Plastic Food Packaging: Consumer Perspective

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The use of plastics for packaging has some advantages, since they are flexible and inexpensive. However, most plastics are of single use, which, combined with low recycling or reuse ratios, contributes substantially to environmental pollution. This work is part of a project studying the habits of Portuguese citizens concerning plastic food packaging and focuses on aspects related to sustainability. The survey was carried out via an online questionnaire about sustainability, recycling, and knowledge of the effects of plastic materials or their residues on the environment. The results were obtained based on a statistical analysis of the data. The participants tend to think about the negative impact of plastic packages on the environment; 39% sometimes do not buy plastic; and 30% try to look for alternatives. A substantial fraction, 81%, support the avoidance of plastic utensils and reduction in the use of plastic bags. Most participants have a good knowledge of recycling and strongly agree with the use of recycled materials, and 87% of respondents practice separation of different types of waste for recycling. Changing plastic consumption habits has not been an easy task. Nevertheless, it is expected that society will increasingly move toward sustainable habits, questioning its actions and considering their impact on the environment.

Keywords: food packaging ; plastic ; recycling ; knowledge ; impact ; questionnaire survey

1. Introduction

Food packaging is absolutely essential and modern food systems could not function properly without packaging. Todays' food chains are characterized by their vast geographical spread as well as by value chains at the global level [1]. The primary function of food packaging is to protect the product it contains, preserving its safety and organoleptic characteristics. Among these, properties such as flavour, colour and aroma are highly important for the consumer who will purchase and consume the product. Additionally, the package serves as a barrier for microorganisms and undesirable changes in temperature, light, and moisture, protecting the product during transport and storage against microbial spoilage, chemical modifications, or physical changes. [2]. The packaging functions required for a food package system are expressed as PC3, which stands for Protection, Containment, Communication and Convenience [3]. However, selecting an appropriate package is not the only factor that guarantees the product's shelf-life. In fact, besides selecting the proper material for packaging, which is crucial, the conditions under which the food is stored are equally important [4]. The package is the face of a product and is often the only experience consumers have before making a purchase [5]. Thus, it is essential that the package presents good aesthetics [4] to convince the consumers to buy the product. In this way, packaging can drive sales in a competitive market, as packaging can be designed to enhance the image or differentiate one product from others [6]. In addition, packages bring essential information about the product, such as a list of ingredients, nutritional composition, preparation instructions, brand identification, and prices [5].

Materials that have been commonly used in food packaging embrace glass [7][8], metals [9][10], paper [11][12], plastics [5][13] [14][15], wood [16][17], textile and cork [4]. Modern packaging can encompass more than one type of material to explore and combine the functional or aesthetic properties of each one [5]. The kind of packaging applied varies according to the product characteristics, the level of protection required, the intended shelf-life, the target market, the distribution and the sales circuit [4]. Packaging production translates into a globalized industry characterized by its internal diversity, while on the other hand, each of its sectors individually influences the market [18].

The use of plastic bags to carry groceries and goods goes back to the 1970s [19], but plastic materials have been increasingly used for food since then. In the latest decades, the relative share of plastic on food packaging systems has been way too high due to the many advantages associated with the use of plastics for food packaging: they are fluid and mouldable, offering considerable design flexibility; they are inexpensive and lightweight; and they have a wide range of physical and optical properties [5]. However, they also have disadvantages, the most important ones being their permeability to light, gases, vapours, and low-weight molecules [5]. Plastics can be divided into two groups: thermoplastics and thermosets. Thermoplastics do not suffer chemical changes in their production so that they can be recycled.

Contrarily, thermosets suffer chemical changes in their production, which preclude a new merge; therefore, they are not recyclable [2].

