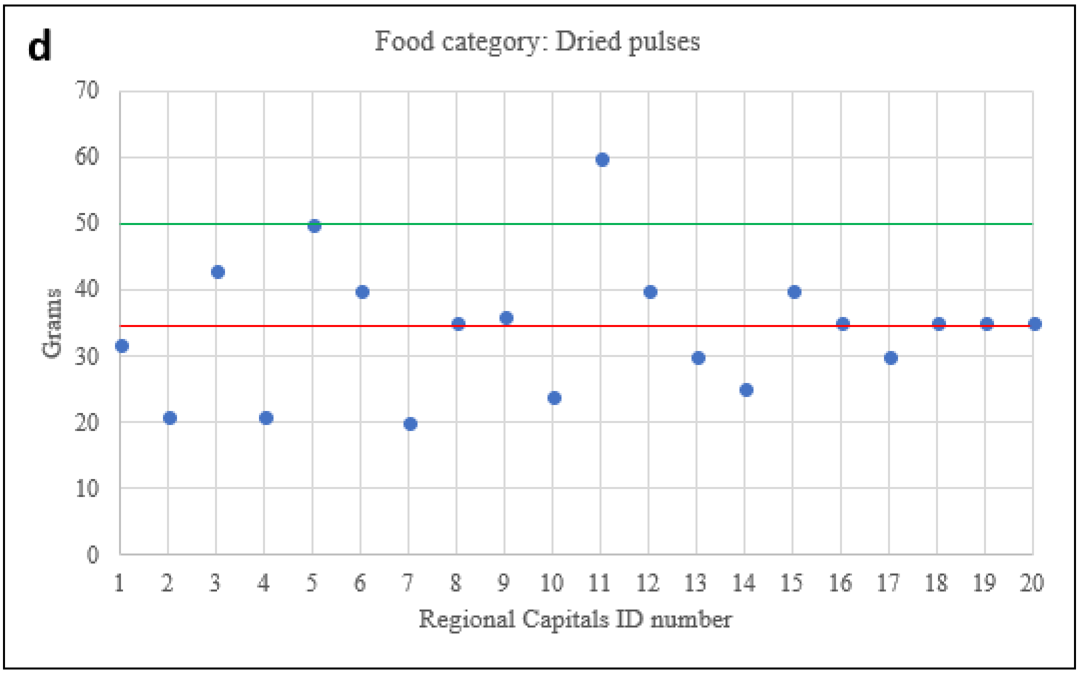


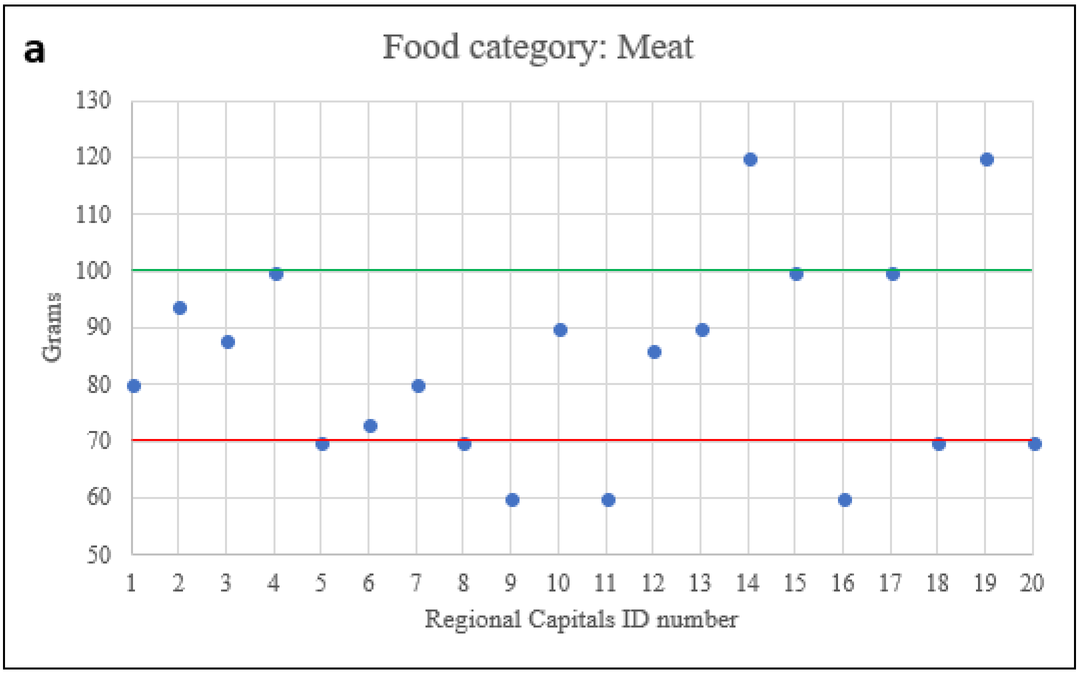
Fig. 1 a, b, c and d. Food category: cereal and pulses, mean values of portion sizes (g) for all RCs. Green line: reference value of adult standard portion; red line: reference value of children standard portion.

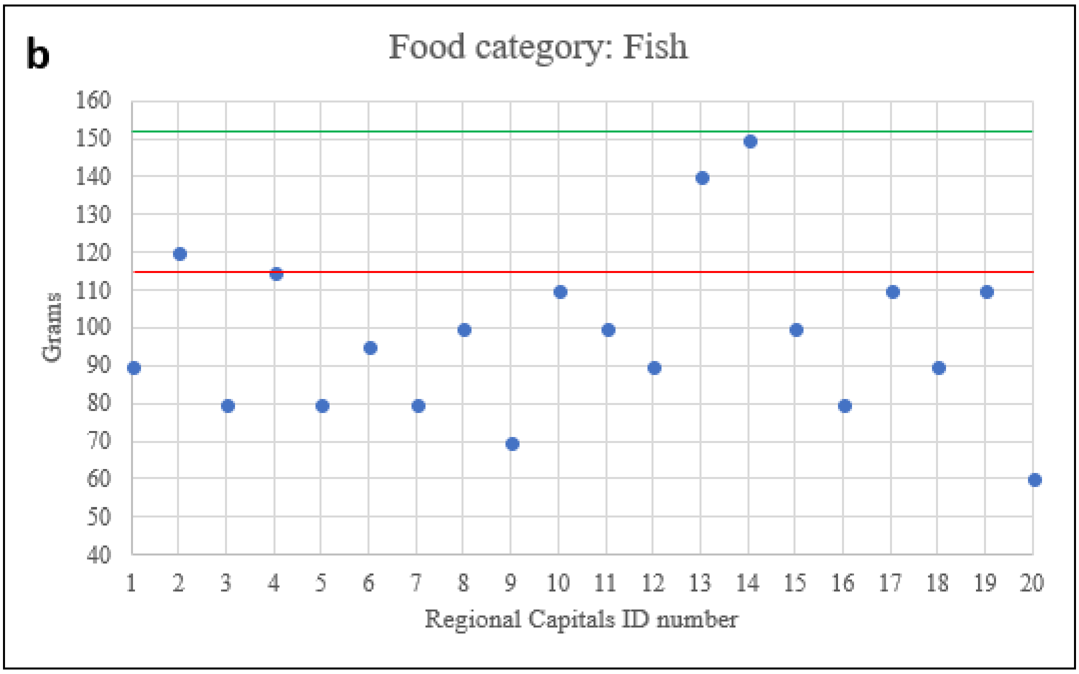
Food of Animal Origin

Figure 2 shows the results for food of animal origin: meat (a), fish (b) and cooked / raw ham (c) for each regional capital. As for meat, the RCs (IDs: 1, 2, 3, 4, 7, 10, 12, 13, 14, 15, 17 and 19) showed higher average values than the children's std portion, ranging from 80 grams (IDs 1 and 7) to 120 grams (IDs 14 and 19). The RCs with IDs (2, 3, 4, 12, 13, 15 and 17) showed comparable values to adult std portion size (100 grams), while the IDs 14 and 19 exceeded the reference adult threshold. The differences were statistically significant (F = 12.50, P <0.001).

The fish portions revealed significant differences (F = 23.26, P <0.001) between the RCs and the reference level (adults and children). In this context the mean values of most of the RCs, except for

IDs 2, 13 and 14, were lower than the children's std portion (115 grams), ranging from 60g (ID 20) to 115g (ID 4). In conclusion, regarding cooked/raw ham, there were statistically significant differences (F = 4.20 P <0.001) between the RCs and the children's std portion size, with values varying from 50 grams (IDs 4, 7, 10 and 11) to 75 grams (ID 13), thus higher than the adult std portion (50g).





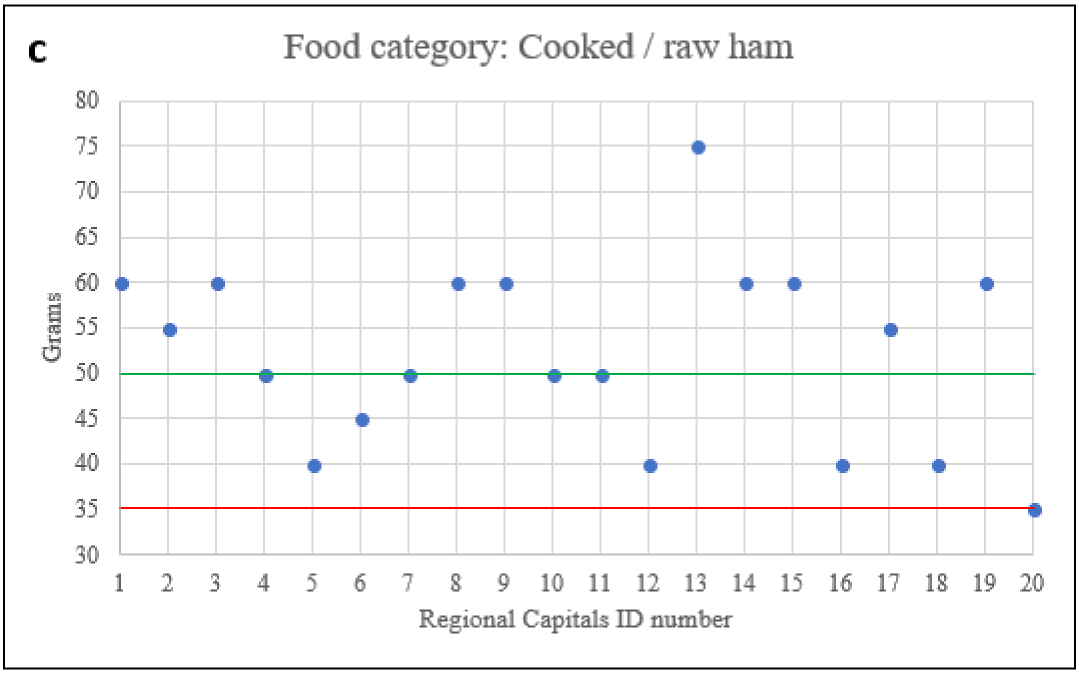
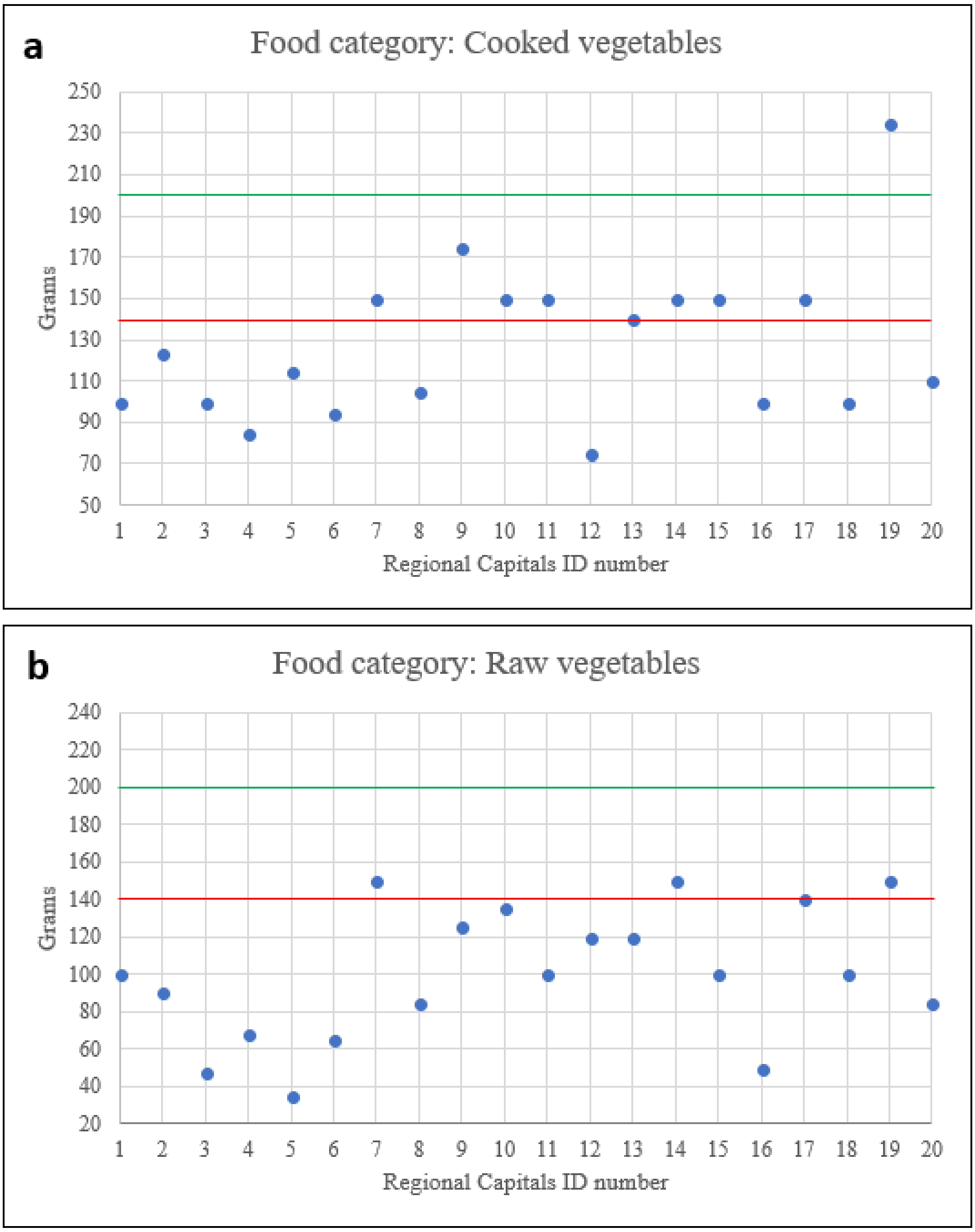


Fig. 2 a, b and c. Food category: food of animal origin, mean portion size values(g) for all RCs. Green line: reference value of adult standard portion; red line: reference value of children standard portion.

Food of Vegetal Origin

Figure 3 shows the results for food of vegetable origin: cooked vegetables (a), raw vegetables (b) and fruit (c) for each regional capital. The cooked vegetable portions showed statistically significant differences (F = 60.44, P <0.001) between the RCs and the reference portion (adults and children). Specifically, the mean values of most of the RCs (IDs 1, 2, 3, 4, 5, 6, 8, 9, 12, 16, 18, 19 and 20) were lower than the children's standard (140 grams) varying from 75g (ID 12) to 123g (ID 2). As regards the raw vegetables, there were statistically significant differences (F = 65.66, P <0.001) between the RCs and the reference portion (adults and children). In this case the values of almost every regional capital showed a lower average than the children's standard (140g), varying from a minimum of 35g (ID 15) to a maximum of 135g (ID 10).

For all the RCs, except for ID 4, fruit (F = 16.95, P <0.001) showed a higher average value than the children's std value (105g).


a
Food category: Cooked vegetables
Grams
250
230
210
190
170
150
130
110
90
70
50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Regional Capitals ID number
b
Food category: Raw vegetables
Grams
240
220
200
180
160
140
120
100
80
60
40
20
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Regional Capitals ID number

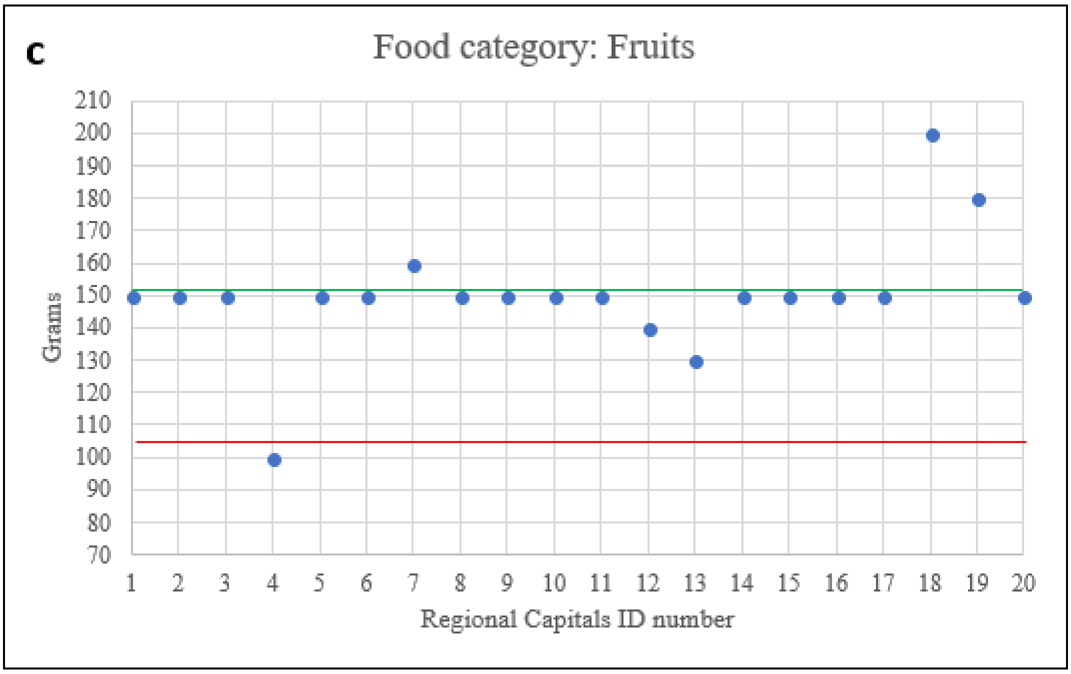


Fig. 3 a, b and c. Food category: food of vegetable origin and fats, mean values of portion sizes (g) for all RC. Green line: reference value of adult standard portion; red line: reference value of children standard portion.

3.2. Meal Portions and Childhood Weight Problems

Table 3 shows the cluster analysis results that were used to determine the segments of RCs that presented different meal portion sizes. A three-cluster solution grouped the RCs based on their conformity to nutritional recommendations (*Delta total* variable), the attendance rate of school meal services at the regional level and the obesity rate.

Cluster 1 represents the group of RCs with a higher value for the sum of the portion of all the food categories included (mean total size =1063 g) and consequently the greatest discrepancy from the reference values (mean Delta total=276). They were characterized as being the RCs with the lowest percentage of children attending school meal services (mean attendance rate= 42.3%), meaning that the majority of pupils in primary schools have lunch at home, instead of consuming meals at school. They also presented the highest level of childhood obesity (mean value 10.6%).

Although they were characterized by lower portion sizes (mean total size =876 g), RCs in Cluster 2 showed a minor but significant discrepancy with reference portions (mean Delta total=89). Compared to Cluster 1, RCs of Cluster 2 were characterized by higher levels of school meal attendance (mean Attendance rate= 51.7%) and lower levels of childhood obesity (mean value 9.8%).

	Cluster		
	1	**2**	**3**
Total size (g) (sum of all food categories)	1063	876	759
Delta total (Total size- Total reference portions size)	276	89	-28
Attendance Rate (%)	42.3	51.7	58.2
RC Obesity rate (%)	10.6	9.8	8.5
Pasta portion size	73	68	71
Rice portion size	73	70	68
Bread portion size	70	52	56
Dried pulses portion size	30	30	36
Meat portion size	120	83	77
Fish portion size	130	102	88
Ham portion size	60	55	48
Cooked vegetables portion size	193	143	98
Raw vegetables portion size	150	118	73
Fruit portion size	165	154	143

Table 3. Output of cluster analysis

Cluster 3 was the most likely to identify healthy RCs, with the lowest portion sizes (mean Total size = 759 g) and the lowest difference with reference values (mean delta total = -28 g). As expected, this high level of compliance with reference portions was coupled with a greater attendance rate of school meal services (mean attendance rate= 58.2%) and the lowest level of childhood obesity (mean value 8.5%).

4. Discussion and Conclusions

The data outlines a significant lack of uniformity in meal portion sizes throughout Italy. Despite the national guidelines containing *ad hoc* estimations of the most adequate nutritional intake for children, the data depict the Italian school meal provision as being highly fragmented in portion sizes. In addition, this work reveals that the portion sizes for school meals in Italy in several cases significantly differ from the standard values for primary schools. In most cases this difference in sizes results in bigger portions, some of which are even bigger than the reference portions for adults, such as for bread. In other cases, such as fish and raw vegetables, the portion sizes are smaller than expected, which introduces additional concerns with respect to the nutritional balance of the school menu. In fact, the data reveal that the food categories that mostly contribute to healthy food consumption, such as fish and vegetables (the food categories which are least liked by children) are offered in smaller portions, whereas calorie-dense food categories (carbohydrates) often exceed the reference portion size.

This discrepancy between standard values and school meal portions has some important implications, considering that several studies reveal that the portion size served to people can predict consumption. Consequently, the provision of larger portion sizes may also play a role in generating over-nutrition and obesity in children.

In addition, the results of the cluster analysis suggest that in the same regions where discrepancy of portions served at school meals was higher, there was a greater incidence of weight problems in children. These results also highlight that in regions where school catering services are offered more extensively, they are also more efficient in terms of compliance with standard portions. In summary, the data highlight that in some regions, portion sizes are normally more in line with national standard portions: these are also regions where the school meal attendance is higher and childhood obesity rates are lower. Thus, the combination of meal portion sizes, school meal attendance rate and obesity in children, as well as their conjoint analysis, provides useful insights into the identification of factors affecting obesity in children in Italy, and consequently, the best approaches to reduce this social issue.

Furthermore, the fact that obesity in children is associated with the non-attendance of school catering highlights the need to implement educational policies involving parents. This would help in creating more nutritionally conscious households, as the literature confirms that family lifestyle and nutritional habits are crucial in obesity prevention [41-43] and that, besides portion size issues, in some cases school meals may be a healthier option than eating at home.

Our results also highlight the second potential effect of food portions, regarding food waste, as the provision of inappropriate food quantities at school can be related to waste generation. In fact, food waste may be influenced by errors in menu planning, an incorrect estimation of the number of meals as well as the food selection (i.e. vegetable and fish are food categories that possibly contribute more to food waste, as they are not well-liked by children) and planning portions.

In summary, there are many different factors that affect the sustainability of school meals and this work highlights that portion size needs to be considered. In addition, general food waste may be significantly diminished by reducing portions, adjusting them to children's nutritional needs and at the same time reducing negative social and environmental impacts: excess edible food can be donated to charitable organizations.

Thus, food education programmes in schools and the development of new best practices could also contribute to substantial increases in the food donations. In terms of policy implications, strategies to better implement dietary guidelines for nutrition in schools could be included in the food waste reduction action plan. Although national guidelines already exist, this work suggests that they are scarcely adopted or implemented.

Appendix 1. Italian regions classified according to their geographical position and related variables.

	ID	Region	RC	N. primary school students (public schools)	Total size (g)	Obesity (%)	Attendance rate (%)
Northern Italy	1	Valle d'Aosta	Aosta	5.606	778	4,2	68,1
	2	Piedmont	Torino	31.751	844	6	71,2
	3	Lombardy	Milano	43.252	769	5,6	68,4
	4	Liguria	Genova	19.456	752	6,4	70,1
	5	South Tyrol	Bolzano	3.037	735	5,2	100,0
	6	Veneto	Venezia	19.220	752	5,7	58,4
	7	Friuli-Venezia Giulia	Trieste	6.862	890	5	67,6
	8	Emilia Romagna	Bologna	12.051	780	7,7	61,1
Central Italy	9	Tuscany	Firenze	12.961	852	5,6	67,1
	10	Lazio	Roma	204.944	886	9,6	55,6
	11	Umbria	Perugia	7.588	865	9,2	46,2
	12	Marche	Ancona	4.208	791	10,4	42,0
	13	Abruzzo	L'Aquila	2.495	925	10,4	42,4
	14	Molise	Campobasso	2.294	1015	15,7	30,7
Southern Italy	15	Basilicata	Potenza	2.963	850	13,1	51,5
	16	Campania	Napoli	42.605	695	17,9	35,4
	17	Apulia	Bari	13.750	926	12,6	26,9
	18	Calabria	Catanzaro	4.080	845	16,4	36,9
Islands	19	Sardinia	Cagliari	15.711	1110	5,5	53,9
	20	Sicily	Palermo	31.981	775	13	20,0

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FEED HUNGRY PEOPLE

3 | DONATE EXTRA FOOD TO FOOD BANKS

Brief Introduction to the Scientific Works

In this section my scientific studies focus on food surplus donations to people in need.
The section is divided into two scientific papers and an applicative study:

- The first study examines hazards identification and potential risk analysis in the phases of recovery, collection, storage and redistribution of food surplus conducted by Charitable Organizations, with the aim to guarantee food safety among this supply chain.
- In the second study, thanks to a scientific evaluation of the third sector, is presented the Manual of Good Procedures for Charitable Organizations validated by Italian Ministry of Health in conformity to Regulation (EC) No. 852/2004.
- The third study is an applicative project, in which the basis of the dispositions contained in the manual of Good Practices for Charitable Organizations has enabled the writing of a simplified H.A.C.C.P system for Centro di Raccolta Solidale per il Diritto al Cibo of Lodi. Subsequently, a training course on good hygiene practices was conducted to help the volunteers during the recovery, and a specific nutrition course was also provided to help guarantee the correct balance of food parcels distributed to the hungry.

Risk Assessment in the Recovery of Food for Social Solidarity's Purpose: Preliminary Data

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The paper is reported keeping the reference style indicated by the journal guidelines

Risk Assessment in the Recovery of Food for Social Solidarity’s Purpose: Preliminary Data

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Abstract

The most recent study, conducted by Politecnico of Milan on food surplus management in Italy, entitled "Surplus Food Management Against Food Waste", shows that in the Italian food supply chain, the food surplus is around to 5.5 million tonnes / year, and the amount of food wasted is around to 5.1 million tons/year.

During 2015, the charitable organizations (COs) belonging to Italian Food Bank Network, active in recovering and distributing food for social solidarity’s purposes, reused 381.345 tons of food from 2.292 donors.

The main supplying sources of the Banco Alimentare Network are: food industries, organized large-scale retail trade and collective catering service.

The aim of this study was to analyze several aspects of the food surplus recovery thanks to the collaboration with the Fondazione Banco Alimentare Onlus (FBAO) and Caritas Italiana.

In particular, two main features were analyzed in the food recovery chain: (i) the microbiological profiles of specific food categories recovered from catering service with the aim to evaluate their conformity in relation to food safety and process criteria.

For this purpose, 11 samples were analyzed in four different moments:

- T0: same day of the collection;
- T1: after four hours of storage at 4°C;
- T2: 24 hours from the collection (storage at 4°C);
- T3: after four days at frozen storage (-18°C).

For all samples several were investigated microbiological parameters: enumeration of Mesophilic aerobic bacteria (AFNOR 3M 01/1-09/89), enumeration of *Enterobacteriaceae* (AFNOR 3M 01/06-09/97), enumeration of *E. coli* (AFNOR 3M 01/08-06/01), enumeration of coagulase-positive *Staphylococci* (AFNOR 3M 01/ 9-04/03), enumeration of *Bacillus cereus* (UNI EN ISO 7932:2005), research of *Salmonella* spp. (UNI EN ISO 6579:2008) and research of *Listeria monocytogenes* (AFNOR BRD 07/4-09/98).

Furthermore, (ii) the volunteer’s knowledge on the correct hygienic procedures during the recovery, were evaluated by the 71 questionnaires with the aim to prevent foodborne diseases.

