# ASPECTS OF SUSTAINABLE PACKAGING TODAY

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***Abstract:*** *The last few years have been marked by an increasing demand for sustainable materials and practices. Thus, a series of measures have been implemented, which involve obligations and recommendations for the use of sustainable packaging. These include: re-use and refill targets, return-warranty systems, certain aspects of labelling, certain restrictions on packaging formats, including single-use plastic packaging, targets for reducing packaging waste, aspects of recyclable packaging.*

***Key words****: packaging, sustainable, recycling, waste, circular economy*

## INTRODUCTION

Current consumption behaviors involve a very large use of packaging and implicitly the generation of impressive amounts of waste, becoming a serious concern both at national, European and global level. From individuals to institutions and large corporations, more and more is produced, consumed and thrown away. In today's consumer societies, most single-use products and packaging are thrown away after use.

According to the Global Waste Index and Eurostat, humanity generates over 2 billion tons of waste per year, and by the end of the decade could exceed 2.5 billion tons annually. Thus, it becomes crucial for each of us to analyze our consumption habits in order to optimize resource consumption. Romania has committed to landfilling only 10% of municipal waste by 2035. The remaining 90% of waste must be recycled or recovered in other forms. Reducing storage can be achieved by collecting recyclables separately. The biggest challenge is to recover biodegradable waste, which accounts for around half of all municipal waste. [10, 13]

In recent years, initiatives and economic currents have emerged that aim to change the behavior and direction in which humanity is heading that consumes excessively and even compulsively.

Developed economies must be characterized by a high degree of sustainability aimed at protecting the environment and assimilating into personal life practices friendly to ecosystems born so far. Sustainable consumption includes, among others, aspects such as. separate collection, recycling, replacement of products that pollute and have a strong impact on the ecosystem. Sustainability is a component of any economic activity and consists of the reuse and reintegration of primary resources and raw materials from elements recovered through separate collection, leading to sustainable development. Thus, natural resources can be protected, conserved or preserved for the future. Sustainable development is complemented by the responsibility of reducing the negative effects that influence the entire environment around us. [5, 12]

A sustainable lifestyle can be adopted starting from individual consumers to large companies through active involvement in the separate collection and recovery of all waste that can generate reusable raw materials, by saving resources and using energy from clean sources as much as possible. In the last decade, several ways have been analyzed for society to become sustainable, in which the environment is protected. Basically, humanity can develop, but without exhausting or abusing the resources that the planet offers, nor

damaging or destroying them. The increasing attention paid to environmental issues and its protection has led to the emergence of institutions and organizations that provide environmental advice and aim to educate legal entities and people to follow healthier and sustainable lives. [1, 5, 12]

## MATERIALS AND METHODS

The research from this article follows as objectives:

- describing the major opportunity of circular economy;
- identifying the main benefits for business, which come with choosing biodegradable packaging products;
- detailing the new concept of eco-design;
- aspects about biodegradable packaging.

In order to achieve the objectives proposed it was used qualitative research method.

## RESEARCH RESULTS

In many regions of the planet, massive pollution causes numerous problems. Factories release chemicals into the air or discharge chemicals into rivers, seas and oceans, affecting flora and fauna, but also human health. The concept of sustainable development is currently supported by the legislation in force that is harmonized with the latest European regulations in this field, that of monitoring, greening, separate collection and recycling of resources, environmental legislation as well as the approach to green energy production technologies.

Recycling, pollution reduction and resource management are the three important factors characterizing the principles of sustainable development. Waste production is a significant problem affecting the whole world due to human activities related to economic development and resource consumption. For this reason, a huge amount of waste is produced every year and large resources are required for its management. In the future, due to population growth and economic development, waste production could be even more significant. In this context, an efficient waste management system plays an important role in the development and general well-being of the population. In this respect, the circular economy plays an important role, which requires action at all stages of the product lifecycle, can help to rethink the problem generated by huge amounts of waste. Efficient collection and recovery of waste will allow it to be transformed into resources that can be reintroduced into the economic system as secondary raw materials, leading to environmental but also economic benefits.

The circular economy is a major opportunity and can support the development of new industries and jobs, reducing greenhouse gas emissions and increasing the efficient use of natural resources. When a product reaches the end of its life cycle, the materials from which it is made are kept in the economy as long as possible through recycling. They can be reused in production. It is an approach that differs radically from the traditional, linear economic model based on the principle of "use-produce-consume-throw away". This traditional model is based on large amounts of cheap and easily accessible materials and energy. [5, 7, 16]

The circular economy addresses consumption and production, focusing on three principles: Eliminating waste and pollution. Circulation of products and materials Regeneration of natural resources. According to the European Commission, more than 60% of ecosystems are already overexploited, which can only cause problems in the future. It is important to reduce the impact that production and consumption have on the environment. Reducing the number of materials used, using resources more efficiently, reducing waste generation and turning waste into resources are ways to achieve this.