Most plastics are produced from petroleum and are discarded in the environment where they are not degradable, creating considerable environmental problems. The incorrect disposal of plastic bags, and other forms of plastics, has created a problem, since they have found a way to be everywhere, including the oceans, posing a threat to aquatic life, agricultural lands, and the environment in general [20]. Thus, alternatives to plastic bags are necessary, but these alternatives should be less harmful to the environment or have no impact at all [19]. The majority of plastics are of single-use; thus, a significant proportion of this material is lost each year. The immense production, combined with low levels of recycling or reuse, and insufficient sustainable policies to support the circular plastic economy, result in a large contribution of waste to the environment. The United States Environmental Protection Agency (EPA) estimated that 14.5 million tons of plastic containers and packaging were generated in 2018, corresponding approximately to 5% of municipal solid waste generation (in this analysis, the “plastic packaging” as a category excluded single-service plates and cups, as well as trash bags, which are classified as nondurable goods). In 2019, plastic packaging generated around 54% of the global anthropogenic waste [21]. According to EPA, the recycling rate of PET bottles and jars was 29.1 percent in 2018 (910,000 tons).

There are two ways to reduce the primary production of packaging, reuse, and recycling. In the reuse, the product is returned and reused in its original form. Another way to reuse is replacement; that is, containers which allow refilling. Examples of reuse are beverage packaging, such as returnable glass bottles, plastic packaging for personal care products, and cleaning products that would enable the use of refills, as well as refillable water bottles. Recycling involves converting the materials, involving reprocessing into new products [5]. Thus, to make recycling economically viable, the materials need to have a market. Recycling effectiveness is linked to several factors, such as the correct disposal of the material, the type of material, and its conditions after use. Materials such as paper and cardboard, metals, and glass have a more consolidated recycling market, unlike plastics, which have, however, gained more attention recently.

Plastic is not biochemically inert; thus, it can interact with the human body and the environment, causing negative impacts [21]. However, investment in truly sustainable innovations is still scarce. Industries that opt for sustainable packaging generally turn to the use of recycled materials, not considering the production of packaging which uses sustainable raw materials with a low degradation time [2]. Reducing the amount of packaging in food products represents an opportunity, as well as a challenge, for the food and beverage industry, as the main concern is related to food safety. Thus, finding ways to reduce its quantity and subsequent waste is a very challenging task [22]. The requirements for packaging and articles which remain in contact with food are becoming systematically more strict [18], as they can affect the health of consumers and the environment. Nevertheless, the criteria for packaging to produce the lowest environmental impact are difficult to define [22].

Recycled metal and glass materials are considered safe for use in packaging that remain in contact with food, as the heat used to melt and form the material is sufficient to kill microorganisms and pyrolyze organic contaminants. However, in the case of plastics, reprocessing uses enough heat to destroy microorganisms, but it is not enough to pyrolyze all organic contaminants. Thus, post-consumer recycled plastics are hardly used for food packaging [5]. In general, the smaller the number of polymeric components and complexity of plastic packaging, the greater is the recycling value, due to the reduction of steps and technological resources applied in the process [23]. The profitability of the package recycling market shows its attractive aspects for business initiatives in the sector. Still, the success of recycling is directly related to cultural, political, and socioeconomic factors, such as the implementation of recycling companies, the existence of selective collection, and the continuous availability of recyclable waste, incentive programs for recycling projects, encouraging the sale of recycled products, as well as actions in the production–use-consumption chain of packaging [23]. Understanding the profile of people who buy plastic is vital for planning future plastic reduction interventions, legislation, and campaigns [24].

The role of consumers is of most importance in order to help decision-making bodies and governmental regulators to successfully implement measures in order to reduce the use of plastic, and particularly those of single use, which have a high impact on the environment, as well as on human health, as final elements of the possible contamination chains. The study by Adam et al. [25] explored consumer’s attitudes towards the single-use plastics in Ghana considering their effect on marine pollution. They found that while some consumers avoid the consumption of single-use plastics, others consume them without any restrictions. Nevertheless, there was a third group that, although also conscientious about the implications of single-use plastics, still sometimes use them. A study conducted with Canadian consumers [26] revealed that practically all of the participants (around 94%) felt motivated to reduce the consumption of foods packed using single-use plastic. In this study, the authors also said that environmental concerns were more critical than food safety from the

point of view of consumers. On this point, it was an undeniable fact that the Covid-19 pandemic brought to light new challenges concerning food safety, and therefore the work by Kitz et al. investigated the consumer perception of food packaging with single-use plastics during the Covid-19 period. They found that the motivation to reduce plastics was not so strong as before the pandemic, but this decline was not so pronounced among women as it was among men.