The results show that the recovery of surplus food from catering service providers and their reuse at COs should be planned with correct procedures, and the volunteer’s knowledge on the hygienic aspects appear to be a critical point.

Food recovery and charitable activities require an appropriate assessment and careful risk analysis, in order to manage the complexity of non profit organization.

1. Introduction

FAO (*Food and Agriculture Organization*) estimates that each year one-third of all food produced for human consumption in the world is lost or wasted and this represents a missed opportunity to improve global food security (FAO, 2013). For this reason, the food surplus recovery for solidarity purposes is an immediate instrument to respond to the problem of food poverty at national and international level.

The latest data from the Organization for Economic Co-operation and Development (OECD) show that the food poverty is paradoxically related to the food waste and surplus (OECD, 2013).

The amount of food wasted each year in Italy is around 5.1 million tons, of which the 53% of food waste is generated by economic players in the sector, the 47% in households and only 500.000 tons are recovered (9% of food surplus).

The "paradox of lack in abundance" and the phenomena of surplus and food waste is ethically indefensible if had not been created the possibility to transform this contradiction in a positive opportunity: the creation of Food Banks.

Food Banks are nonprofit charitable organizations that are active in recovering and distributing food to people in need; these activities are possible thanks to the work of volunteers and donors of large amount of surplus.

The first Food Bank (St. Mary's) was head quartered in Phoenix (Arizona- USA) in 1967 and was founded from John van Hengel.

In Europe the first Food Bank was created in Brussels, subsequently the requirement to speak with one voice to European institutions and international companies became necessary, the creation of the European Federation of Food Banks (FEBA's) in 1986.

The most important Food Banks in Italy are represented by Caritas Italiana and Fondazione Banco Alimentare Onlus. Caritas Italiana is a pastoral organization of the Italian Bishop's Conference, is connected with 220 diocesan Caritas, and is committed through their daily activities to support the neediest people in food poverty. Fondazione Banco Alimentare Onlus (FBAO) was founded in Milan in 1989 and obtained the Onlus qualification in 1999. The foundation coordinates a network of 22 organizations spread all over the country.

FBAO serves 8.898 charitable institutes assisting people in need, while Caritas Italiana has 2.832 Caritas centers. Together they represent nearly 70% of all food assistance provided in Italy.

FEBA, between 1988 and 1992, supported the development of Food Banks in Spain, Italy, Ireland then followed by Portugal, Poland, Greece and Luxembourg from 1994 to 2001. Since 2004, Hungary, the Czech Republic, Slovakia, the United Kingdom, Lithuania and Serbia have joined the network, followed in 2010 and 2011 by the Netherlands, Switzerland, Estonia and Denmark, in 2013 by Bulgaria and Ukraine and by Norway in 2014.

The mission of Banco Alimentare Network is to recover surplus food, still perfectly edible, from food industry, Organized Large Scale Retail Trade and distribute it to the charitable organizations. Several years ago, the "Siticibo" project was born. Thanks to this project, Banco Alimentare can recover non-exposed food through organized catering and mass distribution at the conclusion of the public and private events.

The Banco Alimentare Network's activity is possible thanks to the work of over 1.7000 volunteers. The activities conducted by the nonprofit organizations are permitted and protected from specific law, such as the Law 155/2003 known "Good Samaritan Act", this law enshrines that nonprofit recognized organizations which work for solidarity purposes in accordance with Article 10 of the Legislative Decree of 4th December 1997, n. 460, ff.as amended, and which freely distribute foodstuff to indigents for charitable purposes, are equalized to final consumers. This law, in

conformity to Article 21 of Regulation (EC) n. 178/2002 and civil liability laws previously referred, exceptionally states that the donor is free of possible legal actions arising from given products.
Nonprofit organizations manage food under respect of the European food safety regulation, and, in this specific case, the European food safety legislation provides the application of simplified procedures according to the level of complexity of each Charitable Organization (CO) and permits the elaborationand distribution of Good Hygiene Practices Manuals according to Regulation (EC) n. 852/2004.
In fact, the CO*s* are considered a special category of food business operators, which differ from for-profit businesses in their charitable system of collection and distribution; the most important characteristics being:
the free nature of their activity distinguishes their social scope, the great variety of foods handled, high number and turnover of volunteers with different educational backgrounds, food donated to people in need, the great variety of donors, and the lack of scientific studies about the second life of foodstuff for charitable purposes.
The following items were investigated: (i) the knowledge of food safety of volunteers involved in recovery activities and (ii) the hygienic status of food recovery from private catering at the end of the event, in order to determine, in four following categories (second life) and under several different preservation's terms, the right way for charitable organizations to prevent foodborne disease outbreaks in people in need.
100 questionnaires were distributed to volunteers of 2 Charitable Organizations, distributed throughout Italian territory, and only 71 questionnaires were collected in a complete and anonymous form.

2. Materials and Methods

2.1. Sample Collection

The samples collected at the end of a private catering, were transported to the Laboratory of Food Inspection in a refrigerated termobox at 4°C (±2), and were analyzed in 4 differentcategories: (i) (T0) same day of the collection, (ii) (T1) after four hours of storage at 4°C, (iii) (T2) 24 hours from the collection (storage at 4°C (±2)) and (iv)(T3) after four days at frozen storage (-18°C).
Each food samples (approximately 1 kg) were divided into 4 aliquots.
The samples were divided into 2 categories according to Ce.I.R.S.A guidelines, (Centro Interdipartimentale di Ricerca e Documentazione sulla Sicurezza Alimentare/ Interdepartmental Research and Documentation Centre of Food Safety):
Category A: multi – ingredients preparation cooked ready-to- eat samples.
Specifically, the samples collected were: n°1 (lasagna), sample n°2 (strudel with ham and cheese), sample n°3 (ravioli with meat), sample n°4 (potato dumplings) and sample n°5 (omelet with vegetables).
Category B: multi – ingredients preparation ready- to- eat, to be eaten uncooked or some raw ingredients samples.
Specifically, the samples collected were: sample n°6 (rise salad), sample n°7(wheat salad), sample n°8 (Greek salad), sample n°9 (roast beef), sample n°10 (cous cous with vegetables) and sample n°11 (lemon mousse).
The food samples were preserved (up to 4 hours) in closed gastronorm and the storage temperature were: Category A at ≥+60 °C and Category B at ≤10°C.
The food samples were not exposed at room temperature during the event.

2.2. Microbiological Analyses

The microbiological analyses focused on pathogenic, potential pathogenic microorganism and hygienic markers.

In particular, enumeration of Mesophilic aerobic bacteria, enumeration of *Enterobacteriaceae*, enumeration of coagulase-positive *Staphylococci* (CPS), enumeration of *Bacillus cereus*, enumeration of *Escherichia coli*, and the research of *Salmonella* spp and *Listeria monocytogenes* were investigated.

For the food samples, an analytical unit (10 g) was aseptically taken from each unit, added to 90 ml of sterile diluent solution (0.85% NaCl and 0.1% peptone), and homogenized in a stomacher (Star Blender Digital- EUplug 710-0958) for 1 min at room temperature and then serial 10-fold dilutions were prepared in a sterile saline solution. Mesophilic aerobic plate counts (APC) and *Enterobacteriaceae* plate counts were enumerated using a Petrifilm_ Aerobic Count (3M, St. Paul, Minnesota, USA), following the: AFNOR 3M 01/1-09/89 and AFNOR 3M 01/06-09/97 respectively. Petrifilm_ plates were also used to determine *E. coli* (EC), and CPS, in accordance with the following methods: AFNOR 3M 01/08-06/01 and AFNOR 3M 01/ 9-04/03, respectively. *A bacillus cereus* count was enumerated according to: UNI EN ISO 7932:2005. *Salmonella* spp. detection (analytical unit: 25 g) was carried out using UNI EN ISO 6579:2008 and the presence was confirmed by an API 20E system (Biomerieux, Marcy l'Etoile, France). The detection of *L. monocytogenes* (analytical unit: 25 g) was performed according to AFNOR BRD 07/4-09/98 and the presence was confirmed according to the AOAC N.060402 (MID 67).

2.3. Questionnaire Formulation

The aim of the questionnaire was to investigate the volunteer's knowledge about good hygiene practices in food recovery supply chain.

The questionnaire was divided in two sections: the first one related to characteristics of survey respondents, the second one composed of ten questions.

The first section pertained to personal information: age, sex, educational qualification, the role in the COs organizational chart and their own interest on hygienic aspects related to recovery activities.

The second one was about: knowledge of hygienic prerequisites, food borne diseases, labeling, traceability, and good manufacturing practices (GMPs), to evaluate the volunteer's knowledge were formulated through the questions described in table 1.

The questionnaires were distributed to all the volunteers, who carry out their activities permanently, at the two different CO's, (group n°1 and group n°2).

A total of 100 questionnaires were distributed. In particular: group n° 1 received 70 questionnaires and group n° 2 received 30 questionnaires.

At the end of the survey results were compiled from 50 questionnaires and 21 questionnaires respectively for the group n° 1 and group n° 2.

Furthermore, all the volunteers who completed the questionnaires have not participated in specific training on good recovery practices.

All data derived from the questionnaires were calculated using SPSS (SPSS/PC Statistics 18.0 SPSS Inc., Chicago, IL). Data are presented as percentage of correct reply.

Table 1. Survey questions

Topic	Questions
Knowledge on hygienic prerequisites	1. What are the basic steps for washing hands? 2. What are the correct hygienic procedures for handling of food?
Knowledge on food borne diseases	3. What is a food borne illness? 4. What are the pathogenic that can cause foodborne diseases? 5. What food has a greater contamination risk with Salmonella species?
Knowledge on labeling	6. What is the meaning of *best before?* 7. What is the meaning of *expiry date?*
Knowledge on traceability	8. What are the correct procedures of food registration in incoming and outgoing?
Knowledge on GMPs	9. What are the correct storage temperatures of perishable food? 10. What is the correct sequence of the sanitization procedures?

GMPs, good manufacturing practices.

3. Results

3.1. Microbiological Results

In table 2 are represented the critical limits of the Category A and B and their evaluation standard (Ce.I.R.S.A guidelines)

The microbiological results are represented in table 3, and the data for both categories are expressed in relation to the evaluation in four different moments (T0, T1, T2, T3), and for each investigated parameter.

Two food samples (n° 7: wheat salad and n° 9: roast beef) belonging to Category B (Multi ingredient preparation – ready to eat uncooked or some raw ingredients samples) showed the presence of *Listeria monocytogenes* and *Salmonella* spp. respectively in T0, T1 and T2.

At T4, after freezing for four days, both the food samples were in compliance.

The food samples n° 10 (cous cous with vegetables) shows that for *Bacillus cereus* and *Enterobacteriaceae* parameters an unsatisfying situation, at T0, T1, T2, T3 and at T0, T1 and T2 respectively.

For the remaining samples of category B, the data showed compliance at T0, T1, T2 and T3, and all food samples belonging to the Category A (Multi ingredient preparation cooked ready to eat sample) were compliant at T0, T1, T2 and T3.

Table 2. Microbiological reference standards for the various foodstuffs submitted to microbiological investigation.

Category	Description	Bacteriological tests	Standard (CFU/g)°			
			Satisfying	Acceptable	Unsatisfying	Potentially damaging
A	Fully cooked food (*e.g.* pasta, vegetables)	Aerobic plate counts	$<10^5$	$10^5 \leq x < 10^6$	$\geq 10^6$	
		Enterobacteriaceae	$<10^2$	$102 \leq x < 10^4$	$\geq 10^4$	
		E. coli	<10	$10 \leq x < 10^2$	$\geq 10^2$	
		Coagulase-positive staphylococci	$<10^2$	$10^2 \leq x < 10^3$	$\geq 10^3$ $\geq 10^5$	
		Bacillus cereus	$<10^2$	$<10^2 \leq x < 10^3$	$\geq 10^3$ $\geq 10^5$	
		Salmonella spp.	Absence in 25 g	Absence in 25 g	Absence in 25 g	Absence in 25 g
		L. monocytogenes	Absence in 25 g	Absence in 25 g	Absence in 25 g	Absence in 25 g
B	Multi-ingredients preparations, consisting of cooked and uncooked food ready for consumption (*e.g.* rice salads, mixed salads)	Aerobic plate counts	$<10^6$	$10^6 \leq x < 10^7$	$\geq 10^7$	
		Enterobacteriaceae	$<10^3$	$10^3 \leq x < 10^4$	$\geq 10^4$	
		E. coli	$<5x10^2$	$5x10^2 \leq x \leq 5x10^3$	$>x10^3$	
		Coagulase-positive staphylococci	$<10^2$	$10^2 \leq x < 10^3$	$\geq 10^3 \geq 10^5$	
		Bacillus cereus	$<10^2$	$10^2 \leq x < 10^3$	$\geq 10^3 \geq 10^5$	
		Salmonella spp.	Absence in 25 g	Absence in 25 g	Absence in 25 g	Absence in 25 g
		L. monocytogenes	Absence in 25 g	Absence in 25 g	Absence in 25 g	Absence in 25 g

CFU, colony forming unit; A, multi-ingredients preparation cooked ready-to-eat samples; B, multi-ingredients preparation ready-to-eat to be eaten uncooked or some raw ingredients samples.

°Ce.I.R.S.A guidelines (http://www.ceirsa.org/pubblicazioni.php)

Table 3. Results of microbiological analyses

Category	Parameters	Standard criteria (S=satisfying, A=acceptable, U= Unsatisfying, PD= Potentially damaging)/Sample time (T0, T1,T2,T3)/ID sample[a]															
		T0				T1				T2				T3			
		S	A	U	PD	S	A	U	PD	S	A	U	PD	S	A	U	PD
A	Aerobic plate counts	1_2_4	3_5			1_2_4	3_5			1_2_4	3_5			1_2_3_4			
	Enterobacteriaceae	1_2_4	3_5			1_2_4	3_5			1_2_4	3_5			1_2_3_4			
	E.coli	1_2_3_4	5			1_2_3_4	5			1_2_3_4	5			1_2_3_4_5			
	Coagulase-positive Staphylococci	1_2_3_4	5			1_2_3_4	5			1_2_3_4	5			1_2_3_4_5			
	Bacillus cereus	1_2_3_4	5			1_2_3_4	5			1_2_3_4	5			1_2_3_4_5			
	Salmonella spp.	1_2_3_4_5				1_2_3_4_5				1_2_3_4_5				1_2_3_4_5			
	L. monocytogenes	1_2_3_4_5				1_2_3_4_5				1_2_3_4_5				1_2_3_4_5			
B	Aerobic plate counts	6_10_11	7_9	8		6_7_10_11	9	8		6_7_10_11	8_9			6_7_8_9_10_11			
	Enterobacteriaceae	11	6_7_8_9	10		6_11	9	7_8_10		6_9_11		7_8_10		6_8_9_11	7_10		
	E.coli	6_7_8_9_10_11				6_7_8_9_10_11				6_7_8_9_10_11				6_7_8_9_10_11			
	Coagulase-positive Staphylococci	6_7_8_9_11	10			6_7_8_9_11	10			6_7_8_9_11	10			6_7_8_9_10_11			
	Bacillus cereus	6_7_8_9_11		10		6_7_8_9_11		10		6_7_8_9_11		10		6_7_8_9_11		10	
	Salmonella spp.	6_7_8_10_11			9	6_7_8_10_11			9	6_7_8_10_11			9	6_7_8_9_10_11			
	L. monocytogenes	6_8_9_10_11			7	6_8_9_10_11			7	6_8_9_10_11			7	6_7_8_9_10_11			

A, multi-ingredients preparation cooked ready-to-eat samples; B, multi-ingredients preparation ready-to-eat to be eaten uncooked or some raw ingredients samples; 1, lasagna; 2, strudel with ham and cheese; 3, ravioli with meat; 4, potato dumplings; 5, omelette with vegetables; 6, rice salad; 7, wheat salad; 8, Greek salad; 9, roast beef; 10, cous cous with vegetables; 11, lemon mousse; S, satisfying; A, acceptable; U, Unsatisfying; PD, potentially damaging

3.2. Results of the Survey

The data from the first section reveal that the volunteers of both groups were primarily male, (63%) mostly over fifty years (58%), with an educational qualification corresponding to high school (57%) and the majority were permanent volunteers (61%).
The distribution of correct replies for the topics, between group 1 and 2 is: knowledge on personal hygienic prerequisites (73%vs81%), foodborne diseases (68%vs79%), labeling (72%vs45%), traceability (7%vs31%) and good manufacturing practice (41%vs57%), and in Figure 1 are showed the correct replies for every single question in CO's volunteers belonging to Group n°1 and n°2.
In particular, the data were not statically compared, because the aim of the study was to describe in detail the the volunteer's current knowledge on food safety and GMPs procedures.

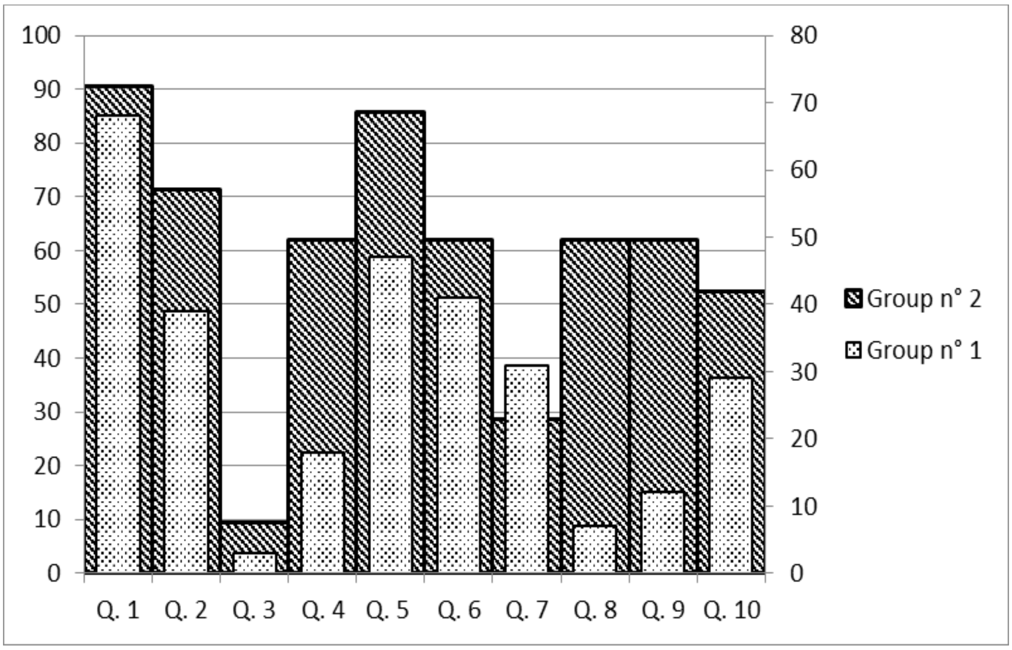

Figure 1. Distribution (%) of correct replies for each question

4. Discussion

The results showed that the samples n° 7 (rise salad) and n° 9 (wheat salad), (18,8% of total food samples), with the presence of *Listeria monocytogenes* and *Salmonella* spp., represent a dangerous situation for public health and that the correct handling procedures are not well applied from catering operators or perhaps the entire flow is out of control.
Also, the amounts of *Enterobacteriaceae* and *Bacillus cereus* in food sample n° 10 (cous cous with vegetables) show that a primary contamination in accordance to a process without use of high temperature (cooking) and represent an important risk situation.
The low (cooling and freezing) storage temperatures did not have any positive influence to improve a food samples such as for sample n°10 (cous cous with vegetables).
All the volunteers (group 1 and group 2) are engaged only in the food recovery phases none in the cooking activity one.
The knowledge of volunteers is lacking especially for group n° 1 on the items about traceability and good manufacturing practices.
The volunteers of group n°2 and n° 1 have an inadequate knowledge on GMPs, and for this reason need further training.

5. Conclusion

The mission of Food Bank is to recover much more food from donors to respond immediately to the nutritional requirements of people in food poverty. CO structure is very complex, and therefore present challenges to handle recovery activities correctly. CO flows are described in the Manual of

good practices for Charitable organizations, validated by the Italian Ministry of Health in compliance with the Regulation (EC) 852/2004 and published on Fondazione Banco Alimentare Onlus, Caritas Italiana and Italian Ministry of Health website.
Food Bank in France established that the food surplus, from catering, stored at 63°C cannot be recovered by COs unless the temperature is not rapidly brought to 10°C, while Caritas Italiana and FBAO, in the Manual of good practices for COs, have established the correct recovery and reuse criteria for food from catering and canteens stored at ≥ 60°C.
The "second life" of surplus, especially if recovered from canteen and catering, is strictly related to the "first life" and the food business operators should evaluate if the food to donate is still in a good and sure state.
Sometimes the ethical approach of food donors, COs and especially of occasional volunteers (no permanent volunteers) is related to the increasing necessity to donate food to needy people, and don't consider risks.
The inadequate knowledge of the volunteers on good manufacturing practices can lead to underestimate the risk in the food recovery chain.
The authors emphasized that all volunteers before handling foods should be trained by safety experts on basic food science, good practices, etc. and must follow the specific regional and national laws on food safety.
On the other hand, the presence of contamination in the sample n° 7, n° 9 and n° 10 at T0, shows the donors should consider the second life of donated food as a primary process and with a system configuration.
First of all, the donors should apply good hygienic practices to ensure a safety donation.
To guarantee the safety all over the food supply chain up to the people in food poverty, the Food Banks should share with donors the complexity of their activities and together plan a safe "second life" of foods recovered.

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Recovery, Collection and Redistribution of Food for charitable purposes: Manual of Good Practices for Charitable Organizations. In accordance with Article 8 of Regulation (EC) 852/2004.

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1. Introduction

Food donation is a form of social assistance with deep roots in the Italian charitable system.

Food donation is the most immediate and concrete way of meeting people's nutritional requirements, which are often of pressing urgency, and is the first step in taking care of their needs as a whole.

In recent years the Italian charitable food system has proved to be efficient and effective in meeting urgent needs given the available resources, although its organisation could certainly be improved. This system consists of tens of thousands of Charitable Organisations (COs) spread throughout Italy, which act for charitable purposes where food demand cannot be met by families or informal networks. In this way, they cover the sectors which the market and public services cannot reach.

COs offer prompt intervention to prevent people from falling into relative or absolute poverty. Although their roles, mission, management and services differ, they have managed to create invaluable support networks founded on donation and thus "unintentionally" improved the efficiency of the system itself.

Within the Italian charitable food system, which can also be regarded as a "relational system", COs and agro-food businesses have been working together for at least 25 years following a "win-win" philosophy; this has given life to the good hygiene practices reported in this manual.

Fondazione Banco Alimentare ONLUS comprises 22 organisations serving 8,898 charitable organizations assisting people in need, while Caritas Italiana has 2,832 Caritas centres. Together, they cover nearly 70% of all food aid provided in Italy.

Given the evident social impact of their actions in favour of those in need, Fondazione Banco Alimentare ONLUS and Caritas Italiana hereby present their "good hygiene practices" in accordance with article 8 of Regulation (EC) 852/2004, with the aim of consolidating food recovery, storage and redistribution along the entire supply chain, thus intercepting the emerging unmet need for food assistance.

2. Scope and Field of Application

The aim of this manual is to propose correct hygiene practices to help non-profit Charitable Organisations (COs) in recovering, collecting, storing and distributing food for charitable purposes in assistance of people in need, while assuring food safety. Correct hygiene practices help maximise the recovery and collection of surplus food from the entire agro-food supply chain, consisting of surplus production, incorrectly labelled products which are unfit for sale but safe for human consumption, food too close to its "use-by-date", food leftovers and surplus from catering and canteen services.

In compliance with Regulation (EC) 178/2002 all food business operators, including non-profit COs distributing food free of charge, are responsible for food safety as applicable to their own operational area. Pursuant to Art. 21 of Regulation (EC) 178/2002, COs are not liable for defective products and under Italian Law 155/2003, given that they are the last link in the food supply chain, they are considered equivalent to final consumers for the purpose of civil liability.

This manual identifies and highlights good hygiene practices designed to ensure the safety of food distributed by COs, in compliance with Article 8 of Regulation (EC) 852/2004 and Article 1, subparagraphs 236 and 237 of Italian Law No. 147/2013. The manual is formulated in line with European and Italian legislation and makes use of the principle of flexibility provided by Regulation (EC) 852/2004. In fact, COs are considered a special category of food business operators, which differ from for-profit businesses in their charitable system of recovery and redistribution as follows:

- The free nature of their activity distinguishes their social scope;
- Limited economic resources;
- Limited possibility of supplier selection;
- Great variety of foods handled which are considered surplus or unfit for sale;
- High number and turnover of volunteers with different professional backgrounds
- Different frequency of food distribution from one organization to another;
- Need for highly flexible management due to the unpredictability of food donations and the great variety of foods recovered and distributed;
- Food donated to people in need.

Given the sector in which it is to be applied, this manual will simplify the routine hygiene practices compatible with acceptable food safety levels.

In this manual, *activity* refers to procedures for the recovery, collection and redistribution of food from the supply chain for charitable purposes as a whole. This manual is intended for **COs whose activity is carried out systematically, requires considerable organization and has a relevant social impact in terms of both the amount of food distributed and the number of beneficiaries.**

The manual thus excludes COs whose activity can be regarded as "private domestic" pursuant to recital 9 of Regulation (EC) 852/2004, given their simpler management system, limited amount of food distributed and low number of beneficiaries. COs of this kind may have the following features:

- **COs that offer periodic food donation** to people in need mainly as "food parcels" containing essential supplies. These foods are generally wrapped, their quantity is usually limited, and they are distributed once/twice a month (or more rarely, weekly) direct to the beneficiaries' homes or from a location normally used for a different purpose and made available free of charge.

- **Foster homes/housing communities** which host limited numbers of minors, people with disabilities, adults in need and/or people with psychosocial problems, usually free of charge.
- **Street outreach teams** of volunteers offering a mobile food distribution service aimed principally at homeless people, often in urban areas. They usually distribute wrapped or fresh food (sandwiches, fruit etc.) and hot drinks (tea and milk) for immediate consumption.

2.1. How to Use this Manual

This manual may be used by CTC and front-line COs (*see terms and definitions*) as a guide to writing instructions and documents for use when carrying out their activity. For meal preparation by front-line COs, see the manuals concerning good hygiene practice in mass catering validated by the Italian Ministry of Health.

3. Terms and Definitions

The definitions in italics are taken from current legislation, while the others are from reference documents for the food business sector.

Chilling: rapid cooling of food to fridge or freezer temperature.

Charitable Organisation (CO): non-profit organisation that distributes food products directly or indirectly to people in need.

Charity-to-charity (CTC) CO: CO with a predominantly logistic activity which distributes food to the front-line COs directly assisting people in need. In Italy, CTC COs include food banks.

Cleaning: use of detergents to remove loose and stubborn dirt from surfaces, through a combination of chemical and physical mechanisms.

Cold Chain: the uninterrupted handling of the product within a low temperature environment (chilled, frozen or quick-frozen) from its production to its distribution or consumption, in order to maintain food safety.

Communities and shelters: residential and/or day (semi-residential) facilities for people in need, providing educational and health services and assistance.

Correct hygiene practices: operating procedures to be applied by food operators to ensure food hygiene.

Course (dish): single portion of food and/or composition of various ingredients, raw or cooked as appropriate and comprising one portion for one final consumer.

Critical Control Point (CCP): *A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level* (Codex Alimentarius 2003, Appendix).

Cross Contamination: situation where hygienically safe food, water or air comes into contact with products, materials, instruments, water or air from contaminated areas and/or equipment.

Disinfection: bacteriostatic and/or bactericidal chemical or physical agents adopted to eliminate or inactivate potentially pathogenic microorganisms.

Disinfestation: all procedures and methods adopted to eliminate pests (particularly rodents, birds, insects).

Donation: Food freely given for charitable purposes.

Final consumer: *the ultimate consumer of a foodstuff who will not use the food as part of any food business operation or activity.* (art. 3 of Regulation (EC) 178/2002)

Flow Diagram: *a systematic representation of the sequence of steps or operations used in the production or manufacture of a particular food item which is subject to hazard and risk analysis.* (Codex Alimentarius 2003, paragraph 2.3).