Two years ago, the European Commission proposed new EU-wide packaging rules that include proposals to improve packaging design. The first step Romania took in terms of circular economy was by implementing the guarantee-return system (SGR), which is a system whereby a deposit of 50 bani is paid when purchasing soft drinks or alcoholic beverages. After consumption, the packaging goes to one of the merchants' return points, at which point the deposit originally paid will be returned. SGR applies to non-reusable beverage packaging made of glass, plastic or metal, with volumes between 0.1 and 3 liters. [7,8, 9, 14,16]

According to the 2023 Circularity Report, the share of circularity worldwide is only 7.2%, down from 2018, the year when the first such report was made. Back then, it was 9.1%. If we had a well-developed circular economy, we could meet people's needs with 70% of the materials we use today. In Romania, the circularity rate is 1.2%. We are within the margin of error, so to speak. In contrast, in the Netherlands, circularity is over 30%. On the other hand, consumption in the Netherlands is huge, much higher than in Romania. [7, 9, 16]

Waste production is a significant problem affecting the whole world due to human activities related to economic development and resource consumption. For this reason, a huge amount of waste is produced every year and large resources are required for its management. In the future, due to population growth and economic development, waste production could be even more significant. In this context, an efficient waste management system plays an important role in the development and general well-being of the population. [10, 12, 13]

Addressing the circular economy, which requires action at all stages of the product lifecycle, can help rethink the problem of huge amounts of waste. Efficient collection and recovery of waste will allow it to be transformed into resources that can be reintroduced into the economic system as secondary raw materials, leading to environmental but also economic benefits. The circular economy is a major opportunity and can support the development of new industries and jobs, reducing greenhouse gas emissions and increasing the efficient use of natural resources. [5,7, 9,10,16]

One solution to more efficient waste management is to use biodegradable products. They are made from renewable raw materials, which eliminates the burden of using rapidly depleting non-renewable resources. For example, in the food industry, circular economy principles have been adopted, producing bio, non-toxic and environmentally safe products, such as biodegradable bags, cardboard cups or biodegradable cane trays. The preference for them reflects the positive attitude of consumers towards the environment, sustainability and pollution. [2, 5, 9, 12, 16]

The amendments regarding the packaging and packaging waste were discussed and agreed by the European Parliament in 2023. [7,8,10,13]

Biodegradable polymers can be of natural or synthetic origin. There is a difference between biopolymer materials and biodegradable materials. All biopolymer materials are biodegradable, but not all biodegradable materials are biopolymers. Biopolymers can be made from renewable resources, e.g. starch, while biodegradable materials are materials that can break down into inorganic compounds such as carbon dioxide, methane, water or biomass. [4,11,15]

For any type of business, there are several benefits that come with choosing biodegradable packaging products: Reducing waste – because biodegradable materials decompose over time, this means a reduction in the volume of waste generated and, implicitly, a smaller amount of those that end up in landfill. Reducing carbon emissions – the manufacturing process of biodegradable materials produces significantly less carbon emissions than for traditional plastic.

Reuse and recycling – biodegradable products are made from malleable and less brittle materials, making them much easier to shape. They can be transformed, recycled and reused several times in their life cycle. In addition, because biodegradable bags and packaging come from natural materials found in nature, there are no hazardous or toxic chemicals in them. Reducing pollution – biodegradable products decompose naturally, without releasing elements toxic to the environment. [5,6,7,9,12,14]

The degradation of organic products releases less harmful gases and solid residues could be used as compost to increase soil fertility. Most of them degrade under natural conditions without the need for energy, as is the case with the incineration of plastic products. In addition, it does not release toxins or other harmful substances into the environment and does not affect the quality of soil and water. Each Member State shall reduce per capita plastic packaging waste compared to per capita plastic packaging waste generated in 2018 as reported to the Commission in accordance with Commission Decision 2005/270/EC by: (a) 10% by 2030; (b) 15 % by 2035; (c) 20% by 2040. [8, 10, 16]

In the context of new environmental measures, a new concept has emerged, that of eco-design that will completely redefine the way products are designed, manufactured and used to minimize adverse consequences on the planet and the environment. The fundamental goal of eco design is to create products that offer functionality, aesthetics and are in harmony with nature. [1,3]

Eco design refers to: responsible use of sustainable materials and manufacturing processes. encourages low-carbon and energy-efficient manufacturing processes. extending product lifetimes creating products that can be recycled efficiently and integrated into the circular economy. Involving consumers through the label In order to increase the volume of recycling and a higher recovery of waste, several directions are required: overcharging the waste deposited in the landfill, empowering producers and educating the population.