2. Discussion

Understanding the different perceptions of the public can allow government authorities to make informed decisions about funding and management priorities, promoting cooperation between society, institutions, and governments [27]. Therefore, knowing the consumers' awareness about the use of plastics and their effects on human health and for the environment can be a trigger for governmental authorities, as well as for industries, to actively promote the shift towards more sustainable packaging systems. Plastics are a part of many items present in our daily lives in many sectors, but packaging is one of the areas that highly contribute to the use of plastics, and in many cases single-use plastics. The increase in the use of plastic in various sectors has caused concern regarding the usage of natural resources for its production, the toxicity associated with its manufacture and use, and the environmental impacts generated by its disposal [20]. To positively contribute to sustainability, packages should be made from environmentally adequate sources, applying clean production technologies with the possibility of being recovered or recycled after being used. Sustainability also depends on consumers, and if the product is not correctly discharged, the sustainability is compromised [2].

The recycling of plastic packaging worries society due to the growing use of these materials and the environmental implications inherent to their non-rational post-consumer disposal [23]. In this work, it was observed that this concern is present since the great majority of participants practice recycling. A similar result was found by Forleo and Romagnoli [28] in Italy, with 87% of respondents always following the separate disposal of plastics. Several factors may have an impact on waste disposal and recycling [5]. Among these stand, for example, the presence of other materials (combined packaging), labels, dirt, damage, or food residues, which remain in post-consumer packaging [23]. Moreover, the economic feasibility of recycling, including the costs of collecting, separating, cleaning or reprocessing and transporting waste [5], highly influences the recycling of plastic materials. In this study, most participants agreed or totally agreed with the use of recycled materials, and demonstrated a good knowledge about recycling, and the higher negative impact of plastics over glass. Plastic is known as the most difficult household waste to degrade. Its degradation releases toxic residues that pollute soil, air, and water [29]. However, people are aware of the negative impact of plastic waste on the environment, and this study confirmed it, with the oceans/seas as the natural sites of greatest concern.

Problems related to its use in food packaging often result from the release of non-plastic components. When exposed to high temperatures, some plastics decompose or oxidize, producing low molecular weight substances that can be toxic. Another problem is related to the ingestion of nano, micro, or macro plastics by animals. Thousands of plastic bags are ingested by animals annually. A study of blue petrel chicks on South Africa found that 90% of them had plastic in their stomachs [20]. These facts contribute to a higher perception in society about the adverse effects of plastics in the oceans/seas. In this sense, measures have been adopted to reduce plastic consumption. China has restricted the use of plastic bags in retail since 2008 and a similar policy was implemented in Malaysia in 2011, in England in 2015 and in Indonesia in 2016 [29]. In Portugal, the plastic bags to carry groceries and other goods were free before, but presently are only provided against payment, encouraging the utilization of reusable bags, and the customers need to bring their own bags or containers. Moreover, in restaurants are prohibited the use of any plastic disposable utensils [30]. This methodology was implemented in Portugal some years ago as a preparatory way for the limitations that the European Union would demand following the regulations approved in 2019, according to which there would be a measurable reduction in the consumption of single-use plastic products in the EU until 2026 [31]. In Portugal, the decrease in the use of disposable plastics in the restoration was expected to start in 2020, before the deadlines established by the European directive. However, due to the Covid-19 pandemic, the measure was postponed. Decree-Law No. 22-A/2021 [32] "is postponed to 1 July 2021 the obligation of catering and beverage service providers to adapt to the provisions of Law no. 76/2019" [33], which determines "the non-use and non-availability of single-use plastic tableware, referring to "activities in the restaurant and/or beverage sector and in the retail trade". As an alternative to disposable plastic, the law defines that "reusable utensils must be used, or, alternatively, utensils made of biodegradable material". Uganda and South Africa have also banned single-use plastic bags. Other countries such as Kenya are considering implementing taxes on plastic bags, or even banning their use [20]. In the current study, 81% of the interviewees committed to avoiding plastic utensils and to reduce their use of plastic bags. The specific recycling rate for plastic packaging in Portugal reached 44% in 2018, surpassing the European targets, which stood at 22.5%. The collection of these packages, which are mostly placed in the yellow recycling bin, totalled 72,000 tons in 2018. In the first half of 2019, there was a 5% increase in the amount of plastic packaging waste sent for recycling. During this period, around 30 thousand tons of plastic were collected in the yellow