Food (or foodstuff): *any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans. It includes drink, chewing gum and any substance, including water, intentionally incorporated into the food during its manufacture, preparation or treatment.* (art. 2 of Regulation (EC) 178/2002).

Food Banks: in Italy, charity-to-charity COs that recover surplus food and/or collect foodstuffs and foodstuffs and distribute them free of charge to front-line charities and non-profit organisations.

Food business: a*ny undertaking, whether for profit or not and whether public or private, carrying out any of the activities related to any stage of production, processing and distribution of food.* (art. 3 of Regulation (EC) 178/2002)

Food business operator (FBO): *the natural or legal persons responsible for ensuring that the requirements of food law are met within the food business under their control.* (art. 3 Regulation (EC) 178/2002)

Food Contamination: *the presence or introduction of a hazard.* (art. 2 of Regulation (EC) 852/2004)

Food hygiene: *the measures and conditions necessary to control hazards and to ensure fitness for human consumption of a foodstuff taking into account its intended use.* (art. 2 of Regulation (EC) 852/2004)

Food Parcel: food aid mostly consisting of non-perishable foods packed in bags or small boxes.

Food Recall: action taken to remove from sale, distribution and consumption foods which may pose a safety risk to consumers whenever other measures are insufficient to ensure safety.

Food recovery: free acquisition of food for free distribution to people in need.

Food Safety: the guarantee that food that is prepared and consumed is not hazardous to the health of the final consumers.

Food supply chain: the system of operations and phases involved in the production, processing, distribution, storage and handling of food and its ingredients, from primary harvesting to consumption, including provision, storage and distribution by COs for charitable purposes.

Freezing: the cooling of a food to –18 °C for subsequent storage, so that most of its water content is transformed to ice crystals.

Front-line CO: CO which directly distributes food to people in need, mostly in the form of periodic assistance (food parcels, outreach centres) and provision of meals (street outreach teams, soup kitchens, housing communities and shelters).

Good Hygiene Practices (GHP): *general procedures aimed at guaranteeing general and specific hygiene requirements and consisting of conditions and measures contributing to the safety and hygiene of a product, from primary production to final consumption.* (Italian Ministry of Health - Guidelines for the preparation and development of manuals of Good Operating Practices).

Hazard: *a biological, chemical or physical agent in, or condition of, food or feed with the potential to cause an adverse health effect.* (art. 3 Regulation (EC) 178/2004).

H.A.C.C.P. (Hazard Analysis and Critical Control Point): *a system which identifies, evaluates, and controls hazards which are significant for food safety (Codex Alimentarius 2003).* An information collection and interpretation process whose aim is to identify potentially significant hazards and evaluate their probability (risk) and severity.
Mass retail: sales to final consumers through supermarkets and other intermediate chains.
Meal: one or more portions of food.
Minimum Durability Date (MDD), 'use by' date: *in the case of foods which, from a microbiological point of view, are highly perishable and are therefore likely after a short period to constitute an immediate danger to human health,* the date of minimum durability must be replaced by the 'use by' date (art. 24 of Regulation (EC) 1169/2011). The date by which the food must be eaten. Sale, reuse and distribution of food past its use-by date is prohibited.
Minimum Durability Date (MDD) of a food: *the date until which the food retains its specific properties when properly stored (art. 2 Regulation (EC) 1169/2011): "best before" when the date reports the exact day or "best before end" in all other cases, followed by the date or indication of where the date is reported on another area of the package. The Minimum Durability Date is determined by the producer or packager or, for imported products, by the first seller in the EU, and is added to the label under their direct responsibility. (art. 10 Italian Legislative Decree 109/1992)*
National Guides to good practice: *manuals concerning good practice developed and disseminated by food business sectors in consultation with representatives of parties whose interests may be substantially affected and having regard to relevant codes of practice of the Codex Alimentarius* (art. 8 of Regulation (EC) 852/2004). Guides for use in Italy are validated by the Italian Ministry of Health to verify that they comply with legal requirements and that their content is effectively useful for their intended sector, and that they are thus a suitable tool to facilitate the application of Regulation (CE) No 852/2004 for the sectors and foods of interest. Use of the manuals by food business operators is optional as they are intended as guides to help operators work in compliance with hygiene legislation.
Non-conformity: deviation from a requirement. With regard to food products, the following situations are possible:

- Qualitative non-conformity (e.g. taste or smell not as required by the product standards);
- Legislative non-conformity (e.g. incorrect or incomplete label);
- Unsafe product, thus unfit for consumption.

Outreach centre: facilities which support people in need in difficult situations through food donations and relational assistance to help them regain their autonomy.
Packaging: *the placing of one or more wrapped foodstuffs in a second container, and the latter container itself.* (art. 2 of Regulation (EC) 852/2004)
Person in need: final consumer of food distributed by COs.
Portioning: dividing raw or cooked foods into single or multiple portions.
Prerequisites/ Prerequisite program (PRP): basic conditions and activities necessary to maintain a hygienic environment along the food supply chain to ensure the production, handling and provision of food safe for human consumption.
Provision: food recovery and collection from any food business operator (FBO).
Ready-to-Eat (RTE) meal: meal which is maintained and served at the same temperature at which it was prepared, without any further heating or chilling before serving.
Recovery: acquisition of surplus food from the food supply chain, food industry, mass

retailers, caterers and public services for free distribution to people in need.
Refrigeration: food preserving method involving cooling to a little above freezing point (4 °C).
Risk: *a function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard.* (art. 3 Regulation (EC) 178/2002). Risk is the result of various factors: intrinsic severity of the hazard, the probability that the consumer is actually exposed to the hazard, how such exposure occurs, characteristics of the person exposed.
Risk analysis: *a process consisting of three interconnected components: risk assessment, risk management and risk communication.* (art. 3 of Regulation (EC) 178/2002)
Sanitisation: all cleaning and disinfection activities and procedures whose aim is to sanitise premises, equipment and instruments.
Surplus food: edible excess food, usually close to its “use by” date or wrongly packaged/wrapped or unconsumed/unsold/unserved.
Traceability: *the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution.* (art. 3 Regulation (EC) 178/2002; art. 3 Agreement 2334 of 28/07/2005, Italian Ministry of Health). Traceability is necessary for the correct implementation of food withdrawal or recall.
Wrapping: *the placing of a foodstuff in a wrapper or container in direct contact with the food concerned, and the wrapper or container itself.* (art. 2 of Regulation (EC) 852/2004)
Volunteers: members of public working for a CO of their own free will and free of charge.

4. Reference Legislation

The responsibility for food safety is shared among all food business operators and, individually, in each stage of the food supply chain. For this purpose, the European Union and Italian institutions have issued laws which aim to guarantee food safety within the entire supply chain. The European and Italian laws relevant to this manual are reported below.

4.1. European Laws

Regulation (EC) 178/2002 is the Framework Regulation for Food Safety and lays down definitions and general rules for all food business operators.
Pursuant to Article 14 thereof, food must not be placed on the market if it is unsafe. In this regard, food must be deemed to be unsafe if it is considered to be injurious to health or unfit for human consumption. Pursuant to Article 17 thereof, all food business operators at every stage of production or distribution under their control must ensure food safety. In this regard, the regulation adopts the principle of traceability, under which food business operators must be able to rapidly identify the supplier and recipient of a food to assure both ingoing and outgoing traceability.
All food business operators must collaborate with the competent authorities in assuring food safety through the relevant exchange of information. In the event of unsafe food as defined in Article 14, the information must be clear, transparent and prompt.
The **“Food Hygiene Package”** encompasses **Regulations (EC) 852/2004, 853/2004 and 854/2004.** It lays down food hygiene rules for food business operators and competent authorities. It is based on a number of fundamental principles, such as risk analysis and proportionality.
The recovery, collection and redistribution activities in this manual fall within the scope of **Regulation (EC) 852/2004.** The activity of COs can be compared to “retail” in compliance with

Article 3, point 7 of Regulation (EC) 178/2002 with regard to storage at the point of delivery to the final consumer, including distribution terminals, company canteens and institutional catering.
This activity, therefore, does not fall within the field of application of **Regulation (EC) 853/2004**, according to **Article 1, paragraph 5, letter a)** thereof, which states: *Unless expressly indicated to the contrary, this Regulation shall not apply to retail.* In addition, the vast majority of activities performed by COs are not contemplated in art. 2 thereof, as they usually deal with foods not of animal origin food or composite foods.
With regard to the operations described in this manual, it is also important to refer to **Regulation (EC) 2073/2005** concerning microbiological standards applicable to food products.
Regulation (EC) 1169/2011 on the provision of food information to consumers applies to the foods dealt with this manual.

4.2. National Laws

This manual was written in compliance with the Italian Ministry of Health's Guidelines for the preparation and development of manuals of correct working practices, (http://www.salute.gov.it/imgs/C_17_pubblicazioni_1479_allegato.pdf).
National laws can be divided into three categories: civil, criminal and administrative, as well as laws specifically concerning food donation/distribution for charitable purposes.

4.3. Civil Laws

The **Consumer's Code (Italian Legislative Decree No 206 of 6/9/2005)** implemented Directive 85/374/EEC concerning liability for defective products (Art. 114 et seq.). These laws lay down the liability of whoever markets a defective product (including food), i.e. one that does not meet the expected level of safety.

4.4. Criminal Laws

These far-reaching laws establish what counts as criminal behavior and, as such, pertain to individuals. It should be remembered that criminal liability is personal: each individual working for a CO is responsible for his/her own conduct.

- **Law No 283/1962** sets forth various criminal behaviors applicable to the food sector, including the distribution of food that has been badly stored or that is in any case harmful for human health (see Art. 5).
- **Art. 444 of the Italian Criminal Code** deals with the distribution and consumption of food substances which, while not counterfeit or adulterated, are nonetheless hazardous to public health.

4.5. Administrative Laws

- **Italian Legislative Decree 190/2006** lays down the sanctions for non-compliance with Regulation (EC) 178/2002 (traceability, etc.).
- **Italian Legislative Decree 193/2007** lays down the administrative sanctions for non-compliance with the laws of the Hygiene Package.

4.6. Specific Laws on Food Redistribution for Charitable Purposes

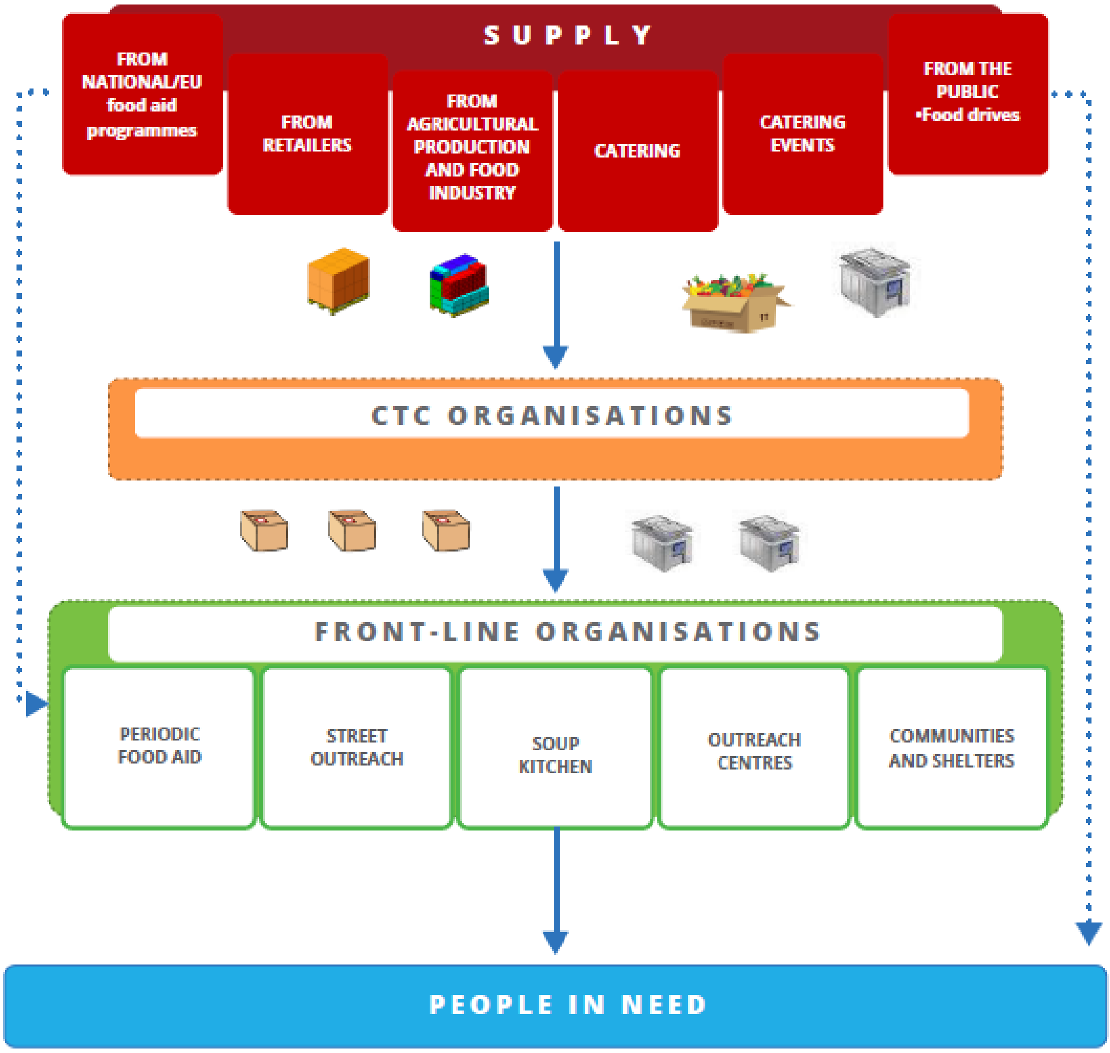
- **Law No 155/2003, the "Good Samaritan Law"**

Establishes that charitable organizations recognized pursuant to Article 10 of Italian Legislative Decree No 460 of 4/12/1997 and subsequent amendments which distribute food free of charge to people in need for charitable purposes are considered equivalent to final consumers. This law, in compliance with Article 21 of Regulation (EC) 178/2002 and the abovementioned civil liability laws, exceptionally provides legal protections from possible lawsuits arising from donated food.

- **Law No 147/2013 art. 1 subparagraphs 236 and 237**

This law recognizes the social value of charities which provide food free of charge to people in need. While reiterating the importance of correct conservation, transport, storage and use of food to all parties involved in the donation, it permits them to prepare a manual of correct hygiene practices in compliance with Regulation (EC) 852/2004.

5. Description of "Recovery System" Chain



The food recovery, collection and redistribution system for charitable purposes described above and hereinafter known as the "recovery system" consists of the following stages:

A. **Food Supply.** This is the initial stage, which involves the acquisition, recovery and collection of surplus food. Sources include national and European food aid programmes, retailers, agricultural producers, the food industry, canteens and catering services, public services, and members of public, such as through the annual Italian food drive day or other minor events, including those organized by individuals.
B. **Transport of recovered and collected food.** The preparation, packaging and amount of food to be transported can all vary. For large volumes, COs may make use of intermodal freight services, while for smaller volumes a small unrefrigerated lorry with insulated containers to ensure correct food preservation may suffice. For highly perishable food requiring immediate distribution, CTC COs can bypass warehouses and transfer food directly to front-line COs. Alternatively, front-line COs can collect food directly from donors.

C. **Storage and conservation.** Food may be stored by both CTC and front-line COs when possible and necessary. CTC COs can store large volumes of food to facilitate the organizational capacity of the front-line COs. Food is stored and kept in warehouses at a controlled temperature or at room temperature, depending on the food type.
D. **Preparation** of food (by CTC COs) and of periodic packages to be distributed directly to those in need (in front-line COs), normally in the form of meals and food parcels.
E. **Redistribution of food to people in need:**
    - prepared food (e.g. sandwiches, cooked meals and drinks)
    - non-perishable/perishable, prepacked/unpackaged food

This manual only considers activities performed directly by COs, as above. It does not cover the primary production of the incoming food or the activities of donors within the food supply chain.

The final recipients of the food aid are families with children, young people, expectant mothers, and vulnerable and poverty-stricken adults and elderly people.

6. Specific Hazards and Risk of Recovery, Collection and Redistribution Activities

Hazard analysis, the first principle of H.A.C.C.P., consists of the identification of hazards in the various phases of the recovery system. Biological, chemical and physical sources of food contamination can all present a risk, i.e. a chance that a hazard is harmful for human health.

Biological hazards are the main hazards to be borne in mind. These include:

- Microorganisms (bacteria, moulds, yeasts, viruses) and/or the substances they produce and release (e.g. toxins);
- Parasites (*Trichinella, Anisakis, Toxoplasma, Giardia, Echinococcus,* etc.) ;
- Pests (birds, rodents and insects).

Microorganisms may derive from:

- Raw materials;
- Equipment and premises;
- Workers;
- Insects and other pests.

The following table lists the main biohazards, sources of contamination, how food becomes contaminated, the most at-risk foods and the diseases caused by the consumption of contaminated foods.

BIOLOGICAL HAZARDS

The multiplication and proliferation of microorganisms is particularly significant under the following conditions:

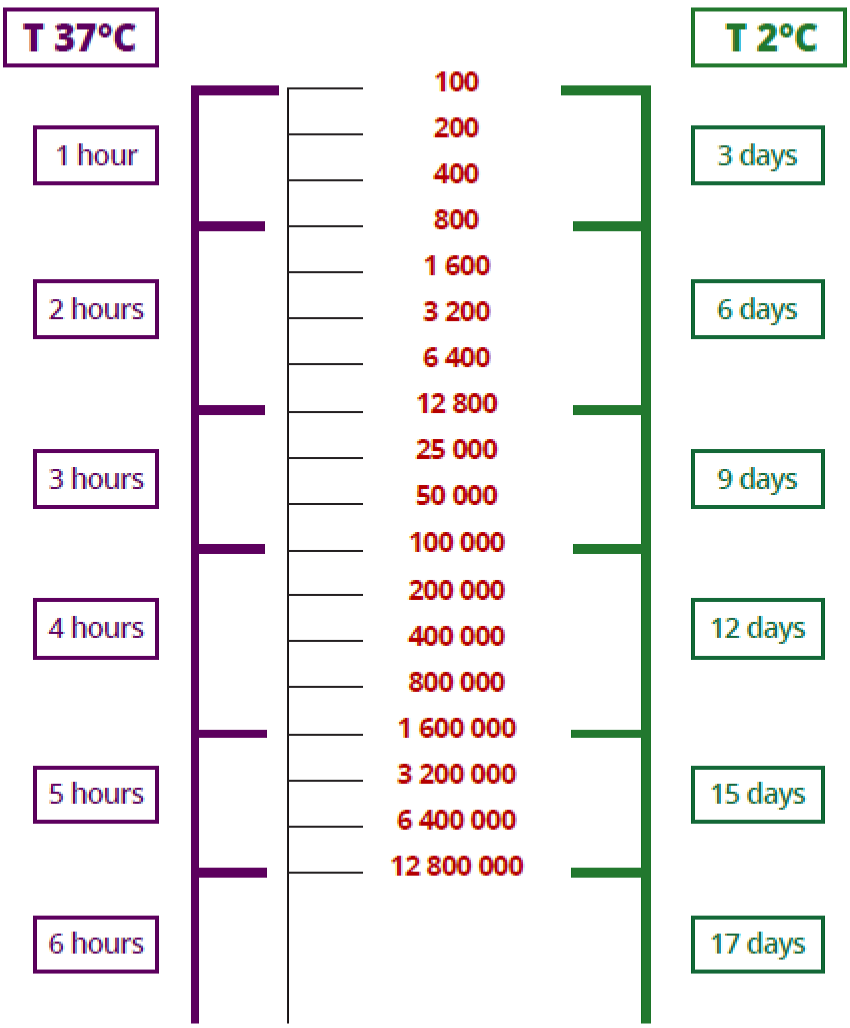
TEMPERATURE
Microorganisms are able to grow between +4 °C and +60 °C, with the optimum between +20 °C and +45 °C. The biological functions of various bacterial species slow down between 0 °C and +4 °C, while their multiplication is reduced or inhibited below -10 °C, between 0 °C and +4 °C and above +60 °C.

WATER
Microorganisms need water to multiply and grow. Perishable foods typically have a high-water content which makes them a favourable medium for bacterial growth. Non-perishable foods generally have a low water content, thus inhibiting bacterial growth.

TIME
Microorganisms multiply rapidly in favourable conditions (temperature, nutrients, water supply, etc.), and can double their number every 20-30 minutes. Long storage times at an unsuitable temperature can lead to rapid microbial proliferation.

EXAMPLE OF BACTERIAL MULTIPLICATION

(Number of microorganisms per gram of product)



Measures to prevent microbial development in food must therefore be taken into account during recovery, collection and redistribution, paying particular attention to suitable storage temperature in relation to storage time.

Chemical hazards arise from the presence of undesirable chemicals, which may derive from the following sources of contamination:

- Detergents and disinfectants used during cleaning and disinfection;
- Pesticide and insecticide residues;
- Medicines or cosmetics which have come into accidental contact with food;
- Chemicals from unsuitable containers used for food transportation.

Physical hazards arise from accidental foreign bodies in food originating from the following sources:

- From raw materials: contaminants, bones, fish bones, plant debris, stones;
- From equipment and premises: metal and plastic fragments, screws, bolts;
- From packaging: glass, wood, plastic fragments;
- From the workplace: dust, rubble, glass fragments from lightbulbs;
- From workers: rings, earrings, bracelets, pens, lighters, buttons, hair, plasters, hairpins, miscellaneous items.

See Chapter 7 for correct hygiene practices and Chapter 9 for food recovery, collection and redistribution criteria to prevent risks for consumers and thus ensure food safety.

7. Correct Hygiene Practices

Adequate food management and operator training, both in accordance with correct hygiene practices, are important to ensure the compliance of the entire process within the Recovery System.

COs must guarantee and verify the suitability of facilities and the conformity of premises. The requirements necessary for the adoption and implementation of good hygiene practices in their facilities are described in this chapter.

7.1. Prerequisites for Food Premises

(CHAPTER I of ANNEX II of Regulation EC 852/2004)

Food premises used for recovery, collection, storage/conservation and redistribution must be built appropriately, be kept clean and maintained in good repair and condition. In all circumstances, cleaning procedures and, where necessary, disinfection of premises and equipment must be adequate to prevent food contamination and comply with the following points:

- The turnover of foodstuffs must be respected. Working areas must be divided to permit a logical throughput, thus avoiding cross-contamination between clean and unclean areas.
- Airborne contamination (dust, smoke, etc.) must be avoided or minimised.
- There must be adequate room to work, so that all operations can be performed hygienically.
- Cleaning procedures must be such as to prevent the accumulation of dirt and contact with contaminated materials.
- Pests and infestations must be prevented.
- Where necessary, temperature-controlled facilities of sufficient capacity must be available to maintain food at the appropriate temperature and enable those temperatures to be monitored and, where necessary, recorded.

RECOMMENDATIONS

- Food storage areas at room temperature should be of sufficient size and be fitted with shelving systems and/or pallets made with easy-to-clean materials. Containers must be raised off the floor and there must be an adequate air flow.
- Cold rooms, fridges and freezers must enable food to be stored and separated according to its nature and temperature requirements (e.g. meat/cured meats/fruit and vegetables); protective systems such as closable containers may be used if necessary.
- Equipment used for refrigeration and freezing/quick freezing must be fitted with accessible, easy-to-read thermometers.

7.1.1. Specific Prerequisites

Provision, storage and redistribution facilities must be provided with:

- Drinking water and washing areas (hands, tools, equipment, etc.).
- Adequate lighting.
- Window screens to prevent the entry of insects and animals, where necessary.
- Sufficient ventilation to prevent condensation, mould and odour.
- Sanitary conveniences for operators, if necessary.

RECOMMENDATIONS

- Check walls and ceilings for mould and damp, peeling paint or plaster and cracks and holes.
- Check floors for loose tiles or worn materials.
- Shelves must be in good condition.
- Equipment (fridges, thermometers, etc.) must always be in good working order.
- Hand washing areas with running drinking water and washing materials must be provided.
- The above measures are applied in line with the CO's activities and type of food handled.

7.1.2. Waste Management Procedure

(CHAPTER VI of annex II of Regulation EC 852/2004)

- Waste must be removed from working areas.
- Waste must be deposited in closable containers.
- Containers must be of an appropriate construction, kept in sound condition, be easy to clean and, where necessary, to disinfect.
- Waste must be disposed of in compliance with any specific measures required by applicable laws.
- Waste storage areas, where present and necessary, must be designed and managed in such a way as to enable them to be kept clean and, where necessary, free of animals and pests.
- All waste must be eliminated in a hygienic and environmentally friendly way in accordance with legislation applicable to that effect and must not constitute a direct or indirect source of contamination.

RECOMMENDATIONS

Food waste and other waste must be kept in easily disinfected closable containers whenever food contamination is a potential risk.

7.1.3. Water Supply Prerequisites

(CHAPTER VII of annex II of Regulation (EC) 852/2004)

- There must be an adequate supply of potable water.
- Where non-potable water is used, for example for fire control, steam production, refrigeration and other similar purposes, it must circulate in a separate duly identified system.

RECOMMENDATIONS

The use of non-potable water is not permitted.

7.1.4. Cleaning and/or Sanitisation Plan

OCs must prepare a suitable cleaning and/or sanitisation plan for working areas, equipment and utensils describing all applicable cleaning and disinfection activities.

Surfaces and equipment must be cleaned and/or disinfected as necessary and in any case as scheduled in the cleaning/sanitisation plan.

RECOMMENDATIONS

- Cleaning and sanitisation are essential, especially when dealing with perishable and bulk food.
- Cleaning procedures should be performed immediately after work has ended to ensure their efficacy:
  - Removal of loose dirt;
  - Wiping and rinsing with clean water to remove dirt;
  - Disinfection and rinsing, if needed;
  - Drying.
- The efficacy must be checked after cleaning by verifying the absence of residues, drops of water, grease and bad smells.

7.1.5. Disinfestation and Rat Control

(CHAPTER IX, Paragraph IV of annex II of Regulation (EC) 852/2004)

Suitable protective and preventive measures must be implemented to impede insects and rodents from carrying pathogenic bacteria from contaminated areas, drains, etc. to food and areas where food is prepared, handled or stored.

As far as is reasonably possible, food handling and storage areas must be designed, sited, built, cleaned and maintained so as to prevent the risk of contamination, especially by insects and animals.

Adequate pest control procedures must be implemented to prevent their access to food handling areas.

RECOMMENDATIONS

- Disinfestation and rat control should be managed by a specialist company with experience in the food sector.
- COs must in any case visually monitor rooms and facilities and surrounding areas for signs of infestation and apply corrective measures as necessary.
- COs must keep all disinfestation and monitoring plan worksheets.

7.2. Prerequisites for Personal Hygiene

(CHAPTER VIII, Paragraph I of Annex II of Regulation (EC) 852/2004)

Even healthy people can carry microorganisms, which live and develop on various body areas such as the hair, nose, mouth, and intestine.

Behaviors which could contaminate food, such as eating and smoking, are forbidden during food storage, conservation and distribution.

All staff working in a food handling area must maintain a high degree of personal cleanliness and wear clean and, where necessary, protective clothing to limit the risk of food

contamination.
All food handlers must be aware of the risk of contamination. CO staff and volunteers must adopt the following preventive measures:

- Refrain from working in the event of any gastrointestinal or respiratory symptoms or illness.
- Keep hands clean.
- Refrain from eating or smoking while working.
- Wear clean garments.

RECOMMENDATIONS

- Wash hands after:
  - Using toilet facilities;
  - Touching dirty surfaces;
  - Blowing nose;
  - Touching waste containers or boxes;
  - Eating;
  - Smoking cleaning;
  - Handling money or using a telephone;
  - Use disposable gloves in the event of any hand wounds.

7.2.1. Staff Training

(CHAPTER XII of ANNEX II of Regulation EC 852/2004)
COs must ensure that:

- Food handlers are trained in food hygiene, in relation to their activity.
- Those responsible for the development and maintenance of permanent procedures based on H.A.C.C.P. principles have adequate qualifications or experience in the sector or have received adequate training in the application of H.A.C.C.P. principles.