Compared to other materials – especially plastic – cardboard packaging reduces oil and carbon dioxide emissions by 60%. Cardboard is 100% biodegradable and can be recycled 5-7 times. However, cardboard is not proven to be a model of durable material. Because biodegradation is a process that emits methane gas into the atmosphere, when cardboard is dumped in landfills, the breakdown of the material comes with a large carbon footprint, and the supply of new fibers requires trees, which pose a significant risk of deforestation. In order to make packaging as environmentally friendly as possible, it is advisable to obtain post-consumer or post-industrial recycled paper and cardboard. Materials marked as FSC certified are also recommended. [6, 9,10,14]

Another organic material that has made forays into the eco-friendly packaging industry is corn starch, derived from the corn or corn plant, with plastic-like properties, making this material a good plastic alternative in many contexts – from bottles to other molded shapes and loose-film packaging. Although it's a more sustainable alternative to petroleum-based packaging, cornstarch isn't without its problems. Because this material is derived from corn grains, it competes with food supply systems for humans and animals, potentially raising the price of corn, one of our staple foods. That's why it's helpful to weigh the pros and cons before using cornstarch plastic. Fortunately, there are more effective alternatives, as outlined below (mushroom, seaweed and microbial polyester packaging). [2,11,15]

Mushroom packaging is created using a process that cleans and grinds agricultural waste, which is then melted together through a mushroom root matrix, also known as mycelium. This raw material can be poured into the desired form, which is dried and finally used as packaging. Agricultural waste is exactly that – waste – and therefore could not be used as a food source for humans or animals. Therefore, this material avoids

possible controversy related to the packaging of corn starch. In addition, it is not only a petroleum-free material, but naturally degrades at an incredible rate. Mushroom packaging can be composted at home, decomposing into non-toxic organic matter. However, at this point, this is just a packaging solution for smaller items. [7,11,15]

Seaweed is a green packaging solution that is made using the gelatinous substance agar – found in a variety of seaweed – that is dehydrated to produce a material that can be used as packaging. The resulting condition depends on the dehydration method used. To create a soft cushioning agent, the material is frozen to produce a rigid, film-like state, which is then compressed. Being made from an abundant and sustainable raw material, seaweed packaging could be the next big step in environmentally friendly, biodegradable packaging alternatives. The need to carry out various processes specific to supply-production-sales activities make the use of 100% recycled plastic and biodegradable options indispensable.

Molds such as barrels, drip trays or pallets for leakage control can be made from recycled plastics to reduce the demand for raw material extraction. However, it should be noted that there is a limit to the number of times plastic can be recycled (2-3 times), which means that even recycled content will soon end up in landfills. Another – and greener – alternative would be to supply biodegradable plastics. Biodegradability describes the extent to which a material can be broken down by living microorganisms that produce water, carbon dioxide and biomass. We've already discussed a bioplastic, cornstarch, but there are others, such as those made from sugar cane and wheat – which, again, compete with human food. However, bioplastics also cover a subset known as microbial polyesters or polyhydroxyalkanoates (PHAs) [4,11,15]

PHA are polyesters that are synthesized and stored by various bacteria. When these microorganisms are grown in limited nutrient concentrations of nitrogen, phosphorus, sulfur or oxygen with excess carbon, they produce biodegradable polyester chains. The only holding back on this plastic alternative is the cost of carbon supplied to be metabolized by microorganisms. Eco-friendly textile packaging will provide added value to consumers while reducing business waste along the supply chain as a sustainable and multi-usable material. Thus, reusable bags can be designed to replace existing plastic bags or textile films that can be reused as surface protection of furniture. [4,11]

There are a variety of organic fabrics on the market, including hemp, organic or recycled cotton, tapioca, and palm leaves. All of these materials are biodegradable, meaning they take relatively less time to decompose naturally. Other uses of organic textiles can relate to: organic wool that can be used as a cushioning agent, linen and poplin can be used as covers or anti-scratch bags, hemp tape can be used to join products together. Edible films can become a sustainable packaging alternative for food. This packaging has the potential to simplify the storage, preparation and, of course, transport of food. Edible films have the potential to reduce food and packaging waste while reducing chemical runoff from plastic layers. [2,12,15]

Various natural products can be used to create edible packaging, but the most effective and widely used is chitosan. Chitosan is a sugar that is made from the chitin shells of shrimp and other shellfish. This makes chitosan one of the most abundant biopolymers after cellulose and is obtained by alkaline deacetylation of chitin. Due to its antimicrobial activity, non-toxicity and biodegradability it has great potential for use as packaging material. Biodegradable materials are undoubtedly only part of the solution for a more sustainable future. Every company must take responsibility for the environment and make the circular economy a priority internal objective.