recycling bin [34]. According to the Portuguese organism for recycling *Sociedade Ponto Verde* (Green Point society), plastic will continue to be part of the consumption cycle, so it is important that all agents have an active contribution in terms of the circularity, sustainability and recyclability of this material. Hence, their compromise is to promote development, knowledge and innovation, investing in valuing and promoting gains from an economic, environmental and positive reputation point of view of a brand, product or company. It is envisaged that Portugal will continue to meet the targets set by the European Union, which stand at 50% in 2025 and 55% in 2030. It is important to emphasize that this requires a joint commitment from all of society, including the citizens, the Government, national and local entities, the industry and the academic community [34].

Six months after implementing the charge for plastic bags in England, it was verified that the number of disposable plastic bags used dropped by more than 85%, around 500 million units. Likewise, there was an increase in the awareness of the environmental impact of household plastic waste and the population's support for the issue [24]. Studies carried out reveal that the reduction policy is effective, instigating the consumer to avoid the use of plastic bags across 52.3% a year [29]. In the current survey, the majority of participants admit to generating one bag of plastic waste per week, or two to five, which represents a great volume of residues.

A survey on marine pollution carried out in Greece by Gkargkavouzi et al. [27] indicated that, in general, respondents showed positive attitudes and a moderate knowledge about the theme of marine pollution and that they value the marine environment due to the ecosystem services provided. Among the main threats identified, garbage and industries were considered the most important, followed by fishing and agriculture. A study carried out in Italy by Forleo and Romagnoli [28] identified a low involvement of people regarding changes in their purchasing behavior to reduce the amount of plastic packaging. When the people were asked if, in the period of six months before the questionnaire was applied, they had adopted purchasing choices aimed at preventing the use of plastic waste, only 16% stated that it reduced a lot, and 24% slightly reduced the purchase. Changing plastic consumption habits has not been an easy task, as it directly depends on the change in the way individuals consume [28]. This could also be verified by the present survey, in which the participants tended to think about the negative impact of the plastic package on the environment. Therefore, the willingness to adopt plastic waste reduction should be strengthened and stimulated, especially among those individuals who are not at all committed or are not often aware of their purchasing and waste behavior. Because of this, research has been carried out to investigate bioplastics, which are polymers from renewable and/or biodegradable resources [35][36][37][38]. Degradable biopolymers are an alternative to traditional plastics, especially when recycling is not economically viable, or when the environmental impact must be minimized [39]. Bioplastics can be defined as plastics based on renewable resources, or plastics that are biodegradable and/or compostable. The use of bioplastics as food packaging materials has limitations, such as higher prices compared to conventional plastics and concerns about availability as well as land for its production [40].

Consumers are increasingly concerned about the safety offered by the products which they consume, such as food, water, health-related products such as medicines and other goods used in everyday life [20]. Lavelle-Hill et al. [24] verified that people more concerned with environmental issues are currently younger, female, have more money and a higher education. They found that young adults are more concerned with the environment, but older adults adopt more pro-environmental behaviors. Therefore, specific actions such as purchasing plastic bags may be less motivated by environmental factors and more by economic ones [24]. Nevertheless, this ecological conscientiousness may help increase the adoption of alternative biodegradable materials similar to plastics and bioplastics, many of them obtained from industrial agro-food wastes, as a replacement of traditional plastic materials [14][41]. Social awareness, education and public pressure play key roles in shaping and encouraging consumer behavioral changes towards a more environmentally friendly responsibility. Nevertheless, correct habits involve more than just motivation, but also self-discipline and a belief in the positive impact of behavior change [24].

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