RECOMMENDATIONS

- Operators must be adequately informed about hygiene risks connected with their activities and instructed in the correct practices to be adopted.
- Operators must be informed about the preventive measures to be adopted and followed to avoid contamination of food, surfaces and equipment.
- Keep records of all training activities.

7.3. Provision, Transport, Storage/Conservation and Redistribution Requirements

Procedures to establish the suitability of surplus foods destined for distribution by COs to people in need must be implemented.

7.3.1. Food Acceptance Prerequisites

Before any food is accepted, its compliance with the following parameters must be ascertained:

- Compliance with transportation temperatures;
- Compliance of expiry date, MDD;
- Primary packaging is undamaged;
- Compliance of labels;
- Appropriate odour, colour and flavour of food;
- Inspection for any evident signs of spoilage.

See Chapter 9 for additional criteria for the acceptance of different food types.

RECOMMENDATIONS

Non-compliant food must not be accepted but must be returned to the supplier or, if it cannot be returned, disposed of or made unavailable for distribution. It must be segregated and specifically labelled as “DO NOT USE” or “RETURN TO SUPPLIER” or similar.

7.3.2. Food Transport Prerequisites

(CHAPTER IV and CHAPTER IX Paragraph IV of annex II of Regulation (EC) 852/2004)
Transport of food is a critical stage which can facilitate the growth of potentially pathogenic bacteria if the temperature is inadequate.

Food must be transported in clean refrigerated vehicles maintained at the correct temperature. Alternatively, unrefrigerated vehicles may be used as long as they are equipped with insulated containers suitable for food, in accordance with food transport regulations.

RECOMMENDATIONS

- Receptacles in vehicles must be adequately cleaned/disinfected.
- Use insulated containers suitable for the food to be transported.
- Stack products tidily, separating them by category if necessary.
- Make sure that food is packed or wrapped so as to prevent any contact with the external environment or other foods.
- Check for parasites and leaks from damaged containers.
- Check the temperature of the vehicle and of any insulated containers at the start of the journey.
- Keep loading and unloading times to a minimum.
- Ensure that refrigerated vehicles are adequately protected from heat.
- If refrigerated vehicles at a temperature of -18 °C are unavailable for the transportation of frozen food, use suitable insulated containers and ensure maintenance of the cold chain.
- Maintain the food temperature within the range reported in appendix A.1 “Food temperature limits during transportation”.

7.3.3. Food Storage and Conservation Prerequisites

All foods must be placed in their storage area at the appropriate temperature as soon as possible to prevent potential contamination or microbial development.

RECOMMENDATIONS

- Store cleaning materials away from food. Implement a stock rotation system.
- Distribute food according to its perishability: “use by” products approaching their expiry date first, followed by products approaching their “best before” date.
- Dispose of any products beyond their “use by” date.
- Foods that can be stored at room temperature (e.g. tins, flour etc.) must be kept in a cool, dry place, away from heat and direct sunlight and in any case as indicated on the label.
- Chilled and frozen products must be placed in a fridge or freezer at the required temperature as soon as possible to prevent any interruption in the cold chain.
- Keep food raised off the floor using suitable means.

CONSERVATION OF CHILLED AND FROZEN PRODUCTS

Different type of foods may be stored together in the same fridge as long as they are separated using appropriate protective measures. In these situations, store at the lowest temperature required. The maximum storage temperatures for chilled and frozen foods are as reported by the manufacturer on the label.

If this information is not available, use the storage temperatures reported in table A0 in Appendix II.

RECOMMENDATIONS

- Chilled and frozen foods must be stored so as to maintain the cold chain.
- Unportioned seasoned products (whole cheeses and cured meats) may be stored at room temperature for a limited time.

7.3.4. Minimum Durability Date (MDD)

(Chapter IV, part II of article 24 of Regulation (EC) 1169/2011)

Foods which have reached or exceeded a “best before” MDD may be distributed.

RECOMMENDATIONS

- Pay attention to the storage temperature (if indicated or required) and information reported on the label.
- Check that packages are undamaged.
- Make sure there are no signs of bulging, rust, mould, spoilage, insects or foreign bodies.

Recommended uses of MDD-expired-foods are reported in the following table, as a reference tool for the preparation of internal CO checklists for correct recovery and redistribution practices.

COs can also require further procedures to establish the conformity of MDD-expired foods beyond the times indicated in the table, in order to ensure food safety. These include analytical monitoring, detailed information from suppliers, etc.

Product category	Recommended use-by period	Do not use if there are signs of:
Dry pasta, rice, couscous, semolina, flour (biscuits, muesli,breakfast cereals, cornflakes, crackers, breadsticks etc.)	1 - 2 months	Mould or mouldy smell, damaged or open packaging, insects.
Prewrapped baked goods and confectionary (cakes, chocolates, etc.)	1 - 2 months	Mould or mouldy smell, damaged or open packaging, insects.
Flour and cereals	1 - 2 months	Mould or mouldy smell, damaged or open packaging, insects.
Ground coffee, cocoa, tea, herbal teas, etc.	12 months	Mould or mouldy smell, damaged or open packaging, insects.
Oils, fats	12 months	Mould or mouldy smell, damaged or open packaging, insects, rancidity.
Products bottled in oil (tuna, artichokes, mushrooms etc.)	12 months	Fermentation (gas bubbles), bulging lid, mould, damaged or open packaging.
Jams, conserves and tinned products (pulses, tomatoes, soups, vegetables etc.)	1 - 2 months	Bulging, change in colour or smell, mould, damaged or open packaging.
Beverages and UHT beverages (fruit juice, milk etc.)	6 months	Change in taste, smell or colour, damaged or open packaging, sedimentation.
Frozen foods	1 - 2 months	Freezer burn or ice crystals.
Powdered freeze-dried products (milk, barley, etc.) except baby food	6 months	Mould or mouldy smell, damaged or open packaging, insects.
Spices, herbs and sauces (mayonnaise, ketchup, mustard etc.)	6 months	Mould or mouldy smell, damaged or open packaging, insects.
Eggs in shell	1 week when stored in fridge and cooked before consumption	Bad smell (on cracking), cracks in shells, change in colour or consistency of the yolk.
Prewrapped breads (sliced bread etc.)	1 week	Mould or mouldy smell, insects.
Bottled water	12 months	Clouding, change in taste.
Whole meats (cured / cooked/ seasoned)	2 months	Mould or mouldy smell, change in appearance, smell or taste, rancid fat
Packed sliced meat products (cured/ cooked/ seasoned)	1 month	Damaged or open packaging, bulging, change in appearance, smell or taste, mould.

7.3.5. Freezing

Freezing enables the original characteristics of food to be preserved for as long as possible through the application and constant maintenance of cold, thus slowing decay processes and ensuring food safety.

COs may freeze foods if they establish a specific procedure reporting:

- The methods used to carry out the process;
- The storage time of frozen foods.

COs may only freeze previously refrigerated raw materials or semi-processed foods if they will be further processed by the CO itself, such as through cooking, before distribution.

Food may be frozen by a CO if it meets the following requirements:

- It is within its use-by date;
- It is completely unspoiled;
- It is portioned into appropriately sized pieces for the equipment or process used;
- It is protected with food wrap, freezer bags or closed containers to prevent freezer burn; packages must report the product name and the date of freezing;
- It has been rapidly chilled if it was previously heated.

RECOMMENDATIONS

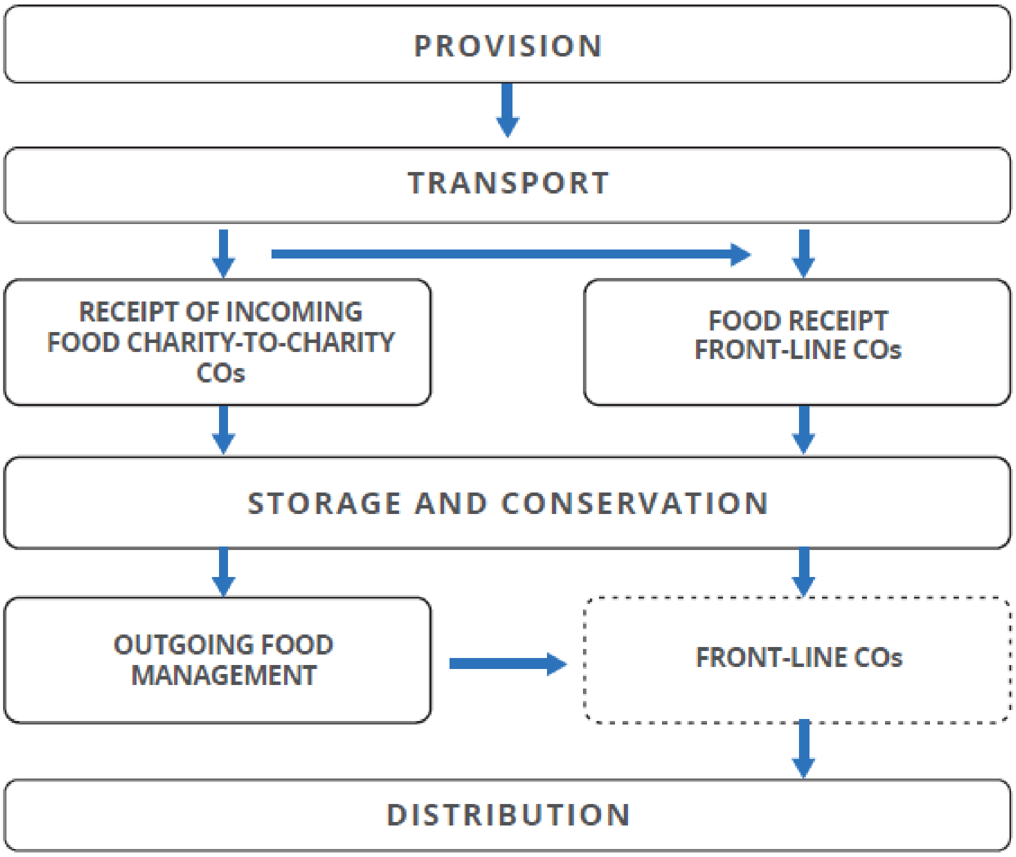
- Raw materials and semi-processed foods may be frozen once only.
- The ingredients of any compound food must be available.
- Food must be kept at below -18 °C.

8. H.A.C.C.P. System

This manual provides COs with the basis for the development of an in-house inspection checklist based on the H.A.C.C.P. system. The checklist can be adapted in line with each CO's nature and activities and takes account of the low complexity of their operations. One of the aims of this manual is to enable the simplified application of the 7 H.A.C.C.P. principles in line with the flexibility permitted by Regulation (EC) 852/2004 and through the correct application of the requirements and correct hygiene practices discussed in Chapters 7 and 9, which will suffice to guarantee the application of the H.A.C.C.P. system.

The following paragraphs report the minimum indications for the development of an in-house inspection checklist. These indications must necessarily be personalised and/or adapted to the organisation, size and activity of each individual CO.

The flow diagram below shows the flow of the main operations/food recovery, collection and storage stages up to their distribution by the CO. This generic diagram can be adapted in line with the variables applicable to each CO.



8.1. Hazard Analysis

Hazard analysis (the first principle of H.A.C.C.P.) involves the evaluation of hazards in all stages of the process, considering epidemiology, microbial ecology and calculation or estimation of probability in order to establish which hazards must be considered in the H.A.C.C.P. food safety management plan. Given the typical application of the recovery system, this manual is limited to general indications based on the evaluations of recovery system operators and on published epidemiological and statistical data.

Chapter 9 discusses three food macro-categories categorized by an attention level of high, moderate or low, identified through the symbols , to be used when handling food in relation to the potential risks and preventive measures to be adopted. Risk analysis considers food production, conservation and origin and intrinsic aspects of the food.

8.2. Critical Control Point (CCP) Identification

Identification of critical control points is the second principle of H.A.C.C.P. This manual presents a brief example in Annex A.3 "Hazard evaluation in the recovery and redistribution stages". It is subdivided by process stage on the basis of the above flow diagram, in which the potential hazards are evaluated for each phase and the relevant chapters of this manual are reported. This approach, which is also permitted by Regulation (EC) 852/2004 considering points 10) and 11) of the recitals concerning simplification, is an alternative to the "decision tree" approach.

8.3. Minimum Documentation and Record Requirements

The documents and records must be adequate for the nature and size of the food business operator.

This manual includes the following **worksheets, documents and minimum records** summarising the application of the requirements:

A.1. Temperature tolerance during transportation;

A.2. Freezing;

A.3. Hazard analysis;

A.4. Disinfestation plan;

A.5. Sanitisation plan;

A.6. Food business operator training;

A.7. Detected non-conformities (NCs);

A.8. List of suppliers;

A.9. Storage temperatures.

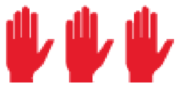
9. Food Recovery, Collection and Management Criteria

The fundamental principle of this manual is the division of foods according to the level of attention which must be observed by operators in relation to the nature of each food, to ensure the correct application of good working practices ensuring the safety of food for human consumption.

As stated in Chapter 8 (H.A.C.C.P.), the parameters for defining the attention level take account of the food production and conservation process and its origin and intrinsic characteristics as well as its category according to CeIRSA (Interdepartmental Centre for Research and Documentation on Food Safety).

THE ATTENTION CATEGORIES ARE AS FOLLOWS:

9.1. High Attention Level



Foods in this category are known as “Fast 60”. “Fast 60” foods are generally recovered by catering establishments and public services. They require high attention due to their typical production and distribution. These foods **have not undergone rapid chilling as they are provided by donors** to COs “as they come” (e.g. cooked pasta or meat dishes, cooked vegetables, rice salads, etc.). For this reason, they **need to be transported rapidly, preferably within 60 minutes** - hence the name “Fast 60”.

THIS CATEGORY INCLUDES:

- Multi-ingredient dishes cooked and ready-to-eat (pasta or meat dishes, etc.)
- Portioned cooked, cured or seasoned meat products
- Portioned dairy products
- Sweet/savoury fresh baked products.

HIGH ATTENTION LEVEL

ACCEPTANCE PARAMETERS

Food must comply with the following on provision:

- Has not already been offered for consumption;
- Kept at temperatures ≥ 60°C for hot meals, ≤ 8°C for cold meals;
- Kept and stored in suitable closed containers;
- Portioned by the donor and packed in appropriate closable containers (e.g. food-grade clingfilm, tinfoil, containers with lids, etc.).

EXCLUSION PARAMETERS

- Meals with non-compliant temperature at the time of collection, as measured by the CO operator;
- Meals based on raw or part-cooked foods of animal origin (steak tartare, rare roast beef, sushi, etc.);
- Meals based on marinated fish;
- Sweet and/or savoury baked products filled with unpasteurized egg-based custards or sauces.

TRANSPORT

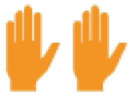
- Food must be transported in insulated containers, differentiated according to the temperature (hot or cold) of the food collected;
- Temperature during transport must be maintained at ≥60 °C for hot food and at ≤8 °C for cold food;
- The transport time between the place of recovery and delivery to front-line COs must not exceed 60 minutes.

MANAGEMENT CRITERIA

Foods may be:

- Consumed within 1 hour of their arrival at the CO;
- Refrigerated and stored at ≤4°C and used preferably within 24 hours of their arrival;
- Frozen, preferably within 1 hour of their arrival.

9.2. Moderate Attention Level



This category includes foods kept in **cold chain conditions** and generally recovered from public or private catering establishments, delicatessens, restaurants and mass retailers.

These foods have undergone rapid chilling by the donor. The attention level is thus related to the product type and storage and use of the cold chain.

THIS CATEGORY INCLUDES:

Meals subjected to rapid chilling:

- Cooked, ready-to-eat, multi-ingredient dishes
- Ready-to-eat, multi-ingredient dishes that are uncooked or contain raw ingredients (e.g. rice salad, couscous, etc.)

Prepacked and fine foods stored in cold chain conditions, such as:

- Prepacked and bulk cured meats
- Prepacked fine foods
- Fresh stuffed pasta
- Prepacked portioned refrigerated meat
- Refrigerated minced meat
- Prepacked whole or filleted fresh fish
- Fish dishes (seafood salad, etc.)
- Fish products (smoked fish, etc.)
- Cooked shellfish and crustaceans
- Fresh pasteurised milk
- Yoghurt
- Cake mixes, puddings, dairy-based desserts
- Ready-to-eat fruits and vegetables
- Butter
- Prepacked portioned fresh cheese (cream cheese, mozzarella, fresh goats cheese, blue cheese, ricotta, cottage cheese, brie, etc.)
- Prepacked portioned mature cheese
- Eggs in shell and egg products

MODERATE ATTENTION LEVEL

ACCEPTANCE PARAMETERS

Food must comply with the following on provision:

- Kept in cold chain at temperatures between +4° and +8 °C;
- Packed in suitable containers, properly labelled or under derogation conditions as described in Chapter 10, paragraph 10.3;
- Food previously displayed in self-service canteens may only be recovered if subjected to rapid chilling.

EXCLUSION PARAMETERS

- Clear signs of spoilage (unpleasant colour and/or odour);
- Damaged packaging which could compromise food safety due to contact with the external environment;
- Expired use-by-date.

TRANSPORT

- Large quantities must be transported in refrigerated vehicles;
- Where different types of foods are to be transported, they must be kept at the temperature required for the most perishable food until arrival at the CO;
- Unrefrigerated vehicles may be used for short journeys and small quantities but insulated containers are mandatory.

MANAGEMENT CRITERIA

- All foods in this category must be stored at ≤4 °C and used as soon as possible; they may be frozen by COs.

9.3. Low Attention Level

This category includes **foods stable at a range of temperatures**, generally recovered from the primary sector (e.g. fruits and vegetables), secondary sector (e.g. food industry), public services and mass retailers. The level of attention is thus related to the production process and the intrinsic characteristics of these foods.

THIS CATEGORY INCLUDES:

- Frozen food
- UHT food (milk, fruit juices)
- Dried food (e.g. spices, dried fruits)
- Tinned and bottled meats, fish, fruits and vegetables
- Fresh unprocessed fruits and vegetables, bread, pasta, rice, baked goods, biscuits, coffee, etc.

LOW ATTENTION LEVEL

ACCEPTANCE PARAMETERS

Food must comply with the following on provision:

- Temperature appropriate for their category;
- Frozen foods must not show signs of defrosting (e.g. presence of liquid);
- No signs of spoilage (unpleasant colour and/or odour, mould);
- Within use-by-date;
- Unopened packages to prevent any contact with external environment,
- Food past its MDD may be recovered, in compliance with the conditions and procedures discussed in Chapter 7.3.4.

TRANSPORT

- Frozen food must be transported in vehicles capable of maintaining a temperature between -18 °C and -15 °C (maximum) to prevent defrosting;
- Fresh, unprocessed fruits and vegetables may be transported at a temperature; between +8 and +10 °C or at room temperature, taking care to protect them from harm;
- Suitable packaged food which does not require cold chain conditions may be transported in unrefrigerated vehicles.

MANAGEMENT CRITERIA

- Bread and other unfilled baked products should be used preferably within 24 hours of their arrival at the CO;
- Bread may be oven-dried for later use;
- Bread may be frozen;
- Food past its MDD may be used, in compliance with the conditions and procedures discussed in Chapter 7.3.4.

10. Traceability

Food traceability must be guaranteed through each stage of provision, transport, storage and final distribution to its beneficiary. Traceability must therefore enable the identification of all operators involved in the distribution process of a given food.

COs should be able to indicate:

A. Supplier identity (backward traceability)
B. Recipient identity (forward traceability)

COs must have systems and procedures in place which enable competent authorities to obtain this information.

The minimum requirements to guarantee traceability are reported below.

10.1. Backward Traceability

All COs must keep an up-to-date supplier list such as that shown below and provided in Appendix III.

All incoming (donated/recovered/collected) food must be accompanied by a movement document (MD).

A.8 Supplier list as per Appendix III

Name	Address	Contact name	Telephone/Fax	e-mail

10.2. Forward Traceability

Requirements differ for charity-to-charity COs and front-line COs.

CHARITY-TO-CHARITY COS:

- Must keep an up-to-date list of front-line COs with full details;
- Food distributed to front-line COs must be accompanied by a movement document (MD);
- When food is delivered directly to the front-line CO without intermediate storage, an appropriate delivery document must be issued.

Front-line COs do not need to keep an updated list of the beneficiaries of food aid, as they are comparable to final consumers buying from retail stores. However, in the event of product withdrawal or recall from the market, users should be promptly informed by all possible means, in order to guarantee food safety.

RECOMMENDATIONS

A suitable procedure for informing the public must be developed to cover the eventuality of the withdrawal or recall of a food that has already been distributed and is thus no longer under the CO's direct control.

10.3. Labelling

Food and labelling legislation does not distinguish food according to the final consumer. However, given the charitable nature of COs, suppliers are permitted to donate unlabeled or inadequately labelled food not fully compliant with legislative and commercial regulations. In these circumstances, donors/suppliers may cede such food to COs by providing them with a separate document, in the appropriate national language, reporting all the information required by **Regulation (EC) 1169/2011** so that it may be available to the recipients. The COs must ensure that such mandatory information is made available to the beneficiaries.

Similarly, suppliers of bulk/non-prepacked foods must provide a list of ingredients which must be made available to the final consumers and, where possible, all individual food packages must bear a label reporting the name of the food and the date of its recovery. For food frozen by the CO, the product name, the date of freezing and the list of ingredients (where applicable) must be reported on a label or on the packet, as specified in Chapter 7.3.5.

APPENDIX I
Guidelines and Reference Literature

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APPENDIX II[2]
A.0. STORAGE TEMPERATURES
A.1. TRANSPORT
A.2. FREEZING
A.3. HAZARD ANALYSIS
A.4.DISINFESTATION PLAN
A.5. SANITISATION PLAN
A.6. STAFF TRAINING
A.7. NON-CONFORMITIES
A.8. LIST OF SUPPLIERS

[2] For issues related to file size, the appendix II of the document is available in digital format at the site: <http://cdn.bancoalimentare.it/sites/bancoalimentare.it/files/manualecaritasbanco_eng_007.pdf>

Development and Sustainability: Management of Food Surplus in a Local Context

On the basis of the dispositions contained in the manual of Good Practices for Charitable Organizations, the project **“Development and Sustainability: management of food surplus in a local context”** has been developed in collaboration with Fondazione Banca Popolare of Lodi and Centro Solidale per il Diritto al Cibo of Lodi.

1. **Principle of Flexibility**

According to the Good Hygiene Manual of Good Procedures for Charitable Organizations and in line with the flexibility principle permitted by Regulation (EC) no. 852/2004 a simplified H.A.C.C.P system was carried out for the Centro Solidale per il Diritto al Cibo of Lodi (Guidelines for Correct Operating practices are reported in Appendix A[3]).

The Guidelines of Good Operating Practices for the Centro Solidale per il Diritto al Cibo of Lodi are prerequisites programs with the instructions and documents for the correct management of food in each stage of recovery.

2. **Training course on food safety**

In order to promote a safe recovery and social utility actions, after the elaboration of the new guidelines, a practical training on food safety was offered to the operators which focused on the various activities operated by Centro Solidale per il Diritto al Cibo of Lodi.

The correct hygiene practices were defined in several distinct prerequisites and best practices: (i) prerequisites for food premise, (ii) prerequisites for personal hygiene during recovery, (ii) correct management of the phases of collection, transport, storage/conservation and redistribution, (iv) food acceptance prerequisites and (v) correct storage temperatures according to the type of food recovered.

3. **Nutritional training course**

In addition, since the operators of charity organizations prepare food aid that consist of non-perishable and perishable food packed in bags or small boxes, they are obliged to guarantee both the food security of the products and the nutritional security estimated on the needs of the families that benefit from it. For these reasons, specific nutritional training was conducted, in order to help the volunteers in the correct balance of food parcels.

[3] The guidelines for Centro Solidale per il Diritto al Cibo of Lodi, originated by this activity, are written in italian and therefore it is appended at the end of the thesis (Appendix A).

FEED ANIMALS

4| DIVERT FOOD SCRAP TO ANIMAL FEED

Brief Introduction to the Scientific Works

In this last section the attention was focused on the development of a wide range of initiatives to re-use food waste at European level. The study starts from an analysis of the factors that generate the food waste and then introduces the implementation of strategies which may reduce food waste and the development of systems that allow a safe re-use and the processing in accordance to the EU hygienic requirements for animal feed.
The section was divided into two scientific papers:

- The first study analyzes the polyphenolic content and antioxidant activity of agri-food waste and by-products in order to estimate their possible utilization in the industrial applications for the production of ingredients to functionalize feedstuffs.
- The second study focuses on the analysis of the European legislation concerning the reuse of food waste and by-products in animal feed in order to promote the validation of food waste in animal feed ingredient through an efficient recycling system applicable to various sectors of the agri-food chain.

Total Phenolic Content and Antioxidant Activity of Agri-Food Waste and By-Products

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Total Phenolic Content and Antioxidant Activity of Agri-Food Waste and By-Products

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Abstract

Agri-food waste (AFW) and by-products represent sources of phytochemicals, such as phenols and antioxidant compounds that can be used as functional ingredients in animal feed. In this study, a selection of AFW and by-products were collected and analysed for their nutrient composition. After chemical (with methanol) and physiological (*in vitro* digestion) extraction, total phenolic content and antioxidant capacity (AOC) were determined in AFW and by-product samples using Folin–Ciocalteu and 2,2′-azinobis (3-ethylbenzothiazoline 6-sulfonic acid)-ABTS methods, respectively. Sample digestibility was also assessed using a multi-step enzymatic technique. After chemical extraction, grape marc showed the highest total phenolic content (4480.5 ± 886.58 mg TAE/100g; $p<0.05$). Fruit and vegetable waste (FVW), orange peel, strawberry, citrus pulp and *Camelina sativa* cake showed a total phenolic content ranging from 238.0 ± 4.24 to 1583.0 ± 154.35 mg TAE/100g. Grape marc also showed the highest AOC (15440.7±2671.85 mg TE/100g). In all other samples, AOC ranged from 43.3 ± 3.17 to 1703.9 ± 391.07 mg TE/100g. After physiological extraction, total phenolic content values higher than 3000 mg TAE/100g were observed in FVW, grape marc and orange peel. Grape marc, *Camelina sativa* cake and orange peel had AOC values of over 5000 mg TE/100g. The digestibility of AFW and by-products ranged from 44.20 to 97.16 %. The lowest digestibility value was observed in grape marc (44.2 ± 2.31%). In conclusion, the results obtained in this study indicate that AFW and by-products could be a source of bioaccessible total phenols and antioxidant molecules as ingredients for monogastric compound feeds.

1. Introduction

The global volume of food wastage is estimated at 1.6 billion tons of "primary product equivalents" and its edible part is roughly 1.3 billion tons (Gustafsson 2013). Food waste has considerable economic and environmental implications: not only does it represent a wasted investment, it also has a negative environmental impact, due to the greenhouse gas emissions and inefficient use of water and land, which in turn can lead to diminished natural ecosystems (Lipinski et al. 2013).

Food waste is generated throughout the entire food life cycle: from agriculture, to industrial manufacturing and processing, in retail and households (Mirabella et al. 2014). Agri-food waste (AFW) and by-products provide a high potential source of bioactive compounds, such as phenols and antioxidants, which could be exploited in the pharmaceutical, cosmetic, and food industries and used as functional ingredients in animal feeds (Fontana et al. 2013). The use of AFW or by-products, such as animal feeds, is already traditional practice in animal husbandry (Bampidis and Rombinson 2006); however, the bioactive potential in feed has not been fully elucidated.

Fruit and vegetable by-products are notably rich in antioxidant phenols (Balasundram et al. 2006; Peschel et al. 2006), such as anthocyanin and flavonoids (Croft, 2016). The enrichment of animal diets with phenolic compounds may have beneficial effects on animal gut health, including anti-inflammatory and antimicrobial activity, along with their antioxidant capacity (Ignat et al. 2011).