## CONCLUSIONS

The current study has focused on the sustainability of packaging materials and where further research on sustainability should go. Packaging materials are also of significant importance in terms of the protection and safety of their contents, as well as the use of natural, biodegradable materials that can fulfil multiple uses. The study also highlights the need for sustainable packaging, with a focus on the environmental impact of packaging materials and the need for recirculation, reuse, which are pillars of a circular economy. The study also highlights the importance of the advantages and disadvantages of using packaging materials in terms of their durability.

Research and development in biodegradable packaging continues to advance, bringing new innovations and solutions to meet these challenges and facilitate their widespread adoption. Given the positive influence that these packaging solutions can have on the environment and consumer health, it is vital that both companies and consumers are informed and consider the use of biodegradable packaging in the purchasing and consumption process. Encouraging and supporting biodegradable packaging manufacturers through policy and regulations can also play a crucial role in accelerating the uptake of these solutions.

It is also important to recognize that biodegradable packaging is not a complete solution to the environmental problems associated with plastic packaging. There is a need to continue searching and implementing alternative solutions, such as reducing the amount of packaging used, using recyclable and reusable packaging and improving recycling and composting infrastructure.

## REFERENCES

**[1]. BALAN IOANA MIHAELA, GHERMAN EMANUELA DIANA, BRAD I., GHERMAN R., HORABLAGA ADINA, TRASCA T. I.**, 2022, Metabolic Food Waste as Food Insecurity Factor-Causes and Preventions, Foods, Vol.11/7/22

**[2]. CIOLAC RAMONA, IANCU T., BRAD I., POPESCU GABRIELA, MARIN DIANA, ADAMOV TABITA**, 2020, Agritourism activity—A "smart chance" for mountain rural environment's sustainability, Sustainability Vol.12/8/3

**[3]. IANCU T., TUDOR VALENTINA CONSTANTA, DUMITRU E. AL., STERIE CRISTINA MARIA, MICU M. M., SMEDESCU D., MARCUTA L., TONEA ELENA, STOICEA PAULA, VINTU C., JITAREANU A. F, COSTULEANU LUIZA CARMEN**, 2022, A scientometric analysis of climate change adaptation studies, Sustainability, Vol. 14/10/10

**[4]. IDOWU DAVID IBRAHIM, YSKANDAR HAMAM, EMMANUEL ROTIMI SADIKU, JULIUS MUSYOKA NDAMBUKI, WILLIAMS KEHINDE KUPOLATI, TAMBA JAMIRU, AZUNNA AGWO EZE AND JACQUES SNYMAN**, 2022, Need for Sustainable Packaging: An Overview, Polymers, 14, 4430

**[5]. SZILAGYI ANDREA, CIOCA L.-I., BACALI LAURA, LAKATOS ELENA-SIMINA, BIRGOVAN ANDREEA-LOREDANA,** 2022, Consumers in the Circular Economy: A Path Analysis of the Underlying Factors of Purchasing Behaviour, International journal of environmental research and public health, Vol.19

**[6]. TUDOR VALENTINA CONSTANȚA, SMEDESCU D., VLAD IONELA MITUKO, DUMITRU E. AL., UNGUREANU G., JITĂREANU A. F., ROBU D. AL., COSTULEANU CARMEN LUIZA,** 2022, Analysis on the collection and recycling of plastic packaging of crop protection products in Romania, Jurnal Environmental Engineering & Management Journal (EEMJ)/12/1

**[7].** *** A European strategy for plastics in a circular economy (COM (2018) 28 final of 16 January 2018)
**[8].** *** Directive (Eu) 2023/2413 of The European Parliament and of the Council, 18 October 2023
**[9].** *** Strategia Națională de Gestionare a Deșeurilor și Planul Național de Gestionare a Deșeurilor
**[10].** *** Zero Waste Europe-Research study on holistic indicators for waste prevention, 2019
**[11].** *** https://evamar.ro/ambalaje-biodegradabile-viitorul-este-unul-sustenabil/
**[12].** *** https://www.mckinsey.com/capabilities/growth-marketing-and-sales/our-insights/irrational-consumption-how-consumers-really-make-decision
**[13].** *** https://sensoneo.com/global-waste-index/
**[14].** *** https://smartmediu.ro/tipul-de-ambalaje-la-care-se-refera-legislatia-sgr/
**[15].** *** https://stratos.ro/ambalajele-biodegradabile-avantaje-standarde-tipuri-si-importanta/
**[16].** *** https://www.thimm.com/ro/sustenabilitate/gestionarea-resurselor/economie-circulara/