Several studies have focused on the quantification of the total phenolic and antioxidant compounds in fruits and vegetables (Ignat et al. 2011, Pastoriza et al. 2011) using different extraction methods. Chemical extraction is widely used (Pastoriza et al. 2011, Attard, 2013) which enables the extraction of a high amount of total phenolic and antioxidant compounds. From a physiological point of view, however, the bio-accessibility of phenolic compounds and antioxidants depends on their release from the food and feed matrix during digestive process. In this study, AFW and by-product samples were analysed in order to assess the total phenolic content and antioxidant capacity. In particular, chemical (with methanol) and physiological (*in vitro* digestion) extractions were performed in order to evaluate the potential bioaccessibility of phenols and antioxidant molecules in monogastric compound feeds.

2. Materials and Methods

AFW and by-products, including fruit and vegetable waste (FVW), *Citrus sinensis* L. (orange peel), *Fragaria ssp.* (strawberries), citrus pulp, *Vitis vinifera* L. (grape marc), *Camelina sativa* (L) Crantz cake (*Camelina sativa* cake) and whey, were collected three times (n = 21) over a one-year period (2016/2017), according to product seasonality. *Camelina sativa* cake and whey were provided by a commercial supplier. Oranges, strawberries and grape marc were freshly collected from a local market and a winery, respectively, situated in northern Italy, and subsequently dried and ground (1mm sieve). Citrus pulp and FVW were provided by the University of Messina and their composition is reported in Chiofalo et al. (2014).

The FVW sample contained different types of vegetables and fruits including: tomato (*Solanum lycopersicum* L.), fennel (*Foeniculum vulgare* L.), pepper (*Capsicum annuum* L.), eggplant (*Solanum melongena* L.), courgettes (*Cucurbita pepo* L.), potato (*Solanum tuberosum* L.), onion (*Allium cepa* L.), lettuce (*Lactuca sativa* L.), cauliflower (*Brassica ssp.*), mushroom (*Agaricus bisporus*, P*leurotus ostreatus*), pear (*Pyrus communis* L.), apple (*Malus domestica*), banana (*Musa spp.*), orange (*Citrus sinensis* L.), strawberry (*Fragaria ssp.*), kiwi

(*Actinidia chinensis*) and pineapple (*Ananas comosus* L.). The chemical analysis of the samples was performed following official methods (AOAC, 2005; European Commission regulation, 2009) and the fiber fractions were analytically determined according to Van Soest et al., 1991, using heat stable α-amylase. Gross energy (GE) values were estimated according to Hoffman & Schiemann's equation (1980).

Each sample was weighed (5 ± 0.5 g), mixed with 30 ml methanol (100%) for 48 hours at room temperature (RT) and, subsequently, filtered with filter paper (Whatman 54, Florham Park, NJ, USA). Chemical extracts were tested for total phenolic compounds and antioxidant capacity, as detailed below.

In parallel, the *in vitro* digestion was performed according to the protocol described by Regmi et al. (2009) with minor adaptations reported by Giromini et al. (2017a) (Figure 1). At the end of the *in vitro* digestion, a soluble fraction and an undigested fraction (UF) were obtained. The soluble fraction was used to quantify the phenol content and the antioxidant capacity (detailed below). The UF was then collected in a filtration unit using a porcelain filtration funnel lined with pre-weighed filter paper (Whatman no. 54). The UF, along with the filter paper, were dried overnight at 65°C. The UF was used to calculate the *in vitro* digestibility (Equation I):

Digestibility (% dry matter, DM) = (sample DM - UF DM) / sample DM*100 (I)

In addition, total phenolic compounds were assayed according to the Folin–Ciocalteu method (Attard, 2013). The total phenolic content was expressed as tannic acid equivalents (mg TAE/100g).

The anthocyanin content was measured in triplicate in each chemical extract according to Theuma et al. (2015) and calculated as follows (Equation II):

Anthocyanin content (mg/kg) = (1000 x volume of extracted sample x absorbance value at 520) / extinction coefficient [58.3 ml (mg.cm)]. (II)

The antioxidant capacity (AOC) was measured following Re et al. (1999). AOC results are expressed as mg Trolox equivalent (TE) /100g sample.

All samples were prepared and analysed in triplicate. The data from total phenolic content and AOC were analysed through one-way analysis of variance (ANOVA) using GLM procedure of SAS (SAS, 9.3 version). Results are expressed as mean ± standard deviation. Data were analyzed using Shapiro-Wilk test to evaluate the normality of sample distribution. The Pearson correlation coefficient (r) and probability-value (p) were used to show correlation and their significance by using SPSS software, Version 24. Chicago, Ill: SPSS Inc; 2002. A probability value of $p < 0.05$ was considered statistically significant.

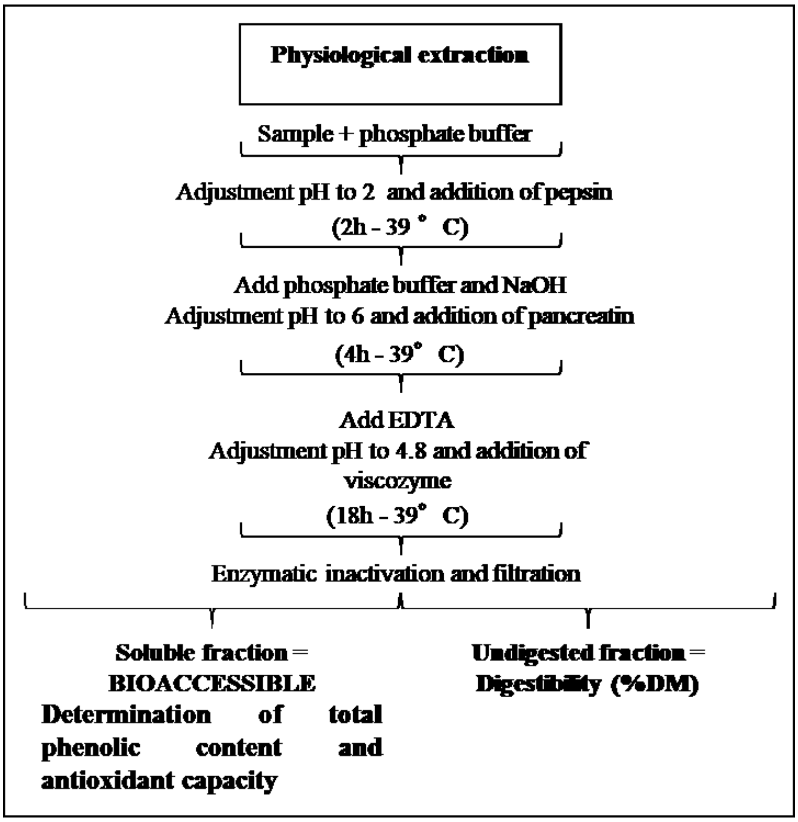

Figure 1. Graphical representation of physiological extraction

3. Results and Discussion

The total phenolic content and AOC of the various AFW and by-product matrixes were analysed in order to assess their use in the animal feed sector. Exploiting AFW and by-products plays an important role in the production of high value functional feed ingredients along with socio-economic and environmental sustainability, according to the circular economy strategy (Mirabella et al. 2014) and according to the “biorefinery” approach where value-added molecules are recovered from waste biomass (Di Donato et al. 2017; Rodríguez-González et al. 2018). The nutrient composition and gross energy content of AFW and by-products are reported in Table 1.

Table 1. Chemical composition of AFW and by-products (% w/w on DM basis)

	DM	**CP**	**EE**	**NDF**	**ADF**	**ADL**	**Ash**	**GE** (MJ/Kg)
FVW	12.3 ±2.20	9.9 ±1.11	0.8 ±0.50	22.2 ±0.41	16.6 ±0.52	10.2 ±0.28	6.1 ± 0.22	16.4
Orange peel	26.6 ±1.24	3.5 ±2.02	1.7 ±0.52	10.0 ±1.30	7.6 ±1.71	1.8 ±0.01	3.8 ±0.24	15.92
Strawberries	7.0 ±1.21	7.7 ±1.40	1.5 ±0.30	12.8 ±0.54	9.7 ±1.58	5.7 ±0.81	4.9 ±0.58	16.99
Citrus pulp	93.7 ±1.22	5.0 ±1.14	2.6 ±0.32	23.0 ±0.60	16.2 ±0.76	3.8 ±1.03	9.0 ±0.88	16.04
Grape marc	26.4 ±1.30	8.0 ±0.30	8.5 ±0.22	20.8 ±0.70	18.9 ±1.49	12.9 ±0.42	1.3 ±1.26	16.86
Camelina sativa cake	92.3 ±1.40	32.2 ±1.40	7.7 ±0.82	46.1 ±1.03	22.0 ±0.91	5.1 ±0.39	5.9 ±1.60	19.3
Whey	92.1 ±0.22	13.0 ±1.22	n.d.	n.d.	n.d.	n.d.	8.7 ±0.56	18.54

Data are presented as mean ± standard deviation, (n=3); FVW: fruit and vegetable waste; DM: dry matter; CP: crude protein; EE: ether extract; NDF: neutral detergent fiber, ADF: acid detergent fiber, ADL: acid detergent ligning, GE: gross energy; n.d.: not detected

Our results confirm that Camelina sativa cake and whey represent valuable protein sources. As for the lipid content, grape marc and Camelina sativa cake had the highest values in terms of ether extract (EE) compared to the other samples. Overall, our results confirm notable amounts of nutrients in the AFW and by-products with a high potential for feeding animals.

Table 2 shows the total phenolic content, AOC and anthocyanin content of AFW and by-products after chemical extraction. In particular, the highest total phenolic content was found in grape marc (4480.5 ± 886.58 mg TAE/100g; $p<0.05$). The total phenolic content of FVW, orange peel, strawberry, citrus pulp and Camelina sativa cake ranged from 238.0 ± 4.24 (Camelina sativa cake) to 1583.0 ± 154.35 mg TAE/100g (orange peel). Grape marc showed the highest AOC value (15440.7 ± 2671.85 mg TE/100g; $p<0.05$) and a notable amount of anthocyanin compared to all other samples. In all other samples, AOC ranged from 427.2 ± 109.91 (citrus pulp) to 1703.9 ± 391.07 mg TE/100g (orange peel). In the whey sample, the total phenolic content, AOC and anthocyanin content were the lowest detected.

Table 2. Total phenolic content, antioxidant capacity (AOC) and anthocyanin content of chemical extracts (n=3) (methanol extraction) from AFW and by-products (mean ± standard deviation).

	Chemical		
	Total phenolic content (mg TAE/ 100g)	**AOC (mg TE/100g)**	**Anthocyanin content (mg/100g)**
FVW	1307.0 ± 182.85^{b}	1112.8 ± 340.62^{c}	18.8 ± 1.92^{b}
Orange peel	1583.0 ± 154.35^{b}	1703.9 ± 391.07^{b}	5.2 ± 0.53^{c}
Strawberries	1253.6 ± 98.57^{b}	1163.7 ± 276.90^{cb}	14.7 ± 2.13^{b}
Citrus pulp	565.6 ± 106.80^{c}	427.2 ± 109.91^{d}	3.4 ± 0.41^{c}
Grape marc	4480.5 ± 886.58^{a}	15440.7 ± 2671.85^{a}	29.6 ± 4.21^{a}
Camelina sativa cake	238.0 ± 4.24^{c}	730.5 ± 16.90^{cd}	1.9 ± 0.48^{c}
Whey	89.5 ± 18.41^{c}	43.3 ± 3.17^{d}	0.4 ± 0.02^{d}

FVW: fruit and vegetable waste; TAE: tannic acid equivalents; TE: trolox equivalents. Different superscript letters in columns indicate significant different data ($P<0.05$)

The high content of phenols and anthocyanin in grape marc samples are in accordance with those reported by Larrauri et al. (1997). The AOC of grape marc was higher in our study than in data reported by Heng et al. (2017). The total phenolic content of orange peel and citrus pulp was similar to values reported for orange peel extract by Attard (2013) and Tzanakis et al. (2006). Strawberry AOC was at least two-fold higher (1163.8 ± 276.90 mgTE equivalent/100g) than values reported by Özşen and Erge (2013) (568 - 642 mg TE equivalent/100g) and Gössinger et al. (2009) (530-805 mg TE /100g). The total phenolic content, AOC and anthocyanin content obtained after chemical extraction show a large variability among different studies due to the lack of assay standardization (Pellegrini et al. 2003). As demonstrated by Thomas et al. (2018), the variations in the total phenol content might be due to several factors such as genetic variability, environmental pressure, cultivation techniques, age and maturity of the plants and postharvest treatments.

A positive correlation ($r=0.95$, $p=0.01$) was observed between the total phenolic content and AOC in the chemical extracted samples. The anthocyanin content was correlated with the total phenolic content ($r=0.87$, $p=0.01$) and with AOC ($r=0.80$, $p=0.01$). The positive linear relationships between the total phenolic content and AOC values are in accordance with the results of other authors (Ehlenfeldt and Prior, 2001; Connor et al. 2002) confirming that total phenolic compounds largely contribute to the AOC of AFW and by-products (Dudonné et al. 2009).

In vitro digestion (physiological extraction) was performed to evaluate the bioaccessibility of total phenolic and antioxidant compounds in AFW and by-products. The soluble fraction of the digestion was used to measure the phenol content and AOC, and the results are reported in Table 3.

Table 3. Total phenolic content, antioxidant capacity (AOC) and anthocyanin content of physiological extracts (n=3) (*in vitro* digestion) from AFW and by-products (mean ± standard deviation).

	Physiological		
	Total phenolic content (mg TAE/ 100g)	**AOC (mg TE/100g)**	***In vitro* digestibility (% of DM)**
FVW	3230.7 ± 122.26^{a}	3783.4 ± 604.43^{b}	78.7 ± 2.84^{b}
Orange peel	3596.0 ± 420.37^{a}	5233.9 ± 1518.18^{ac}	88.7 ± 3.44^{a}
Strawberries	2335.5 ± 462.26^{c}	4346.5 ± 1065.86^{bc}	86.8 ± 2.61^{a}
Citrus pulp	836.5 ± 18.43^{b}	4059.8 ± 55.84^{b}	78.9± 1.01^{b}
Grape marc	3552.2 ± 446.17^{a}	5511.4 ± 938.07^{a}	44.2 ± 2.31^{d}
Camelina sativa cake	879.7 ± 74.87^{b}	5262.3 ± 449.76^{a}	66.8 ± 0.82^{c}
Whey	219.2 ±8.05^{d}	3258.3 ± 215.44^{b}	97.2± 1.61^{a}

FVW: fruit and vegetable waste; TAE: tannic acid equivalents; TE: trolox equivalents. Different superscript letters in columns indicate significant different data (P<0.05)

We found that the total phenolic content was significantly high (3000 mg TAE/100g; p<0.05) in FVW, grape marc and orange peel, compared with the other samples. The AOC was higher than 5000 mg TE/100g in grape marc, Camelina sativa cake and orange peel. A high AOC value was also observed in the whey sample (3258.3 ± 215.44 mg TE/100g), compared with the value obtained after chemical extraction, thus suggesting the liberation of antioxidant compounds encrypted in whey proteins. Thus, the AOC of whey mainly depends on the high biological value of bioactive peptides (Giromini et al., 2017b) and on the high oligosaccharides and B-vitamin content.

In addition, the undigested fraction obtained from the physiological extraction (Figure 1) was used to calculate the in vitro digestibility. Notably, the digestibility of AFW and by-products showed a mean value of 77.33 %. The highest digestibility was observed in whey (97.2 ± 1.60 % DM), while the lowest (44.2 ± 2.30 % DM) was reported for grape marc (Table 3).

The in vitro digestion protocol exploited in the present study had previously been used to test the monogastric digestibility of feeds, showing a great correlation with the in vivo digestibility values (Regmi et al. 2009). The feed bioaccessibility corresponds to the feed portion effectively released from the matrix and available for intestinal absorption. The application of in vitro digestion to AFW and by products enables the physiological bio-accessible phenols and antioxidant compounds to be studied in more depth in soluble fractions. However, the UF obtained may still contain bioactive components (Chen et al., 2014) which may play an essential role at the gut level (e.g. intestinal epithelial cells, microbiota).

In our study, total phenolic content and AOC values were higher in the physiological than in the chemical extracts. This suggests that digestion can enhance their bioaccessibility, except for grape marc in which the phenols and antioxidant molecules were lower in the physiological than the chemical extracts. The latter aspect is related to the low digestibility observed in grape marc (44% DM, Table 3) which may have negatively affected the liberation of phenols and the AOC, although no overall correlation was observed (p>0.05). This aspect, however, needs further investigation, using an improved protocol to simulate the in vitro digestion and assess the digestibility of the grape marc, also taking into consideration the relatively high lipid content of the sample. From an application point of view, dietary supplementation with enzyme-based additives could be a valid technique to improve the bioaccessibility of phenols and antioxidant molecules of AFW and by-products and to implement their use in animal nutrition (Chamorro et al. 2015).

Other aspects related to data application in animal nutrition should also be considered, i.e. palatability, stability, storage conditions and food safety issues such as the risk of mycotoxin contamination in AFW and by-products.

4. Conclusions

This study contributes to the current knowledge on the functional role of agri-food waste and by-products in the diet of monogastric animals. The results indicate that agri-food waste and by-products are a good source of phenols and antioxidant molecules. Further issues, however, need to be considered when using agri-food waste and by-products in feed formulations. The highly variable chemical composition, along with the storage and processing conditions need to be correctly addressed in order to guarantee the stability of the bioactive components in agri-food waste and by-products.

Overall, the reuse of agri-food waste and by-products as functional ingredients in animal feed is crucial, not only because it reduces the costs of disposal costs and the amount of food waste, but also because of the promising potential as functional feed ingredients.

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Disclosure statement

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Pet Food as the Most Concrete Strategy for Using Food Waste as Feedstuff within the European Context: A Feasibility Study

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Pet Food as the Most Concrete Strategy for Using Food Waste as Feedstuff within the European Context: A Feasibility Study

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Abstract

Food loss and waste have a negative environmental impact due to the water, land, energy and other natural resources used to produce the wasted food, along with post-consumption disposal costs. Reducing food waste will thus help improve sustainability and decrease the environmental impact of the food system. Using food waste for animal feed is of growing importance in terms of the policies targeted at tackling food waste but the current legal framework in the European Union (EU) strongly restricts the possibility of using food waste for this purpose. The aim of this work is to evaluate the feasibility of innovative measures for feed production in the EU and to identify the best strategies to implement them. First, a technical evaluation of a case study is presented, which is a process developed in the United States for urban food waste transformation into animal feed. Second, there is an analysis of the potential application of this process in the European Union within the current legal framework. The results reveal that the feed product derived from food waste is compliant with EU safety requirements and is nutritionally valuable. This work also suggests that the implementation of this kind of process in the European Union has great potential, provided that food surplus is recovered and treated before it turns into waste and that the different types of food surplus identified are used as feed for the right animal type in accordance with European legislation (i.e., livestock, aquarium fish, pets). On these terms, pet food can be the most concrete strategy for using food waste within the European context. In general, the implementation of feed-from-food measures to reduce food waste in Europe is already possible and does not need to wait for further policy interventions.

1. Introduction

Promoting environmental, economic and social sustainability is the real challenge that agri-food systems are faced with, and food waste is certainly one of the most complex and important problems in developed countries. Studies commissioned by the Food and Agriculture Organization (FAO) in 2015 found that one-third of food produced for human consumption is lost or wasted globally [1]. More specifically, the quantification of food waste production in the United States was estimated at 66 million tons in 2010 which was selected as the baseline for national food loss, and a target of a 50% reduction in the waste program by 2030 was set. In the European Union, 88 million tons of food are wasted annually in the EU, 70% of which come from households, food services and retail sectors, and the remaining 30% come from the production and processing sectors [2]. However, the different interpretations of the concept of food waste makes the global food waste issue difficult to define conclusively [3] and recent studies highlight the importance of measuring the quantity and value of food waste accurately [4,5]. Nevertheless, the basis for a correct measurement is the distinction between the terms food surplus and food waste: In this article, the term "food surplus" refers to food produced beyond our nutritional needs, whereas waste is whatever is produced in the food system that ends up in the landfill [4,6].

Due to the magnitude of the related ethical and economic issues, the scientific literature has increasingly focused on the impact of waste treatment strategies [7–12].

There are multiple ways of decreasing the generation of waste, and despite the fact that there are differences in national policies among EU and US Countries, their common pillar is the prioritization of food waste prevention. Strategies for better production, such as planning and resource use, improving preservation and packing technologies, and transportation and logistics management are implemented for this purpose [1]. Prevention includes supplementary actions such as the redistribution of food surpluses to people for charitable purposes: The guidelines for a common European food waste policy (FUSIONs) foster a policy environment focused on social innovation initiatives to promote food redistribution and cooperation with the actors in the food supply chain. One example of this is an EU-wide program that encourages food business operators to distribute their unsold edible food to charities. Although food redistribution strategies can provide both pro-social and pro-environmental gains due to their concern to reduce food surplus and food insecurity [13], several studies have shown that they offer a limited contribution to food waste prevention [14,15].

Finally, the re-use of food for animal feed can be included as part of the prevention strategies such as the last chance to use food and its nutritional properties before it turns into waste, and thus treated through anaerobic digestion, composting, incineration or landfill. Several studies demonstrate that food waste-derived feed is an adequate alternative when properly supplemented [16,17] and a number of East Asian states have in the last 20 years introduced systems for the safe recycling of food waste into animal feed [18].

Converting food waste into animal feed is also a sustainable practice compared to the environmental and health impacts of different technologies for food waste processing, including anaerobic digestion and composting [19]. The authors found that feed production from food waste has the lowest impact and is thus capable of providing environmental and public health benefits at a societal level.

Given this potential, it is clear that the reuse of food for feed purposes needs to be more extensively explored and evaluated. Although fostering the use of (former) foodstuffs and by-products for feed production is part of the recommendation released by the EU Fusion project, to date these practices are hardly implemented in the European Union due to the current legal framework on food waste management and livestock feeding. Several authors have highlighted this lack of practice and proposed to introduce policy changes, together with consumer and industry support, in order to re-introduce the possibility of using food waste as livestock feed in the European Union [18–22].

The aim of the study is to evaluate the feasibility of innovative measures for feed production in the EU and to identify the best strategies to implement them. Starting from an analysis of an innovative food waste treatment for feed production developed in the US (nutritional properties and safety), the present study provides an evaluation of its potential applicability in the European Union, given the current legal framework in force. The study also suggests strategies to implement similar technologies within the European framework on food waste use.

2. Methodology

In evaluating the potential application of new feed-from-food-based strategies, which have, as of yet, never been implemented in the European Union, a food waste treatment operating in the US was considered as a case study. The methodology used is composed of two main steps: an analysis of the case study in order to evaluate the characteristics of the final product (feed) obtained and, in a second stage, an assessment of the applicability of such a treatment within the European legal framework.

2.1. Definition of the Flow Process

The survey was carried out from January 2016 to January 2017, during which the data were collected from a specific transformation technology located in the USA that receives food waste through controlled flows and procedures from commercial and residential locations in order to produce secondary food products for animal feed. The facility is powered daily through the collection of commercial and residential food scraps in coordination with several urban centers and institutions, including: City of Santa Clara, Stanford University, City of San Jose and the City of Sunnyvale. The daily amount of urban food waste collection is of 50 tons /die on average.

Figure 1 shows the steps of a system for processing primary food product waste into a secondary food product.

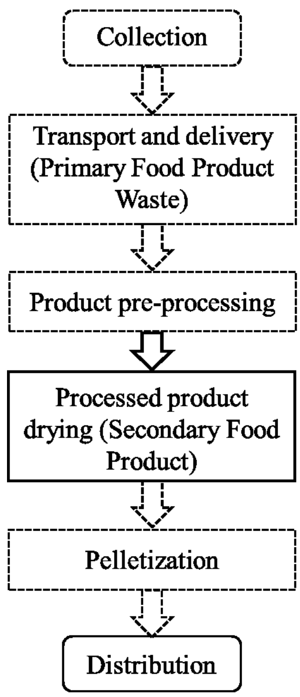


Figure 1. Flow chart of the system.

2.2. Characterization of Secondary Food Product

The secondary food product was evaluated in terms of the EU sanitary requirements to understand whether this product could be included in an animal feed formulation. From January 2016 to January 2017, the secondary food product sampling took place once every two months. On each collection day, three batches of secondary food product with a mass of 2–3 kg were randomly selected in order to obtain a complete safety and nutritional assessment of the product. All study parameters regarding the secondary food product derived from the process were determined by identifying the EU hygiene requirements for pet food, which was regulated by the Directive 2002/32/EC of the European Parliament and the Council on 7 May 2002 on undesirable substances in animal feed. The sampling and the analysis methods were carried out taking into account the Commission regulation (EC) No 152/2009 of 27 January 2009 which laid down the methods of sampling and analysis for the official control of feed. The undesirable substances studied were: nitrites, the presence and the level of contamination of mycotoxins pesticides, heavy metal and microbiological parameters (Table 1).

Table 1. Parameters for secondary food product evaluation.

Nitrites	Sodium Nitrite
Mycotoxins	**Deoxynivalenol, fumonisin B1 and B2, aflatoxin B1 ochratoxin A and zearalenone.**
Pesticides	**Acephate, Azinphos ethyl, Azinphos methyl, bromophos methyl, Carbophenthio, Chlorfenvinphos, Chlorpyrifos ethyl, Chlorpyrifos methyl, Chlorthiophos, Coumaphos, Diazinon, Dichlorvos, Dimefox, Dimethoate, Ethion, Fenchlorphos, Fenitrothion, Fonofos, Phorate, Phosalone, Phosphamidon, Isofenphos, Malathion, Methamidophos, Methidathion, Mevinphos, Omethoate, Parathion ethyl, Parathion methyl, Pirimiphos Methyl, Profenofos, Quinalphos, Terbufos, Tetrachlorvinphos, Thionazin, Vamidothion.**
Heavy metals	**Pb, Cd, As and Hg.**
Microbiological analyses	**Mesophilic aerobic bacteria, enumeration of *Enterobacteriaceae*, enumeration of *E. coli*, enumeration of coagulase-positive staphylococci, *Bacillus cereus*, total coliform bacteria, sulphite-reducing Clostridia, *Clostridium perfringens*, detection of *Salmonella* spp., *Listeria monocytogenes*, staphylococcal enterotoxins, *E. coli* STEC, *Yersinia enterocolitica* and *Clostridium botulinum.***
Physical contaminants	**Lithoid material (>5 mm), other inert materials such as glass and metal (<3.3 mm and 3.3 mm–10 mm), plastic material (<3.3 mm and 3.3–10 mm), plastic material and other inert materials (>10 mm), and glass metal and plastic (>2 mm).**

Physical contaminants were studied in order to verify the efficiency of the identification pre-process and the separation of oversized and inorganic material in the secondary food product (Table 1). The secondary food product was evaluated in terms of its nutritional suitability as a raw material for animal feed, the nutritional parameters analyzed were: dry matter, crude protein, ether extract, crude fiber, ash, mineral content (Ca, P, K, Na, Mg, Fe, Zn, Mn, Cu and Cr), and fatty acid content.

2.3. Applicability in EU

Estimating the degree of technical applicability of innovative treatments that are able to produce animal feed, using food waste as input, need to take into account the specific food waste measures currently in force in the European Union. A systematic classification was thus carried out of the complex scenario of the regulations regarding (i) re-using food waste and the provisions for its reduction; and (ii) provisions for animal feed production in the European Union and its composition and safety requirements. Based on the analysis of the regulatory framework, a final evaluation of the applicability of the US case study considered was performed. In addition, the best strategies to improve the conversion of food waste into animal feed within the European Union were therefore suggested.

3. Results and Discussion

3.1. Definition of the Flow Process

3.1.1. Collection, Transport and Delivery—Primary Food Product Waste

The primary food product waste is collected on site and emptied into a special transport vehicle that keeps the waste product separate from the general environment, thus keeping odors to a minimum, minimizing the attraction of insects, rodents, and other vectors, and also to reduce the contamination of the primary food waste during transport.

3.1.2. Production Pre-Processing

At the time of delivery to the processing site, the primary food waste is pre-processed to produce an intermediate product (mash). The pre-processing subsystem is comprised of a magnetic and a screening subsystem for removing oversized and inorganic material, including ferromagnetic material, glass and plastic.

3.1.3. Processed Product Drying—Secondary Food Product

The mash is held in a tank and then transferred to the dryer through a progressive cavity pump. The dryer is configured to reduce the moisture content of the mash. The under vacuum condition lowers the effective boiling point within the dryer to remove the evaporated moisture safely below a temperature at which the primary food waste could burn or otherwise might overheat, thus minimizing emissions.

The water vapour can then be condensed into water which is then captured by the dryer, and can be used for various purposes, including cooling and cleaning sections of the dryer.

The dryer gradually dries the mash without exceeding 120 °C so that the nutrients are retained in the dried product.

3.1.4. Pelletization

The secondary food product is dried by the dryer to a 10–20% moisture content, then extruded and cut to generate a finished dried meal or a pellet. The temperatures and pressures created in the extrusion process allow for a high temperature and short time (HTST) process.

3.2. Characterization of Secondary Food Product

The analysis of the undesirable substances found in each batch of secondary food products showed that the nitrite levels were below 4 mg/kg, in accordance with the maximum EU legal limit of 15 mg/kg expected for raw materials for animal feed formulations (Table 2). The mycotoxin level in all batches was below the detection limit (<0.05 μg kg^{-1} wet weight). The results of the mycotoxins level of the secondary food product presented in this study are within the expected limits because the food waste collected in the US was mainly generated from food residues for human consumption (Table 2). Pesticide residues were not detected in any of the batches of the secondary food product, and thus the product appeared to be in line with the permitted EU limits. The heavy metals analyzed were found with the following concentrations: Pb (3.44 mg/kg ± 0.08), Cd (0.22 mg/kg ± 0.003), As (0.68 mg/kg ± 0.005) and Hg (under the detection limit of the analysis method <0.100 mg/kg), and all the results were well below the maximum permitted limits (Table 2).

Microbiological analyses showed that *Salmonella* spp. and *Listeria monocytogenes* were absent in 25 g of all analyzed batches thus conforming to the Reg. (EC) No. 2073/2005. In addition, the absence of Staphylococcal enterotoxins, *Bacillus cereus* enterotoxins, *E. coli* STEC, *Clostridium botulinum* and *Yersinia enterocolitica* and the presence below the detection limit of 1 log CFU/g of the hygiene process indicator microorganisms confirmed the compliance of the secondary food products with EU food and feed safety criteria. As confirmed by previous studies, heat treatment plays an important role in decreasing the pathogen population in several food matrices such as food scraps [23,24]. Physical contaminants were not detected in any of the batches of the analyzed secondary food product.

Table 2. Guide values in relation to feedstuff in the EU.

	Secondary Food Product	Maximum Level in EU [a]	EU Regulation	Specification
Nitrites	<4	15	2002/32/EC	Limits for complete feedstuff for pets
Deoxynivalenol,	below detection limit	Not available	2006/576/EC	
Fumonisin B1 + B2	below detection limit	5	2006/576/EC	
Aflatoxin B1	below detection limit	0.02	2002/32/EC	
Ochratoxin A	below detection limit	Not available	2006/576/EC	
Zearalenone	below detection limit	Not available	2006/576/EC	
Pb	3.44	5	2002/32/EC	Limits for complete feedstuff
Cd	0.22	2	2002/32/EC	Limits for complete feedstuff for pets
Total arsenic	0.68	6	2002/32/EC	Limits for complete feedstuff for fish and fur animals
Hg	below detection limit	0.4	2002/32/EC	Limits for complete feedstuff for pets

[a] Guide values in mg/kg (ppm) relative to feedstuff with a moisture content of 12%.

The results of the chemical composition, fatty acid and mineral content are shown in Tables 3–5, respectively. The data related to the nutrient composition of the secondary food products was highly variable. In fact, the variation in feed values of food waste depends on the origin of the waste and other social aspects such as the age profile, ethnic origin and dietary habits of householders [25–27].

Given that food waste reflects the human diet, the feed it is derived from is very often nutritionally balanced, with a good nutritional quality as shown by the nutrient analysis [28]. Some authors highlight that restaurant food waste is higher in fat and protein as found in the secondary food product analyzed in this study [29,30].

The high protein content in food waste responds to the necessity to find new protein sources, since Europe's capacity to produce protein feed is seriously inadequate to meet market demand [31]. According to Pond and Maner [32], one of the barriers to feeding animals with food waste is the variation in types and sources, which is reflected in the varied composition of the secondary food product. Further studies are thus necessary in order to standardize the raw materials derived from food waste transformation.

The fatty acid profile of secondary food product appears to be an interesting source of essential fatty acids, in terms of the omega 6 (26.3%) and omega 3 content (3.2%). In line with results, Myer, et al. [26] reported a similar fatty acid profile and indicated that the results depend on the mixture of animal and vegetable fat normally found in household and restaurant waste. Macro-minerals such as calcium, potassium, phosphorous, sodium and magnesium were found in all the batches analyzed, and the heterogeneity of food waste makes the secondary food product a good source not only of protein but also of minerals.

Table 3. Chemical composition of the secondary food product.

Parameters [a]		
Dry matter	Mean	87.07 ± 0.02
	Min	84.40
	Max	88.96
Crude protein	Mean	24.00 ± 0.02
	Min	19.61
	Max	27.10
Ether extract	Mean	7.94 ± 0.05
	Min	3.89
	Max	15.00
Crude fiber	Mean	16.62 ± 0.03
	Min	11.00
	Max	21.00
Ash	Mean	12.68 ± 0.02
	Min	9.95
	Max	12.00

[a] Data are reported as % on wet weight ± standard deviation.

Table 4. Fatty acid content in secondary food product.

Fatty Acid Content [a]	(% of Total Fatty Acids)
Saturated fatty acids (SFA)	37.42 ± 0.30
Monounsaturated fatty acids (MUFA)	33.28 ± 0.16
Polyunsaturated fatty acids (PUFA)	29.31 ± 0.13
Omega-3 fatty acids	3.28 ± 0.05
Omega-6 fatty acids	26.03 ± 0.08
C12:0 Lauric acid	0.94 ± 0.08
C14:0 Myristic acid	2.02 ± 0.04
C16:0 Palmitic acid	23.56 ± 0.11
C16:1 Palmitoleic acid	1.95 ± 0.47
C17:0 Margaric acid	0.31± 0.01
C17:1 Magroleic acid	0.12 ± 0.00
C18:0 Stearic acid	7.82 ± 0.08
C18:1 Oleic acid	30.63 ± 0.27
C18:2 Linoleic acid	25.5 ± 0.06
C18:3 Linolenic acid	3.03 ± 0.03
C20:0 Arachidic acid	0.41 ± 0.04
C 20:1 Gadoleic acid	0.38 ± 0.02

[a]Data are reported as mean ± standard deviation.

Table 5. Mineral content of secondary food product.

Element	
Ca [a]	1.17 ± 0.08
P [a]	0.23 ± 0.07
K [a]	0.66 ± 0.10
Na [a]	0.61 ± 0.05
Mg [a]	0.15 ± 0.05
Fe [b]	2.21 ± 0.02
Zn [b]	155 ± 47.3
Mn [b]	47.2 ±2.33
Cu [b]	22.4 ± 2.55

[a] Values in % calculated on dry matter, [b] Values in mg/kg (ppm) calculated on a moisture basis of 12%.

3.3. New Perspectives: Applicability in the EU

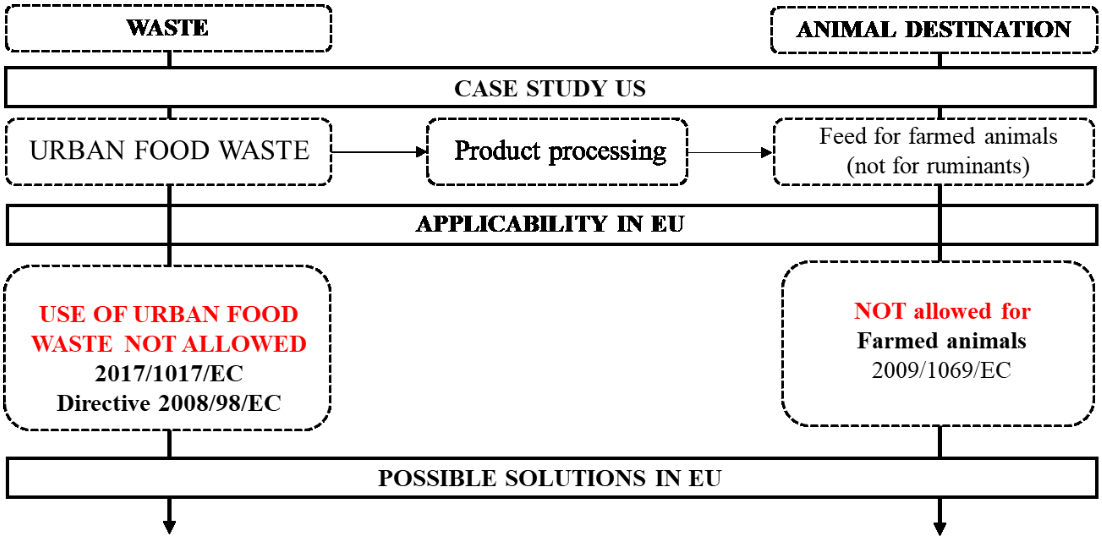
Figure 2 outlines the main results with reference to the applicability analysis. With respect to the legal framework on food waste and feed production currently in force, the case study analyzed has proven not to be fully suitable for implementation in the EU due to two main drawbacks: The nature of the raw material used as input for the food waste transformation process and, secondly, the destination of the final product.

More specifically, with regard to the type of waste used, the US case study processes urban food waste, which is not allowed in the EU in accordance with Directive 2008/98/EC which considers food and kitchen waste from households, restaurants, caterers and retail premises as bio-waste for composting and digestion. Despite the fact that the final product analyzed showed its compliance with safety requirements and a good nutritional profile, the European approach, which does not permit urban waste to be used as raw material for the food chain, can be considered as the best solution for public health protection.

Nevertheless, a large proportion of food waste that could be legally recycled under the current legislation already exists, as provisioned by the Commission Regulation No. 1017/2017 in the catalogue of feed materials. More specifically, the Regulation includes former foodstuffs (Figure 2, source 1), defined as food products manufactured for human consumption in full compliance with the EU food law but which are no longer intended for human consumption for practical or logistical reasons. The second type of source is fruit and vegetable surplus, which is composed of surplus derived from the industrial processing of raw fruit and vegetables, such as fruit pulp.

The third type of food surplus identified is catering reflux, defined by Regulation 2017/1017/CE as all waste food containing material of animal origin originating in restaurants, catering facilities and kitchens, including central kitchens and household kitchens. The food material comprised in this category can be considered as one of the most interesting sources for animal feed production and derives from three main origins: Sludge due to kitchen procedures, the food surplus generated by unconsumed food portions (which can also be redistributed for human consumption) and plate leftovers, under specific safety conditions determined by HACCP procedures.

Source 4, namely the fish and meat surplus, is composed of animal products or by-products with or without treatment, such as fresh, frozen and dried food products.



1. Former food	**2017/1017/EC**	**Farmed animals, aquarium fish and pets**
2. Fruit and vegetable surplus	2017/1017/EC	Farmed animals, aquarium fish and pets
3. Fish and meat surplus	**2017/1017/EC 2009/1069/EC**	**Aquarium fish and pets**
4. Catering reflux	2017/1017/EC, PART C (list of feed materials), number 9.9.1 2009/1069/EC	Aquarium fish and pets

Figure 2. Applicability analysis of US case study for the EU.

The second critical point relates to the final destination of the product, namely the type of animals that can be fed with the product originating from the food waste treatment. EU legislation Reg. No. 1069/2009 stipulates the health rules regarding animal by-products and derived products not intended for human consumption. However, it does not permit the feeding of farmed animals with processed animal proteins. This measure derives from past crises related to outbreaks of foot-and-mouth disease, the spread of transmissible spongiform encephalopathies such as bovine spongiform encephalopathy (BSE), and the occurrence of dioxins in feedstuff.

Notably, sources 1 and 2 (former food and fruit and vegetable surplus) can be used for farmed animals, since the absence of animal proteins makes them suitable for transformation into livestock feed within the EU safety requirements.

Furthermore, all the sources listed in Figure 2 can be used for the manufacturing of pet food including catering reflux, under specific conditions. This is particularly noticeable since the European Pet Food Industry Federation in 2014 reported an annual growth rate of 1.8%, with 9 million tons in volume of annual sales of pet food products, and a turnover of 15 billion euros [33]. Given the size of the industry, the adoption of sustainable practices could have a significant impact globally. Moreover, protein is the most expensive macronutrient in ecological and economic terms, and therefore the one requiring the most attention with respect to sustainability [34]. In fact, the animal protein content significantly determines the environmental impact of dog and cat food formulas, and there is an increasing demand for culturally-acceptable products for pet owners, while still being nutritious and palatable to the pets [35,36]. Eco-conscious pets-owners wish to balance their pets' dietary needs with protecting the planet. Thus, the development of controlled measures for collecting, transporting and storing raw materials is the principal condition for the safe use of the raw materials identified as livestock feed or pet food.

4. Conclusions

In terms of the global impact, the results of the present study highlight that *feed-from-food* strategies can be implemented within the European legal framework and represent a highly sustainable way of reducing the socio-economic costs related to food waste, resulting in a more efficient food chain.

The fact that the process uses food scraps as raw material implies that the costs related to food waste disposal and treatment are expected to be significantly lower. The secondary food product could also partially replace the traditional raw materials needed for feed and consequently provide a potential land/water saving for crop cultivation. In addition, the reduced competition among food/feed/energy crop use could reduce the environmental impact of feed production.

The system analyzed would seem to have a positive socio-economic impact and to successfully contribute to the improvement in the global sustainability of the agri-food system, in accordance with the objectives of the circular economy.

The results of the study also highlight the wide margin of improvements for food waste prevention within the current EU framework, without necessarily changing regulations on food waste management. However, the basis for the implementation of the proposed strategies consists in the development of controlled systems that would guarantee that the food surplus is collected and managed in compliance with the most stringent safety requirements.

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5 | CONCLUSIONS

The magnitude of these environmental, social and economic issues requires all actors in the food chain to play a role in preventing and reducing food waste.
Interest in the reduction of food waste is rapidly increasing due to the quantities of food wasted along the food supply chain.
The prevention and development of strategies that exploit the potential value of food waste as a resource in different fields represents an opportunity to meet the circular economy objectives of the European context.

5.1. Source Reduction

Innovation and research to develop new packaging plays a strategic role in the lifecycle of food products: from production to storage and down to consumption.
Research and technology applied to the packaging sector can improve the food sustainability challenge if a new packaging approach is adopted. Smart packaging is an integrated approach, from design to communication to disposal, which takes into account all the steps of a product generation process. It can aid in the implementation of a new models of circular economy.
Another fundamental aspect is the prevention of waste. In fact, the European Parliament has recognized waste prevention as the first strategic tool to tackle the challenge of food chain efficiencies.
For this reason, food waste prevention in school meals, even if nowadays it has been scarcely investigated, is very important because it plays a special role in providing nutritious, well-balanced meals for students and in educating the next generation about environmental issues through the reduction and recycling of waste.
In addition, a more comprehensive evaluation, that reflects the real situation concerning waste, needs to take into account the whole food supply chain and reduce inefficiencies at each point at which the waste arises.
In that regard, the formulation of food portion sizes to be served in school catering can have a relevant role in food waste prevention, based on the assumption that school meals, where not completely consumed, generated food waste.
For this reason, the determination of the variables that influence food waste in school meals and new critical points have a fundamental role in the application of new action aimed at the prevention of waste production.

5.2. Feed Hungry People

As time passes, the system of food aid has the potential to improve thanks to the approval of national European regulations and specific legislation of the third sector. Italy represent a best practice with regard to the recovery and redistribution of surplus food for charitable purposes also thanks to the law No. 166/2016 on the donation and distribution of food and pharmaceutical products, also known as the “Gadda Law”.
Today charitable organizations represent the link with which surplus food has the possibility to be recycled with a social utility purpose, following the logic from FOOD to FOOD. The donations to charitable organizations represent a growing phenomenon: “the system of food aid” to this day has been capable of efficiently answering the urgent needs that have arisen and of utilizing the available resources, but certainly it can be improved from the point of view

of organizational, management and hygiene requirements. Providing tools and supporting this work with scientific research will extend the field of action in food recovery, avoiding the disposal or the waste of the products still perfectly suitable for human consumption.

5.3. Feed Animals

The reuse of the waste for animal feed is still discussed at European level, but it has been recognized as a strategic tool in the fight against the food waste.
In this context, a careful analysis of the regulations in force allows us to focus on the points where it is possible take action with innovative solutions to protect human and animal health. The analysis of different types of waste enable to establish, on one side, the limitations and from the other, the identification of the possibilities of the re-use for animal feed, following the logic from food to feed.

It is necessary for a long-term goal to establish not only an efficient and effective management of waste, but a model that combines the social, environmental and economic aspects of this issue.

ABOUT MY WORK

In "**How to Transform Food Waste into a Resource**", Dr. Marta Castrica organizes some of the global challenges attached to food supply which directly correlate to and result in food waste in way that demonstrates how to evaluate the various facets of food supply that cause food waste. She simultaneously demonstrates how it is possible for simple policy changes, which theoretically should help support or at least align with the existing complex web of industrial, institutional, economic, and regulatory factors, to measurably decrease food waste. Dr. Castrica's research shows that innovations decreasing food wastage can be remarkably simple.

An example given in her thesis considers the alignment of factors and influences to decrease food waste, highlighting the correlation between portion size, expense, obesity, and food waste in the provisioning of meals for school-aged children. The prevention of food waste through better planning and controls in feeding these children generate positive outcomes in every area, including, importantly, healthier children. It is not hard to imagine that, upon examining every instance where food is wasted similar findings will emerge.

In setting context for this work, Dr. Castrica brings into focus the very premise of the Blue Economy, using it to help frame the seriousness of the global food waste problem. This Blue Economy context argues that waste does not exist, since discards from one system can represent food for another, transforming what has traditionally been thought of a linear "cradle to grave" concept into a circular one. That food waste frequently meets the end of its life in a landfill, rather than having its life cycle extended through optimally extracting and using its nutrients to re-feed humans and animals and/or to generate energy or other products constitutes one of the greatest worldwide emergencies. This is so regardless of perspective: economic, ethics, human and environmental health and so forth.

This thesis organizes research and conclusions into the categories of Source Reduction, Feed Hungry People, Feed Animals, and Reflection. The work introduces a foundation upon which an entire body of continuing work can be organized. It also suggests a trajectory that can be followed in transforming the current context of wasted food into one where food prepared for humans is considered the resource it is. With an increasing awareness of the food waste problem and an ever-expanding network of governments, non-governmental agencies, non-profits, institutions, industry actors, and environmentalists working on solving it, this thesis, which can help scientifically and logistically organize efforts, is critical and timely.

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A | APPENDIX

Linee Guida per Corrette Prassi Operative

FONDAZIONE
BANCA POPOLARE
DI LODI

UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI SCIENZE VETERINARIE
PER LA SALUTE, LA PRODUZIONE ANIMALE
E LA SICUREZZA ALIMENTARE

Vespa

Versione 01- Marzo 2016

Predisposizione, attuazione e mantenimento
delle procedure aziendali in applicazione del
D.Lgs. 193/2007
e
Regolamento CE n. 852/2004
(Piano di autocontrollo)

INDICE DEGLI ARGOMENTI

PREMESSA

Il presente piano di autocontrollo aziendale è redatto a seguito delle disposizioni contenute nel Regolamento CE 852/2004 le quali comportano che:

(art. 5, paragrafo 1)	*"…Gli Operatori del settore alimentare predispongano, attuino e mantengano una o più procedure permanenti, basate sui principi del sistema HACCP".*
(art. 5, paragrafo 2)	I principi del sistema HACCP di cui al paragrafo 1 sono i seguenti:

a) *Identificare ogni **pericolo** che deve essere prevenuto, eliminato o ridotto a livelli accettabili;*

b) *Identificare i **punti critici di controllo** nella fase o nelle fasi in cui il controllo stesso si rivela **essenziale** per prevenire o eliminare un rischio o per ridurlo a livelli accettabili;*

c) *Stabilire, nei punti critici di controllo, i **limiti critici** che differenziano l'accettabilità e l'inaccettabilità ai fini della prevenzione, eliminazione o riduzione dei rischi identificati;*

d) *Stabilire ed applicare **procedure di sorveglianza** efficaci nei punti critici di controllo;*

e) *Stabilire le **azioni correttive** da intraprendere nel caso in cui dalla sorveglianza risulti che un determinato punto critico non sia sotto controllo;*

f) *Stabilire le **procedure**, da applicare regolarmente, per verificare l'effettivo funzionamento delle misure di cui alle lettere da a) ad e);*

g) *Predisporre **documenti e registrazioni** adeguati alla natura e alle dimensioni dell'impresa alimentare al fine di dimostrare l'effettiva applicazione delle misure di cui alle lettere da a) ad f)."*

(all'art. 5, paragrafo 4)	*…Gli Operatori del settore alimentare:*
	a) Dimostrino all'Autorità Competente che essi rispettano il paragrafo 1, secondo le modalità richieste dall'Autorità Competente, tenendo conto del tipo e della dimensione dell'impresa alimentare; *b) Garantiscano che tutti i documenti in cui sono descritte le procedure elaborate a norma del presente articolo siano costantemente aggiornati;* *c) Conservino ogni altro documento e registrazione per un periodo adeguato ";*
e che…	*"…Qualora intervenga un qualsiasi cambiamento nel prodotto, nel processo o in qualsivoglia altra fase, gli Operatori del settore alimentare riesaminino la/e procedura/e vi apportino le necessarie modifiche."*

Il presente piano di autocontrollo contiene tutte le informazioni concernenti, la natura, la frequenza ed i risultati relativi all'applicazione di quanto previsto *dall'art. 5, paragrafo 1*, necessarie a garantire le misure igieniche specifiche delle proprie produzioni alimentari.

Il documento è suddiviso in tre capitoli:

CAPITOLO PRIMO:	*. Trascrizione di dati ritenuti significativi per identificazione dell'impresa del terzo settore e dei suoi relativi stabilimenti.* *. Identificazione delle aree/locali, impianti, attrezzature che sono oggetto dell'attività dell'impresa alimentare.*
CAPITOLO SECONDO:	*. Descrizione delle modalità di espletamento dell'attività produttiva.* *. Identificazione delle macrofasi caratterizzanti l'attività con individuazione di dettaglio delle fasi specifiche inerenti i processi produttivi aziendali e relativa rappresentazione attraverso diagrammi di flusso.* *. Tabella riassuntiva di analisi dei pericoli con valutazione del rischio (PCC), attraverso il metodo dell'albero delle decisioni (decision tree) proposto dal Codex Alimentarius e suggerito dalla Comunità Economica Europea unitamente all'identificazione delle relative procedure per eliminare o ridurre il rischio medesimo.*
CAPITOLO TERZO:	*. Elenco e stesura delle procedure ritenute importanti a garanzia dell'igiene e salubrità delle proprie produzioni. Ogni procedura è strutturata in otto punti (scopo, campo di applicazione, terminologia ed abbreviazioni, responsabilità, descrizione dell'attività, riferimenti normativi, archiviazione, allegati). Le procedure costituiscono materiale informativo/formativo per gli addetti appartenenti all'impresa alimentare.*

Il presente piano si basa sull'avvenuta considerazione, che per la realizzazione di un efficiente autocontrollo, l'Università degli Studi di Milano, Facoltà di Medicina Veterinaria, Dipartimento di Scienze veterinarie per la salute, la produzione animale e la sicurezza alimentare a:

a) Verificare la propria conformità a tutta la normativa cogente relativa ai requisiti di igiene generale quali quelli di igiene delle strutture edilizie, degli impianti, dei servizi ausiliari, del personale;
b) Avvalersi delle indicazioni contenute nei *"manuali nazionali di corretta prassi igienica di settore"*;
c) Avvalersi delle indicazioni contenute al punto 4.2 delle "*linee, guida per la progettazione e realizzazione di un sistema di autocontrollo basato sul metodo HACCP*" ad opera dell'Ente Nazionale Italiano di Unificazione (UNI 10854 dicembre 1999).

(Il Responsabile dell'Autocontrollo)

…………………………………………….

GLOSSARIO

Alimento (o prodotto alimentare, o derrata alimentare): *qualsiasi sostanza o prodotto trasformato, parzialmente trasformato o non trasformato, destinato ad essere ingerito o di cui si prevede ragionevolmente che possa essere ingerito, da esseri umani. Sono comprese le bevande, le gomme da masticare, e qualsiasi sostanza, compresa l'acqua, intenzionalmente incorporata negli alimenti nel corso della loro produzione, preparazione o trattamento. (Reg. CE n. 178/2002 art. 2)*
Approvvigionamento: recupero e raccolta di alimenti da diversi Operatori del Settore Alimentare (OSA).
Analisi del rischio: *processo costituito da tre componenti interconnesse, valutazione, gestione e comunicazione del rischio. (Reg. CE n. 178/2002 art. 2)*
Banchi alimentari: organizzazioni non-profit di primo livello che operano ai fini di beneficenza; un banco alimentare recupera eccedenze alimentari e raccoglie derrate alimentari e le ridistribuisce gratuitamente ad associazioni ed enti caritativi, organizzazioni NP di secondo livello.
Catena del freddo: percorso, insieme di attività atte a mantenere a basse temperature i vari prodotti alimentari, refrigerati, surgelati o congelati dal luogo di produzione a quello di distribuzione o somministrazione, al fine di non compromettere la salubrità degli stessi.
Consumatore finale: il consumatore finale di un prodotto alimentare che non utilizzi tale prodotto nell'ambito di un'operazione o attività di un'impresa del settore alimentare. *(Reg. CE n. 178/2002 art. 2)*
Contaminazione degli alimenti: *la presenza o l'introduzione di un pericolo. (Reg. CE n. 852/2004 art. 2)*
Contaminazione crociata: fenomeno che si realizza quando alimenti, acqua o aria igienicamente sicuri, subiscono una contaminazione da parte di prodotti, materiali, strumenti, acqua o aria provenienti da aree e/o impianti inquinati.
Confezionamento: *il collocamento di un prodotto alimentare in un involucro o contenitore posti a diretto contatto con il prodotto alimentare in questione, nonché detto involucro o contenitore. (Reg. CE n. 852/2004 art. 2)*
Generalmente *l'involucro e contenitore* è denominato anche confezione.
Corrette Prassi Igieniche: modalità operative da applicare da parte degli operatori per garantire l'igiene degli alimenti.
Data di scadenza "da consumarsi entro": *Nel caso di alimenti molto deperibili dal punto di vista microbiologico che potrebbero pertanto costituire, dopo un breve periodo, un pericolo immediato per la salute umana, il termine minimo di conservazione è sostituito dalla data di scadenza. (Reg. CE n. 1169/2011 art. 24)*
E' la data entro la quale il prodotto alimentare deve essere consumato.
È vietata la vendita, il recupero e la distribuzione dei prodotti con data di scadenza superata.
Detergenza: operazione effettuata con detergenti, sostanze capaci di distaccare per azione chimico-fisica lo sporco dalle superfici alle quali questo è più o meno tenacemente attaccato.
Diagramma di flusso: *rappresentazione schematica e sistematica della sequenza delle fasi di operazioni utilizzate nella produzione e distribuzione di un alimento e oggetto dell'analisi dei pericoli e rischi effettuata.(Codex Alimentarius 2003, par. 2.3)*
Disinfestazione: complesso di procedimenti e operazioni atte a distruggere infestanti (in particolare roditori, volatili, insetti).
Disinfezione: operazione effettuata con l'ausilio di agenti chimici o fisici dotati di azione batteriostatica e/o battericida, al fine di distruggere o inattivare i microrganismi potenzialmente patogeni.
Donazione: cessione gratuita nello specifico di alimenti ai fini di solidarietà sociale.
Eccedenze alimentari: derrate alimentari, edibili, generalmente prossime alla data di scadenza o con errato confezionamento/imballaggio o in eccedenza rispetto al loro consumo (pietanze non servite o commercializzate).
Includono derrate alimentari realizzate nel settore primario, trasformate nello stadio di trasformazione, distribuite nello stadio di distribuzione, preparate o servite nello stadio di ristorazione.
Filiera alimentare: sequenza di fasi e operazioni coinvolte nella produzione, lavorazione, distribuzione, immagazzinamento e gestione di un alimento e dei suoi ingredienti, dalla produzione primaria al consumo, comprendendo le fasi di recupero, raccolta e distribuzione effettuate dai soggetti che agiscono ai fini di solidarietà sociale, le OC.

GDO: Grande Distribuzione Organizzata, sistema di vendita al dettaglio attraverso una rete di supermercati e di altre catene di intermediari di varia natura.

GHP (Buone Pratiche Igieniche): *insieme di pratiche generali atte a garantire il rispetto dei requisiti generali e specifici in materia d'igiene, consistenti in condizioni e misure utili a contribuire alla sicurezza e all'idoneità igienica di un prodotto, dalla produzione primaria al consumo. (Ministero della Salute-Linee Guida per l'elaborazione e lo sviluppo dei Manuali di Corretta Prassi Operativa)*

H.A.C.C.P ("Hazard Analysis and Critical Control Point" - Analisi dei Pericoli e dei Punti Critici di Controllo): *sistema che identifica, valuta e controlla i pericoli che sono significativi per la sicurezza alimentare.(Codex Alimentarius 2003)* Si tratta di un processo di raccolta e di interpretazione delle informazioni avente come obiettivo l'identificazione dei pericoli potenziali significativi, la valutazione della loro probabilità di comparsa (rischio) e gravità.

Igiene degli alimenti: *misure e condizioni necessarie per controllare i pericoli e garantire l'idoneità al consumo umano di un prodotto alimentare tenendo conto dell'uso previsto. (Reg. CE n. 852/2004 art. 2)*

Imballaggio: *il collocamento di uno o più prodotti alimentari confezionati in un secondo contenitore, nonché detto secondo contenitore. (Reg. CE n. 852/2004 art. 2)*

Impresa alimentare: *ogni soggetto pubblico o privato, con o senza fini di lucro, che svolge una qualsiasi delle attività connesse ad una delle fasi di produzione, trasformazione e distribuzione degli alimenti. (Reg. CE n. 178/2002 art. 2)*

Indigente: il consumatore finale dei prodotti alimentari distribuiti dalle OC.

Manuale di corretta prassi operativa/igienica: *manuali elaborati e diffusi dai settori dell'industria alimentare, eventualmente in consultazione con i rappresentanti di soggetti i cui interessi possono essere sostanzialmente toccati e tenendo conto dei pertinenti codici di prassi del Codex Alimentarius. (Reg. CE n. 852/2004 art. 8)*

I Manuali sono validati dal Ministero della salute per verificare il rispetto dei requisiti di legge applicabili, che il contenuto risulti funzionale per i settori a cui sono destinati e quindi essi costituiscano uno strumento atto a favorire l'applicazione dei requisiti del Reg. CE n. 852/2004 nei settori e per i prodotti alimentari interessati. Gli operatori del settore alimentare possono usare i manuali su base volontaria. Tali manuali hanno lo scopo di guide, documenti consultivi e orientativi per l'applicazione e l'osservanza degli adempimenti in materia di igiene.

Non Conformità: mancato soddisfacimento di un requisito.

In riferimento ai prodotti alimentari si possono verificare le seguenti ipotesi:

- prodotto difettoso sul piano qualitativo (es. caratteristiche organolettiche non conformi agli standard di prodotto prestabiliti);
- prodotto non in possesso dei requisiti di legge (es. carenza o errore di indicazioni in etichetta);
- prodotto non sicuro e, come tale, non idoneo al consumo.

Operatore del settore alimentare (OSA): *la persona fisica o giuridica responsabile di garantire il rispetto delle disposizioni della legislazione alimentare nell'impresa alimentare posta sotto il suo controllo. (Reg. CE n. 178/2002 art. 2)*

Organizzazione Caritativa (OC): organizzazione senza fine di lucro operante ai fini di beneficenza che distribuisce direttamente o indirettamente derrate alimentari agli indigenti.

OC di I Livello: OC che distribuisce gratuitamente derrate alimentari ad OC di II Livello le quali assistono direttamente l'Indigente, come i Banchi Alimentari, con attività prevalente di logistica.

OC di II Livello: OC che distribuisce gratuitamente derrate alimentari all'Indigente, prevalentemente sotto forma di sostegno periodico (pacchi viveri, Empori Solidali) e fornitura di pasti (Unità di Strada, Mense, Comunità e residenze di accoglienza).

Pacco viveri: trattasi di fornitura di alimenti prevalentemente non deperibili e comunque confezionati in sacchetti o piccoli cartoni.

Pericolo (hazard in lingua inglese): *agente biologico, chimico o fisico contenuto in un alimento o un mangime, o condizione in cui un alimento o mangime si trova, in grado di provocare un effetto nocivo sulla salute. (Reg. CE n. 178/2002 art. 3)*

Prerequisiti/Programma di prerequisiti (PRP): condizioni e attività di base (della sicurezza alimentare) necessarie per mantenere un ambiente igienico lungo tutta la filiera alimentare idoneo alla produzione, gestione e fornitura di prodotti finiti sicuri alimenti sicuri per il consumo umano.

Punto critico di controllo (CCP): f*ase /punto del processo in cui può essere applicato il controllo e che è essenziale per prevenire o eliminare un pericolo per la sicurezza alimentare o ridurlo ad un livello accettabile. (Codex Alimentarus, Appendice).*
Si tratta di un punto, fase in corrispondenza della quale può essere messo in atto un'attività che consenta la prevenzione/riduzione/eliminazione del pericolo. I Punti Critici di controllo di un processo produttivo/distributivo sono definiti da ciascuna azienda sotto la propria responsabilità.
Raccolta prodotti: acquisizione gratuita di derrate alimentari al fine della distribuzione gratuita all' indigente.
Recupero: acquisizione di derrate alimentari, eccedenze alimentari, da tutta la filiera agroalimentare, industria alimentare, Grande Distribuzione Organizzata, ristorazione collettiva e non, catering e pubblici esercizi, al fine della distribuzione gratuita all'indigente.
Refrigerazione: sistema di conservazione dei prodotti mediante abbassamento della temperatura al di sopra del loro punto di congelamento (4°C).
Richiamo dell'alimento: *qualsiasi misura di ritiro del prodotto rivolta anche al consumatore finale, da attuare quando altre misure risultino insufficienti a conseguire un livello elevato di tutela della salute.*
Rintracciabilità: *la possibilità di ricostruire e seguire il percorso di un alimento, di un mangime, di un animale destinato alla produzione Alimentare o di una sostanza destinata o atta ad entrare a far parte di un alimento o di un mangime attraverso tutte le fasi della produzione, della trasformazione e della distribuzione. (art. 3, Accordo n. 2334 del 28/07/2005, Ministero Italiano della Salute, 2005; Reg. CE n. 178/2002 art. 3.)*
La Rintracciabilità è necessaria per la corretta esecuzione delle procedure di ritiro e richiamo degli alimenti.
Rischio: *funzione della probabilità e della gravità di un effetto nocivo per la salute, conseguente alla presenza di un pericolo.(Reg. CE n. 178/2002 art. 3)*
Sostanzialmente il rischio è la risultante di diversi fattori: l'intrinseca gravità del pericolo stesso, l'effettiva probabilità che questo ultimo venga a contatto con il soggetto esposto, le modalità di esposizione e le caratteristiche del soggetto esposto.
Sanificazione: complesso di procedimenti e operazioni atte a rendere igienici locali, attrezzature e utensili mediante l'attività di detergenza-disinfezione.
Sicurezza Alimentare: garanzia che i prodotti alimentari non abbiano un effetto pericoloso sulla salute dei consumatori finali quando vengono preparati e consumati.
Termine Minimo di Conservazione (TMC): *è la data fino alla quale il prodotto Alimentare conserva le sue proprietà specifiche in adeguate condizioni di conservazione, (Reg. CE n. 1169/2011 art. 1.), " Da consumarsi preferibilmente entro…" quando la data contiene l'indicazione del giorno o con la dicitura "da consumarsi preferibilmente entro la fine…" negli altri casi, seguita dalla data oppure dalla indicazione del punto della confezione in cui essa figura. Il Termine Minimo di Conservazione è determinato dal produttore o dal confezionatore o, nel caso di prodotti importati, dal primo venditore stabilito nell'Unione europea, ed è apposto sotto la loro diretta responsabilità.(Dlgs n. 109/1992 art. 10)*
Volontario: soggetto privato che svolge attività di aiuto e di sostegno, in modo gratuito e spontaneo, presso le OC.

CAPITOLO PRIMO

1.1 DATI IMPRESA DEL TERZO SETTORE

Impresa del Terzo Settore: Centro Solidale per il Diritto al Cibo

N° stabilimenti appartenenti all'impresa alimentare: **1** Centro Logistico (Via Pace di Lodi, 9 26900 LODI)

Responsabile del Piano Autocontrollo: Giunta Emanuele

Team Autocontrollo:

Antonella Baldi – Università degli Studi di Milano, facoltà di Medicina Veterinaria
Cristian Bernardi – Università degli Studi di Milano, facoltà di Medicina Veterinaria
Marta Castrica – Università degli Studi di Milano, facoltà di Medicina Veterinaria
Lorenzo Musitelli – Centro Solidale per il Diritto al Cibo di Lodi
Emanuele Giunta – Centro Solidale per il Diritto al Cibo di Lodi
Hounsinou Akossiwoua Akpene – Centro Solidale per il Diritto al Cibo di Lodi

1.2 AREE, LOCALI, IMPIANTI E PERSONALE

LOCALI E IMPIANTI

1. L'attività di recupero e/o acquisto degli alimenti viene svolta in forma ambulante, per l'effettuazione della stessa vengono utilizzati :

    - automezzo tipo: FIAT DUCATO, targa: CD339XG;
    - automezzo tipo: FIAT DOBLO', targa: CT297XC;
    - automezzo tipo: MERCEDES VITO, targa: AY251YN;
    - automezzo tipo: PEUGEOT BOXER, targa: DY244NM;
    - automezzo tipo: PEUGEOT YCDMAB, targa: DT086EE

2. L'attività di stoccaggio in magazzino degli alimenti è svolta in n° **2** locali;
3. L'attività di conservazione degli alimenti è svolta in n° **2** locali (cella frigorifera) di mq:

    - cella N.1: 12 mq^2
    - cella N.2: 5,25 mq^2

4. L'attività di preparazione degli alimenti da distribuire è svolta in n° **1** locale;
5. L'attività di distribuzione degli alimenti da distribuire è svolta in n° **1** locale.

PERSONALE e MANSIONI

Fase/attività	**Descrizione**	**Area/locale**	**Resp. fase / Resp. della verifica**
Approvvigionamento/ Trasporto	Approvvigionamento/trasporto degli alimenti recuperati e/o acquistati	Automezzo refrigerato o non refrigerato	Giunta Emanuele
Ricevimento merci/Controlli al ricevimento	Arrivo alimenti recuperati e/o acquistati / Controllo per accettazione / Procedura operativa	Ricevimento merci	Giunta Emanuele
Stoccaggio/ conservazione	Conservazione alle temperature di riferimento dei prodotti recuperati e/o acquistati	Magazzini Dotazioni frigorifere	Giunta Emanuele
Preparazione degli alimenti da distribuire	Attività di manipolazione degli alimenti per la preparazione alla distribuzione	Nel locale predisposto a questa attività	Giunta Emanuele
Distribuzione	Attività di distribuzione degli alimenti recuperati	Nel locale predisposto a questa attività	Giunta Emanuele

DEFINIZIONE DEL PRODOTTO

Descrizione delle tipologie dei prodotti recuperati e/o acquistati e/o stoccati e/o conservati e/o distribuiti:
Il Centro Solidale di Raccolta per il Diritto al Cibo gestisce prodotti riconducibili a due categorie:
- Deperibili
- Non deperibili

Nel caso di prodotti deperibili gli alimenti necessitano una conservazione in catena del freddo continua affinché possano giungere al consumatore finale, l'indigente, con lo standard qualitativo iniziale.

Elenco dei prodotti gestiti dall'impresa del Terzo Settore sono riconducibili a due macrocategorie:

Prodotti di origine animale e vegetale preconfezionati conservati in catena del freddo quali:
- Prodotti di salumeria preconfezionati
- Carne fresca refrigerata in tagli preconfezionati
- Latte fresco pastorizzato
- Yogurt
- Preparati per torte, budini, creme
- Frutta e verdura di IV gamma
- Formaggio fresco porzionato preconfezionato (ricotta, primo sale)
- Formaggio stagionato
- Uova

Prodotti con caratteristiche di stabilità termica quali:
- Alimenti trattati ad alte temperature UHT (latte, succhi di frutta)
- Essiccati (spezie, frutta secca)
- Conserve di carne e pesce
- Ortofrutta di I gamma, pane, pasta, riso, prodotti da forno, biscotti, caffè, etc…

CAPITOLO SECONDO

2.1 DESCRIZIONE ATTIVITÀ

L’Impresa del Terzo Settore opera nel “sistema di recupero e distribuzione ai fini di solidarietà sociale”, come un centro di raccolta e stoccaggio/conservazione e distribuzione di derrate alimentari diretta e indiretta al beneficiario finale (l’indigente) di prodotti alimentari recuperati e/o acquistati con attività regolarmente autorizzata, ai fini igienico sanitari, dagli Organi Competenti Territoriali.

Le modalità di espletamento dell'attività produttiva sono state identificate in:

1. ATTIVITÀ GENERALI: ovvero, tutte quelle attività che precedono lo stoccaggio/conservazione;

2. ATTIVITÀ SPECIFICHE: ovvero, tutte quelle attività che intercorrono tra lo stoccaggio/conservazione iniziale dei prodotti alimentari fino al momento della distribuzione al consumatore finale/indigente.

ATTIVITA' GENERALI
Approvvigionamento (recupero/acquisto) prodotto alimentare regolati contrattualmente con il Centro di Raccolta solidale per il Diritto al Cibo
Trasporto dei prodotti alimentari

ATTIVITA’ SPECIFICHE * vedere diagramma di flusso specifico
Ricevimento, parametri d’accettazione dell’alimento (Controlli al ricevimento)
Stoccaggio/conservazione di prodotti alimentari
Preparazione, gestione degli alimenti in uscita
Distribuzione degli alimenti

Il cap. 2.2 rappresenta la modalità con cui si sono individuate le fasi inerenti il processo di gestione degli alimenti recuperati dell’insediamento con l’ordinamento logico sequenziale in diagrammi di flusso.

Il successivo cap. 2.3 riporta l’analisi dei pericoli e la valutazione dei rischi effettuata con il metodo proposto dalla Comunità Europea per l’identificazione dei CCP “Albero delle decisioni (Decision Tree).

2.2 IDENTIFICAZIONE DELLE FASI PRODUTTIVE E DIAGRAMMI DI FLUSSO

MACROFASE	DEFINIZIONE	PRESENZA	FASE
APPROVVIGIONAMENTO	Azione mediante la quale un prodotto viene acquistato e/o recuperato da industrie, GDO e OC di I livello.	X	APPROVVIGIONAMENTO: Ricevimento e/o acquisto di prodotti alimentari con consegna regolata dal contratto con il Centro Solidale per il Diritto al Cibo
TRASPORTO	Azione mediante la quale gli alimenti acquistati e/o recuperati vengono trasportati in mezzi refrigerati o non refrigerati all'OC.	X	TRASPORTO: In automezzo Refrigerato (T °C ≤ 4), vedi allegato A1 T °C non controllata/ambiente
RICEVIMENTO	Fase in cui gli alimenti vengono sottoposti a controllo per confermarne l'accettabilità al recupero	X	Controlli al ricevimento
STOCCAGGIO	Azione mediante la quale un prodotto viene custodito nel tempo	X	STOCCAGGIO/CONSERVAZIONE: In cella frigorifera (T °C ≤4) T °C non controllata/ambiente
PREPARAZIONE	Attività di manipolazione degli alimenti per la preparazione dei prodotti da distribuire	X	PREPARAZIONE: Rotazione degli stock nei locali di stoccaggio e celle frigorifere Preparazione pacchi viveri
DISTRIBUZIONE	Trasferimento dei prodotti al beneficiario finale o organizzazione caritativa	X	DISTRIBUZIONE: In automezzo: Refrigerato (T °C ≤4) T °C non controllata/ambiente Direttamente al beneficiario finale nei locali predisposti alla distribuzione

ATTIVITÀ GENERALI

1

APPROVVIGIONAMENTO

Recupero e/o acquisto dei prodotti alimentari,
con consegna regolata dal Contratto con Centro Solidale per il Diritto al Cibo

2

TRASPORTO

In automezzo:
Refrigerato (T °C ≤4)
T °C non controllata/ambiente

3

ALLA "TIPOLOGIA DI ALIMENTO"

ATTIVITA' SPECIFICHE

- **Alimenti deperibili confezionati a temperatura controllata conservati in catena del freddo continua** (conservazione in cella frigorifera ±4°C)

DAL TRASPORTO (2)

⇩

3
RICEVIMENTO
Controlli al ricevimento
Parametri d'accettazione

⇩

4
CONSERVAZIONE
In cella frigorifera (T °C ≤4)

⇩

5
PREPARAZIONE
Gestione degli alimenti in uscita

⇩

6
DISTRIBUZIONE
degli alimenti diretta/indiretta

- **Alimenti deperibili non confezionati con caratteristiche di stabilità termica** (conservazione a temperatura ambiente +18/20°C)
- **Alimenti non deperibili confezionati**

DAL TRASPORTO (2)

⇩

3
RICEVIMENTO
Controlli al ricevimento
Parametri d'accettazione

⇩

4
STOCCAGGIO IN MAGAZZINO
T °C non controllata/ambiente

⇩

5
PREPARAZIONE
Gestione degli alimenti in uscita

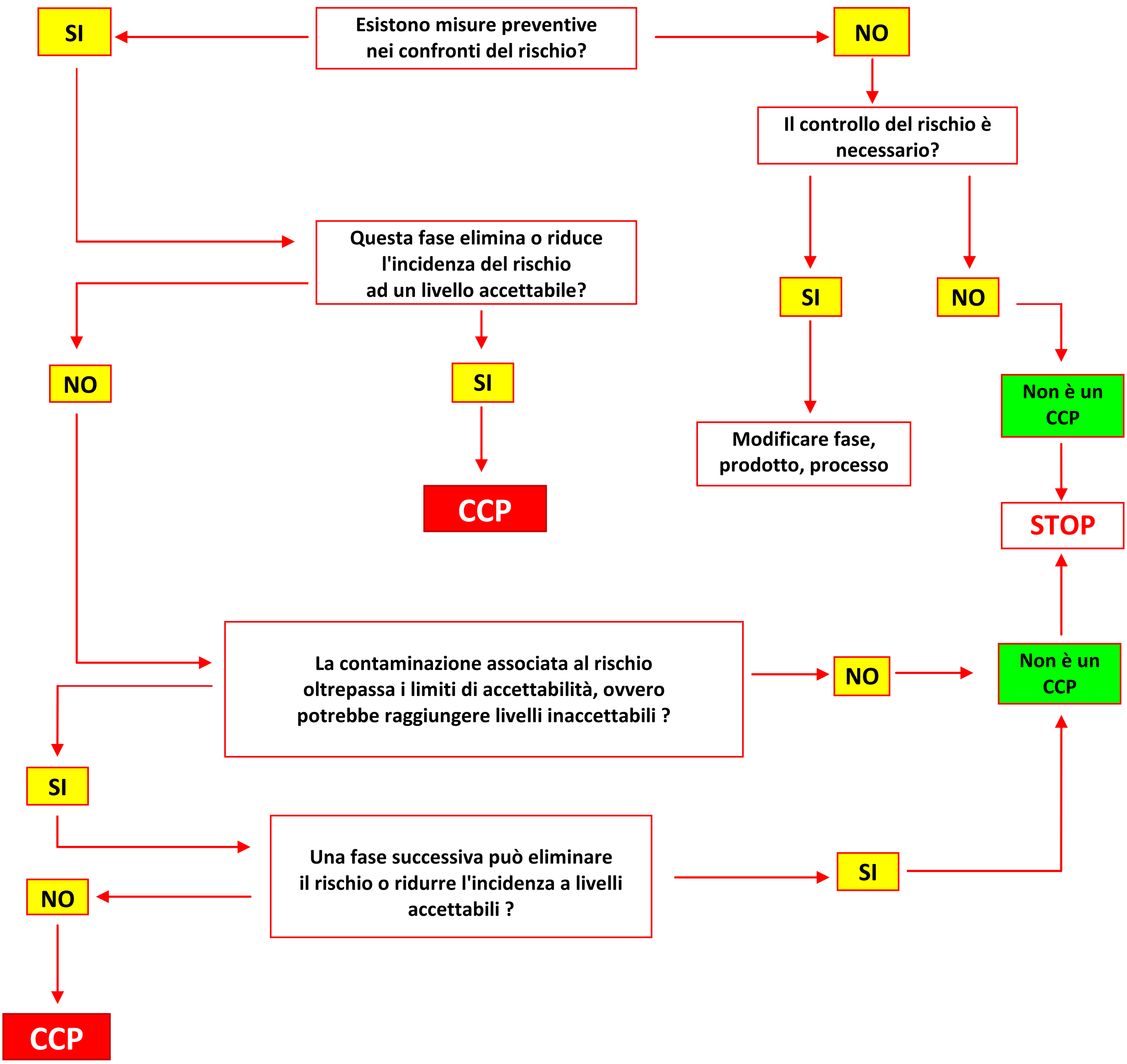
⇩

6
DISTRIBUZIONE
degli alimenti diretta/indiretta

2.3 ANALISI DEI PERICOLI E VALUTAZIONE DEI RISCHI

ALBERO DELLE DECISIONI
DECISION TREE

Per ogni rischio identificato rispondere in sequenza alle domande sotto riportate



***CCP: Punto Critico di Controllo**

FASE PROCESSO	PERICOLO	PC	PCC	MISURA DI CONTROLLO	LIMITE CRITICO	MONITORAGGIO METODO	MONITORAGGIO F.Q. VERIFICA	AZIONE CORRETTIVA
APPROVVIGIONAMENTO Recupero/acquisto dei prodotti alimentari	**B F**		X	Procedura 02 Procedura 03 Procedura 04 Procedura 09	Integrità delle confezioni Presenza di regolare etichettatura Data di scadenza o TMC (ove prevista) non superati Assenza di colore, odore o consistenza anomali Assenza di rigonfiamenti delle confezioni e dei barattoli Assenza di corpi estranei visibili. Rispetto delle corrette temperature di conservazione	Controllo visivo Controllo etichettatura	Come da procedure: Procedura 02 Procedura 03 Procedura 04 Procedura 09	Rifiuto dei prodotti non conformi Avviso al fornitore dell'accaduto
TRASPORTO In automezzo: Refrigerato (T °C < 4) T °C non controllata/ambiente	**B C F**		X	Procedura 01 Procedura 03 Procedura 04 Procedura:05 Procedura 08	Tollerabilità alle temperature durante il trasporto	Controllo pulizia di mezzi e attrezzature Controllo della temperatura durante il trasporto	Come da procedure: Procedura 01 Procedura 03 Procedura 04 Procedura 05 Procedura 08	Gli alimenti non trasportati a temperatura adeguata devono essere esclusi dal recupero Verificare la temperatura e lo stato di pulizia degli automezzi
STOCCAGGIO T °C non controllata/ambiente	**B C F**		X	Procedura 01 Procedura 02 Procedura 03 Procedura 05 Procedura 07 Procedura 08	Integrità delle confezioni Presenza di regolare etichettatura Data di scadenza o TMC (ove prevista) non superati Assenza di colore, odore o consistenza anomali Assenza di rigonfiamenti delle confezioni e dei barattoli Assenza di corpi estranei visibili.	Controllo visivo Controllo etichettatura Controllo pulizia attrezzature Eseguire corretto sistema di rotazione degli stock	Come da procedure: Procedura 01 Procedura 02 Procedura 03 Procedura 05 Procedura 07 Procedura 08	Gli alimenti che presentano evidenti segni di contaminazione essere eliminati Verificare l'idoneità dei locali di stoccaggio

CONSERVAZIONE Refrigerata (T °C < 4)	**F B**		X	Procedura 01 Procedura 02 Procedura 03 Procedura 05 Procedura 07 Procedura 08	Temperature di conservazione	Controllo sensoriale Controllo del rispetto delle corrette temperature di conservazione Controllo etichettatura	Come da procedure: Procedura 01 Procedura 02 Procedura 03 Procedura 05 Procedura 07 Procedura 08	Gli alimenti conservati a temperatura non adeguata devono essere eliminati Verificare la temperatura e lo stato di pulizia delle dotazioni frigorifere
PREPARAZIONE Gestione degli alimenti in uscita	**B C F**		X	Procedura 02 Procedura 03 Procedura 08	Assenza di contaminazioni Rispetto delle norme di corretta prassi igienica (GHP) e di igiene personale	Valutazione idoneità dell'alimento	Come da procedure: Procedura 02 Procedura 03 Procedura 08	Eliminazione dei prodotti che risultano non conformi
DISTRIBUZIONE degli alimenti	**B C F**	X		Procedura 02 Procedura 03 Procedura 08 Procedura 09	Rispetto delle norme di corretta prassi igienica (GHP) e di igiene personale	Corrette procedure di distribuzione	Come da procedure: Procedura 02 Procedura 03 Procedura 08 Procedura 09	

B: biologico C: chimico F: fisico **PC: punto di controllo** **PCC: punto critico di controllo**

CAPITOLO TERZO

ELENCO E DESCRIZIONE DELLE PROCEDURE

01 MANUTENZIONE DEI LOCALI E DELLE ATTREZZATURE
02 IGIENE DEL PERSONALE
03 FORMAZIONE DEL PERSONALE
04 REQUISITI APPLICABILI AI PRODOTTI ALIMENTARI RECUPERATI IN ENTRATA
05 PROCEDURE IGIENICHE NELLE VARIE FASI DI GESTIONE DEL PRODOTTO: TRASPORTO, STOCCAGGIO, CONSERVAZIONE E DISTRIBUZIONE
06 GESTIONE DEI RIFIUTI
07 CONTROLLO DEGLI INFESTANTI
08 PULIZIA E DISINFEZIONE DEI LOCALI E DELLE ATTREZZATURE
09 RINTRACCIABILITÀ

SCOPO

La presente procedura ha lo scopo di illustrare compiti, responsabilità e le attività svolte dal Centro Solidale per il Diritto al Cibo di Lodi nella manutenzione dei locali e delle attrezzature.

CAMPO DI APPLICAZIONE

La presente procedura si applica a tutti i locali e le attrezzature utilizzate dal Centro Solidale per il Diritto al Cibo di Lodi.

RIFERIMENTI E RICHIAMI

Manuale per le Corrette Prassi Operative per le Organizzazioni Caritative (MCPO-OC), 2016
Capitolo I dell'allegato II al Regolamento CE 852/2004

RESPONSABILITÀ

Funzionario Responsabile del piano di autocontrollo
Volontari del Centro per il Diritto al Cibo di Lodi adetti alla manutenzione dei locali e delle attrezzature

CRITERI GENERALI

I locali devono essere tenuti puliti, sottoposti a manutenzione e tenuti in buone condizioni.

Requisiti generali dei locali e delle attrezzature

- Devono consentire un'adeguata pulizia e disinfezione;
- Devono essere tali da impedire l'accumulo di sporco e il contatto con materiali tossici, penetrazione di corpi estranei nei prodotti alimentari e per quanto possibile la formazione di muffa indesiderabile sulle superfici;
- Devono consentire una corretta prassi igienica impedendo ogni forma di contaminazione dovuta al corretto stoccaggio;
- Devono fornire ove necessario adeguate condizioni di temperatura per una corretta conservazione dal punto di vista igienico delle derrate alimentari;
- I locali destinati allo stoccaggio/conservazione dei prodotti alimentari devono essere separate dai locali adibiti allo stoccaggio di altri prodotti (prodotti per la pulizia dei locali e delle attrezzature);
- Tutte le attrezzature che vengono a contatto con le derrate alimentari devono essere tenute pulite al fine di evitare contaminazioni.

SCOPO

La presente procedura ha lo scopo di definire le regole igieniche in merito all'abbigliamento ed al comportamento che deve essere adottato del personale volontario nelle diverse fasi del recupero.
Il responsabile del piano di autocontrollo ha il compito di vigilare e accertarsi che tali regole siano rispettate e che gli addetti volontari abbiano ricevuto un'adeguata formazione, in materia di igiene alimentare, in relazione al tipo di mansione espletata.

CAMPO DI APPLICAZIONE

Tutti gli addetti volontari impegnati nelle fasi di recupero, stoccaggio/conservazione e distribuzione degli alimenti raccolti a fini caritativi.

RIFERIMENTI E RICHIAMI

Manuale per le Corrette Prassi Operative per le Organizzazioni Caritative (MCPO-OC), 2016
Capitolo VIII, dell'allegato II al Regolamento CE 852/2004
D.P.R 327/80

RESPONSABILITÀ

La responsabilità ricade su tutti gli addetti volontari impegnati nelle fasi di recupero, stoccaggio, distribuzione degli alimenti raccolti a fini caritativi.
Gli addetti volontari hanno il dovere di:
-sottoporsi a formazione
-applicare gli standard previsti dal Centro Solidale per il Diritto al Cibo di Lodi
-segnalare ogni problema che possa sorgere nell'applicazione della presente procedura

CRITERI GENERALI

L'abbigliamento da lavoro è indicato/definito nella tipologia dal Centro Solidale per il Diritto al Cibo di Lodi.

<u>Utilizzo degli abiti da lavoro</u>

Il personale addetto / volontario deve:

- Indossare l'abbigliamento indicato per le varie fasi dal responsabile del piano di autocontrollo;
- Gli indumenti e/o le divise dove previste devono essere di tipo usa e getta;
- Togliere qualsiasi monile, piercing, orologio, orecchini etc… eccetto la fede, ove previsto e necessario e durante l'espletamento di manipolazione diretta degli alimenti.

Modalità di Lavaggio delle mani

Il lavaggio delle mani deve essere eseguito nella seguente maniera:

1. Risciacquo in acqua tiepida;
2. Insaponatura completa di tutta la superficie della mano avendo cura di strofinare particolarmente il palmo, i polpastrelli e le zone poste tra le dita e sotto le unghie;
3. Risciacquo per almeno 20 secondi sotto il getto d'acqua;
4. Asciugatura con salviette o rotoli di carta a perdere;
5. Gettare immediatamente la carta a perdere utilizzata nel cestino;
6. Evitare di toccare con le mani appena lavate maniglie e rubinetti sporchi.

Criteri per il lavaggio delle mani

Gli addetti / volontari devono lavarsi le mani dopo:

1. Essere andati ai servizi igienici;
2. Aver toccato superfici sporche;
3. Essersi soffiato il naso;
4. Aver toccato i contenitori dei rifiuti o cartoni;
5. Aver mangiato;
6. Aver fumato;
7. Aver eseguito operazioni di pulizia;
8. Aver maneggiato denaro o telefono;
9. Utilizzare guanti mono-uso in caso di ferite alle mani.

Prescrizioni comportamentali

Gli addetti / volontari devono osservare le seguenti disposizioni:

- Divieto di prestare la loro opera in presenza di sintomatologia gastro-enterica o respiratoria e patologie conclamate;
- Divieto di fumare e mangiare durante lo svolgimento delle attività;
- Utilizzare guanti mono-uso in caso di ferite alle mani.

SCOPO

Fornire al personale volontario/addetti una formazione continua e specifica in materia di sicurezza alimentare in relazione all'attività svolta, con lo scopo di formare il personale sul sistema HACCP, le sue metodologie di monitoraggio e raccolta dati e sul proprio ruolo di responsabilità all'interno dello stesso.

CAMPO DI APPLICAZIONE

Tutti gli addetti volontari impegnati nelle fasi di recupero, stoccaggio/conservazione e distribuzione degli alimenti raccolti a fini caritativi.

RIFERIMENTI E RICHIAMI

Manuale per le Corrette Prassi Operative per le Organizzazioni Caritative (MCPO-OC), 2016
Capitolo XII, dell'allegato II al Regolamento CE 852/2004

RESPONSABILITÀ

Funzionario Responsabile del piano di autocontrollo.

CRITERI GENERALI

La formazione deve essere documentata ed aggiornata ogni volta vengano apportate modifiche alle procedure stabilite
Gli attestati di formazione rilasciati al termine del corso devono contenere:

- I dati personali del soggetto formato;
- Le ore di corso svolte;
- La data ed il luogo di rilascio dell'attestato;
- I dati relativi al soggetto formatore;
- Il programma relativo al corso svolto.

I successivi aggiornamenti sono registrati su apposita scheda riportante nome e cognome del personale presente all'incontro formativo, argomenti trattati, data dell'evento, firma dei partecipanti e del docente.

DOCUMENTI E REGISTRAZIONI
A5

SCOPO

La presente procedura ha lo scopo di illustrare compiti, responsabilità e le attività svolte dal Centro Solidale per il Diritto al Cibo di Lodi nell'approvvigionamento dei PRODOTTI ALIMENTARI dai:
Punti vendita della Grande Distribuzione Organizzata, di seguito GDO;
Dalle organizzazioni caritative di primo livello, di seguito OC I livello.

CAMPO DI APPLICAZIONE

La presente procedura si applica agli alimenti messi a disposizione dalla GDO e dalle OC di I livello, secondo quanto previsto da Accordi Quadro debitamente sottoscritti dal Centro Solidale per il Diritto al Cibo di Lodi.

RIFERIMENTI E RICHIAMI

Accordo Quadro con GDO e OC I LIVELLO di riferimento
Manuale per le Corrette Prassi Operative per le Organizzazioni Caritative (MCPO-OC), 2016
Regolamento CE 852/2004, 853/2004, 854/2004, 882/2004
Regolamento CE 178/ 2002
D.P.R 327/80
Legge 283/1962
C.D Legge del Buon Samaritano n. 155/2003
Legge 147/2013

RESPONSABILITÀ

Funzionari Amministrazione del Centro Solidale per il Diritto al Cibo di Lodi per stesura Accordi e loro gestione;
Funzionario Responsabile logistica gestione ritiri;
Responsabile di Rifermento GDO e della OC I livello;
Volontari del Centro per il Diritto al Cibo di Lodi addetti al ritiro;
Responsabili accettazione prodotti alimentari e loro gestione.

CRITERI GENERALI

La periodicità, il numero dei ritiri, l'orario dei ritiri nonché la tipologia dei prodotti oggetto di cessione sono concordati tra il responsabile di riferimento/l'ente donatore (GDO e/o OC di I livello) e il responsabile di riferimento del Centro Solidale per il Diritto al Cibo di Lodi/ ente ricevente, tenendo conto delle esigenze delle due parti, in modo da non intralciare le attività ordinarie, per favorire la successiva distribuzione dei prodotti.

Modalità di accettazione dei prodotti

I volontari addetti al ritiro del Centro Solidale per il Diritto al Cibo devono assicurare che gli alimenti messi a disposizione dalla GDO e dall'OC I livello (ente donatore) siano stati selezionati e pesati per tipologia.
Devono inoltre assicurarsi che, per quanto possibile, cioè in relazione alle quantità e alla modalità di preparazione dei rolls o dei pallets, etc… che :

- I prodotti non abbiano oltrepassato la data di scadenza;
- I prodotti abbiano una TMC possibilmente non superata e/o comunque all'interno dei criteri previsti dal Manuale per corrette prassi operative per le organizzazioni caritative (preso come riferimento);
- I prodotti refrigerati siano ad una temperatura ≤4°C o che comunque non abbiano una temperatura superiore a 8°C;
- Gli imballi primari e secondari siano integri;
- Siano presenti le etichette e le relative date di scadenza o TMC visibili;
- Gli alimenti in lattina o tetrapack ecc. non siano danneggiate e non presentino fessurazioni o bombature, percolamenti di liquido ecc.;
- Abbiano aspetto, odore, colore, ove sia possibile l'accertamento, conforme e tipico.

DOCUMENTI E REGISTRAZIONI
A4

SCOPO

La presente procedura ha lo scopo di illustrare compiti, responsabilità e le attività svolte dal Centro Solidale per il Diritto al Cibo di Lodi nelle varie fasi di gestione del prodotto: trasporto, stoccaggio, conservazione e distribuzione.

CAMPO DI APPLICAZIONE

La presente procedura si applica agli alimenti RECUPERATI dal Centro Solidale per il Diritto al Cibo di Lodi.

RIFERIMENTI E RICHIAMI

Manuale per le Corrette Prassi Operative per le Organizzazioni Caritative (MCPO-OC),2016
Regolamento CE 852/2004

RESPONSABILITÀ

Funzionario Responsabile Logistica gestione ritiri e Responsabile piano di autocontrollo
Volontari del Centro per il Diritto al Cibo di Lodi Addetti VARIE FASI DI GESTIONE DEL PRODOTTO: TRASPORTO, STOCCAGGIO, CONSERVAZIONE E DISTRIBUZIONE.

CRITERI GENERALI

La periodicità, il numero dei ritiri, l'orario dei ritiri nonché la tipologia dei prodotti oggetto di cessione sono concordati tra il responsabile di riferimento/l'ente donatore (GDO e/o OC di I livello) e il responsabile di riferimento del Centro Solidale per il Diritto al Cibo di Lodi/ ente ricevente, tenendo conto delle esigenze delle due parti, in modo da non intralciare le attività ordinarie, per favorire le successive fasi di stoccaggio, conservazione e distribuzione dei prodotti.

FASE

Trasporto degli alimenti dal punto di ritiro al Centro Solidale per il Diritto al Cibo di Lodi

Il trasporto degli alimenti deve avvenire nel più breve tempo possibile e comunque con modalità tali da impedire il rialzo termico oltre ai criteri stabiliti per le differenti categorie alimentari come previsto dalla legge.

I mezzi di trasporto a disposizione per il trasporto degli alimenti possono essere:

- Automezzo refrigerato con vano di carico a + 10°C
- Automezzo non refrigerato

Procedura per il trasporto degli alimenti alimenti deperibili confezionati a temperatura controllata conservati in catena del freddo continua

- Automezzo refrigerato con temperatura impostata sul mantenimento del prodotto più delicato.

Procedura per il trasporto degli Alimenti deperibili non confezionati con caratteristiche di stabilità termica (conservazione a temperatura ambiente 18/20°C) **e alimenti non deperibili confezionati**

- Automezzo non refrigerato salvaguardando l'integrità della merce e mantenendo gli imballi ove presenti integri.

Igiene e sicurezza
Gli automezzi e le attrezzature utilizzate per il trasporto degli alimenti, specialmente crudi, verranno sanificati alla fine di ogni trasporto.

Da evitare
Trasportare contemporaneamente nello stesso termobox DIVERSE TIPOLOGIE DI ALIMENTI (es. carne, pesce, latticini, etc) per prevenire rischi di contaminazioni crociate DOVUTE A EVENTUALI DANNEGGIAMENTI DELLE CONFEZIONI.

Da raccomandare
La dotazione di cassette in plastica alimentare per il trasporto di frutta, pane e altri alimenti che non necessitano di refrigerazione.
Tutti i prodotti alimentari devono essere collocati nei rispettivi locali di conservazione il più rapidamente possibile, in modo da proteggerli da qualsiasi forma di contaminazione e sviluppo microbico e nel rispetto delle temperature idonee di conservazione.

FASE
Stoccaggio degli alimenti presso il Centro Solidale per il Diritto al Cibo di Lodi

Procedura di Gestione degli alimenti nel magazzino
- Conservare I materiali per la pulizia separati dagli alimenti;
- Attuare un corretto sistema di rotazione degli stock;
- Distribuire prima i prodotti più vicini alla scadenza "da consumarsi entro il…" e/o successivamente i prodotti vicini alla TMC " da consumarsi preferibilmente entro il…";
- Eliminare i prodotti che hanno oltrepassato la data di scadenza, "da consumarsi entro il…";
- Collocare in un luogo fresco e asciutto, lontano da fonti di calore e dalla luce diretta del sole e comunque secondo le indicazioni riportate in etichetta i prodotti che possono essere conservati a temperatura ambiente (es. scatolame, farine ecc.);
- Utilizzare idonei supporti per evitare che gli alimenti siano collocati a terra.

FASE
Conservazione degli alimenti presso il Centro Solidale per il Diritto al Cibo di Lodi

- I prodotti refrigerati, devono essere riposti il prima possibile nelle idonee attrezzature di conservazione e alle temperature previste per evitare l'interruzione della catena del freddo;
- Utilizzare idonei supporti per evitare che gli alimenti siano collocati a terra;
- La conservazione degli alimenti di tipologia differente nello stesso frigorifero può essere condotta ma occorre mantenere un'idonea separazione utilizzando adeguati sistemi protettivi, in questo caso la temperatura di conservazione sarà quella dell'alimento che deve essere conservato a temperatura inferiore;
- Le temperature massime di conservazione dei prodotti refrigerati sono quelle indicate dai produttori sulle confezioni.

FASE
Preparazione e distribuzione degli alimenti presso il Centro Solidale per il Diritto al Cibo di Lodi

- I prodotti alimentari al momento della preparazione per la successiva distribuzione non devono presentare segni di contaminazioni, confezioni non integre, presenza di segni di deterioramento.
- Nella fase di preparazione e distribuzione devono essere rispettate le norme di corretta prassi igienica (GHP) e di igiene personale.

Gestione degli alimenti non conformi
I prodotti alimentari non conformi (confezione danneggiata, date di scadenza superata), non devono essere accettati ma resi al fornitore, e/o in caso di impossibilità di reso eliminati e comunque resi indisponibili alle successive fasi di distribuzione saranno quindi segregati in scatole adibite a questo scopo, e identificati con apposito cartello, separati quindi dai prodotti alimentari conformi.

SCHEDE TEMATICHE
A0
A1

SCOPO
La presente procedura ha lo scopo di illustrare compiti, responsabilità e le attività svolte dal Centro Solidale per il Diritto al Cibo di Lodi nella gestione dei rifiuti.

CAMPO DI APPLICAZIONE
La presente procedura si applica al Centro Solidale per il Diritto al Cibo di Lodi.

RIFERIMENTI E RICHIAMI
Manuale per le Corrette Prassi Operative per le Organizzazioni Caritative (MCPO-OC), 2016
Capitolo VI, dell'allegato II al Regolamento CE 852/2004

RESPONSABILITÀ
Funzionario Resp del piano di autocontrollo
Volontari del Centro per il Diritto al Cibo di Lodi

CRITERI GENERALI
I rifiuti devono essere gestiti in maniera tale da non creare rischi di contaminazione per i prodotti alimentari, per questo motivo i rifiuti devono essere allontanati periodicamente, nell'arco della giornata, dai locali sono vengono gestiti i prodotti alimentari.
Gli imballaggi vuoti, in carta, cartone, plastica, vetro etc…, vengono conferiti al Servizio pubblico di raccolta, tramite gli appositi cassonetti specializzati.

Procedure di gestione dei rifiuti
- I rifiuti, devono essere raggruppati in appositi contenitori chiusi, con coperchio apribile a pedale e devono essere mantenuti in buone condizioni igieniche;
- I rifiuti non devono essere mai abbondonati nelle aree di lavoro;
- I locali di deposito dei rifiuti devono essere puliti e al riparo da animali e infestanti.

SCOPO

La presente procedura ha lo scopo di illustrare compiti, responsabilità e le attività svolte dal Centro Solidale per il Diritto al Cibo di Lodi nel monitoraggio degli animali e degli infestanti.

CAMPO DI APPLICAZIONE

La presente procedura si applica ai locali interni e nel perimetro esterno al Centro Solidale per il Diritto al Cibo di Lodi.

RIFERIMENTI E RICHIAMI

Manuale per le Corrette Prassi Operative per le Organizzazioni Caritative (MCPO-OC), 2016
Capitolo IX, dell'allegato II al Regolamento CE 852/2004

RESPONSABILITÀ

Funzionario Responsabile del piano di autocontrollo

CRITERI GENERALI

È obbligatorio adottare procedure atte a monitorare periodicamente e a rielevare l'eventuale presenza di insetti o animali infestanti (ratti), attraverso il piazzamento all'interno dei locali in punti strategici dei dispositivi di monitoraggio (trappole).
Solo nel caso in cui si rilevi la presenza di infestanti si deve procedere con un piano di disinfestazione e/o derattizzazione.

Procedure per il monitoraggio degli insetti e animali infestanti

Metodo di controllo:

1. Verificare l'eventuale presenza di tracce riconducibili ad una probabile infestazione (ragnatele, escrementi, cavi rosicchiati, frammenti d'insetti);
2. Controllo visivo dei locali.

Frequenza del controllo: Settimanale.
Registrazioni: Registro controllo infestanti mensili.
Limiti: Assenza infestanti.

Interventi:
In caso di infestazione si procede come di seguito:

1. Chiudere i locali da sottoporre ad intervento;

2. Contattare un'impresa specializzata per effettuare gli opportuni interventi di bonifica;

3. Rimuovere tutti gli alimenti presenti nei locali;

4. farsi rilasciare dalla ditta incaricata una relazione completa e dettagliata dell'intervento eseguito da allegare al presente piano d'autocontrollo;

5. Sanificare gli ambienti e le attrezzature secondo quanto previsto dalle relative procedure.

DOCUMENTI E REGISTRAZIONI
A3

SCOPO

La presente procedura ha lo scopo di illustrare compiti, responsabilità e le attività svolte dal Centro Solidale per il Diritto al Cibo di Lodi nella pulizia e disinfezione dei locali e delle attrezzature.

CAMPO DI APPLICAZIONE

La presente procedura si applica ai locali interni del Centro Solidale per il Diritto al Cibo di Lodi.

RIFERIMENTI E RICHIAMI

Manuale per le Corrette Prassi Operative per le Organizzazioni Caritative (MCPO-OC), 2016
Regolamento CE 852/2004

RESPONSABILITÀ

Funzionario Responsabile del piano di autocontrollo
Volontari del Centro per il Diritto al Cibo di Lodi addetti alla pulizia dei locali e delle attrezzature

CRITERI GENERALI

Le superfici dei locali, in particolari i locali dove vengono svolte le attività di stoccaggio/conservazione e distribuzione degli alimenti, devono essere tenute in perfetto stato di pulizia eseguendo una corretta procedura di sanificazione.
Il processo di sanificazione si basa su due operazioni ben distinte: la detersione e la sanificazione.

Procedura di pulizia dei locali e delle attrezzature

Sequenza delle operazioni:

1. Rimozione dello sporco grossolano
2. Detersione
3. Risciacquo
4. Disinfezione
5. Risciacquo
6. Asciugatura

Modalità operative:

Fase di rimozione dello sporco: svolta attraverso l'utilizzo di spazzole, getti d'acqua, panni/materiali monouso;
Fase di Detersione: svolta attraverso l'utilizzo di acqua calda (temperatura ottimale 45/50°C) e idoneo detersivo e per un tempo di contatto con la superficie e/o attrezzatura (tempo di contatto di almeno 5 minuti);
Fase di risciacquo: svolta attraverso l'utilizzo di acqua;
Fase di disinfezione: svolta attraverso soluzioni opportunamente diluite, con tempi di contatto di almeno 15-20 minuti in quanto l'effetto di un disinfettante non è mai istantaneo;
Fase di risciacquo: svolta attraverso l'utilizzo di acqua;
Fase di asciugatura: svolta attraverso l'utilizzo di panni/materiali e/o lasciare asciugare spontaneamente.

Igiene e sicurezza

Una superficie sanificata ha i seguenti requisiti:

1. Assenza di tracce di contaminanti (chimici, fisici e microbiologici);
2. Assenza di odori sgradevoli;
3. Assenza al tatto di grasso o polvere.

SCOPO

Garantire la tracciabilità dei prodotti alimentari in entrata e in uscita gestiti dal Centro Solidale per il Diritto al Cibo di Lodi.

CAMPO DI APPLICAZIONE

La presente procedura si applica ai prodotti alimentari gestiti dal Centro Solidale per il Diritto al Cibo di Lodi.

RIFERIMENTI E RICHIAMI

Manuale per le Corrette Prassi Operative per le Organizzazioni Caritative (MCPO-OC), 2016
Regolamento CE 178/2002

RESPONSABILITÀ

Funzionario Responsabile del piano di autocontrollo
Volontari del Centro per il Diritto al Cibo di Lodi addetti alla gestione dei prodotti alimentari in entrata e in uscita

CRITERI GENERALI

All'interno del "processo distributivo" deve essere garantita la tracciabilità dell'alimento in modo da poter identificare il percorso dell'alimento iniziando: dall'approvvigionamento, trasporto, stoccaggio, conservazione e distribuzione finale al beneficiario, l'indigente.

Tracciabilità in entrata

Documenti:

1. Lista aggiornata dei fornitori con anagrafica;
2. Documento in entrata (DDT) per gli alimenti oggetto di cessione.

Tracciabilità in uscita

Documenti:

1. Elenco aggiornato dei beneficiari finali.

Da raccomandare

Ai fini della salute pubblica in caso di ritiro/richiamo dal mercato si deve provvedere, comunque, a darne comunicazione ai propri utenti con tutti i mezzi possibili.

DOCUMENTI E REGISTRAZIONI

A6

CAPITOLO QUARTO

SCHEDE TEMATICHE

A0 TEMPERATURE DI CONSERVAZIONE

A1 TOLLERABILITA' ALLE TEMPERATURE DURANTE IL TRASPORTO

DOCUMENTI E REGISTRAZIONI

A2 PIANO DI SANIFICAZIONE

A3 REGISTRO DISINFESTAZIONE E DERATTIZZAZIONE

A4 REGISTRO DELLE NON CONFORMITA'

A5 FORMAZIONE DEL PERSONALE

A6 ELENCO FORNITORI

TEMPERATURE DI CONSERVAZIONE		
PRODOTTO	TEMPERATURA DI CONSERVAZIONE	TOLLERABILITA'
• Prodotti di salumeria preconfezionati • Carne fresca refrigerata in tagli preconfezionati • Latte fresco pastorizzato • Yogurt • Preparati per torte, budini, creme • Frutta e verdura di IV gamma • Formaggio fresco porzionato preconfezionato (ricotta, primo sale) • Formaggio stagionato • Uova	**0/+4°C**	**±2°C**
• Alimenti trattati ad alte temperature UHT (latte, succhi di frutta) • Essiccati (spezie, frutta secca) • Conserve di carne e pesce • Ortofrutta di I gamma, pane, pasta, riso, prodotti da forno, biscotti, caffè	**TEMPERATURA AMBIENTE** **(+18/20°C)**	**±2°C**

TOLLERABILITA' ALLE TEMPERATURE DI CONSERVAZIONE DURANTE IL TRASPORTO			
PRODOTTO	TEMPERATURA MASSIMA durante il trasporto (°C)	TEMPERATURA per periodi di breve durata oppure temperatura massima tollerabile nella distribuzione frazionata	NORMATIVA DI RIFERIMENTO
LATTE PASTORIZZATO IN CONFEZIONI	**+4**	**MAX +9**	Allegato C Parte II DPR 327/80 (come sostituito con DM 01/04/88 n. 178)
YOGURT E ALTRI LATTI FERMENTATI IN CONFEZIONE	**+4**	**MAX +14**	Allegato C Parte II DPR 327/80 (come sostituito con DM 01/04/88 n. 178)
PRODOTTI LATTIERO-CASEARI IN CONFEZIONE, PANNA, FORMAGGI FRESCHI	**+4**	**MAX +14**	Allegato C Parte II DPR 327/80 (come sostituito con DM 01/04/88 n. 178)
RICOTTA	**+4**	**MAX +9**	Allegato C Parte II DPR 327/80 (come sostituito con DM 01/04/88 n. 178)
CARNI CONFEZIONATE	**+4**		Reg CE 853/04 All.III, Sez. I-V
CARNI MACINATE	**+2**		Reg CE 853/04 All.III, Sez. I-V
UOVA	**+4** (Temperatura più adatta, preferibilmente costante, per garantire una conservazione ottimale delle loro caratteristiche igieniche)	**MAX +8**	Reg CE 853/04 PARERE EFSA
PASTE STABILIZZATE	Temperatura ambiente (consigliato +18/20)		Art. 9 DPR 187/01

PIANO DI SANIFICAZIONE

PUNTI D'INTERVENTO	INTERVENTO				PRODOTTO	FREQUENZA				ATTREZZATURE	NOTE
	P	De	Di	S		G	S	M	A		

LEGENDA

P= pulizia: rimozione dello sporco grossolano visibile
De= Detersione: rimozione dello sporco con detergente
Di = Disinfezione: eliminazione dei microrganismi patogeni
S = Detersione+sanificazione con impiego di un unico prodotto con capacità detergente e disinfestazione
G = giornaliera
S = settimanale
M = mensile
A = annuale

PROCEDURA COMPLETA DI PULIZIA E SANIFICAZIONE

1. Rimuovere lo sporco visibile grossolano con mezzi meccanici
2. Distribuire sulla superficie il prodotto detergente, preventivamente diluito in acqua non troppo calda (temperatura ottimale compresa tra i 45°C e i 50°C) secondo le proporzioni indicate dal produttore
3. Attendere che il prodotto faccia effetto (normalmente 5 min.)
4. Risciacquare con acqua tiepida
5. distribuire sulla superficie il prodotto disinfettante, preventivamente diluito in acqua secondo le proporzioni e alle temperature indicate dal produttore
6. Attendere che il prodotto faccia effetto (normalmente 15/20 minuti)
7.Risciacquare e lasciar asciugare con panno pulito o carta a perdere

PRODOTTO			NON COMMERCIABILE	% DI DILUIZIONE	TEMPERATURA ACQUA	TEMPO DI CONTATTO	NOTE
De	Di	S					

PIANO DI DISINFESTAZIONE																
	PIANIFICAZIONE			RISULTATI												NOTE
POSTAZIONE	PUNTO DI MONITORAGGIO		FREQUENZA	GENNAIO	FEBBRAIO	MARZO	APRILE	MAGGIO	GIUGNO	LUGLIO	AGOSTO	SETTEMBRE	OTTOBRE	NOVEMBRE	DICEMBRE	
ANIMALI (RODITORI E VOLATILI)																
1																
2																
3																
4																
5																
INSETTI STRISCIANTI																
1																
2																
3																
4																
5																
INSETTI VOLANTI																
1																
2																
3																
4																
5																
RISULTATI: **X**=INFESTAZIONE ASSENTE**; KO=**INFESTAZIONE PRESENTE																

NON CONFORMITA' (NC)			
DATA	PROBLEMA	AZIONE CORRETTIVA ADOTTATA	FIRMA

FORMAZIONE DEL PERSONALE	
DATA DELL'INCONTRO FORMATIVO:	
DURATA:	
NOME E COGNOME DI CHI HA TENUTO L'INCONTRO:	
FIRMA:	
ARGOMENTI TRATTATI:	
ELENCO PARTECIPANTI	
NOME E COGNOME	FIRMA

ELENCO DEI FORNITORI				
RAGIONE SOCIALE	INDIRIZZO	REFERENTE	TELEFONO/FAX	E-MAIL

CAPITOLO QUINTO – BIBLIOGRAFIA DI RIFERIMENTO

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BIOGRAPHY

Marta Castrica was born on the 20st of July 1990 in Rome, Italy. After finishing her bachelor’s degree in Animal Production Sciences at the University of Perugia (Italy), she graduated in Veterinary Biotechnology Sciences (Master’s degree) at the University of Milan (Italy), with a thesis focused on the hygienic aspect in relation to food recovery system.
During her thesis internship, she worked in the ACCREDIA accredited Food Inspection laboratory at Faculty of Veterinary of Milan, and she worked as a voluntary consultant in the quality sector for Fondazione Banco Alimentare Onlus, Milan. In 2015 she started her PhD program in Veterinary and Animal Science at the Department of Health, Animal Science and Food Safety, University of Milan (Italy). During the PhD years she has focused the attention on Innovative Food Waste Reduction and Reuse Strategies.