

## INNOVATIVE FOOD PACKAGING AS A KEY SOLUTION TO THE GLOBAL FOOD WASTE PROBLEM

*Дослідження присвячене аналізу ролі інноваційної упаковки у зменшенні обсягів харчових відходів. Розглянуто основні причини втрат продуктів харчування на різних етапах постачання. Особливу увагу приділено технологіям модифікованого газового середовища, розумній упаковці з індикаторами свіжості та використанню біорозкладних матеріалів. Визначено економічні та екологічні переваги впровадження сучасних пакувальних рішень, а також окреслено основні виклики, що стоять перед харчовими технологіями у цій сфері.*

**Ключові слова:** харчові відходи, інноваційна упаковка, активна упаковка, смарт-упаковка, термін придатності, сталий розвиток, харчові технології.

*This study analyzes the role of innovative packaging in reducing food waste. The main causes of food loss at various stages of the supply chain are examined. Particular attention is paid to modified atmosphere packaging technologies, smart packaging with freshness indicators, and the use of biodegradable materials. The economic and environmental benefits of implementing modern packaging solutions are identified, and the main challenges facing food technologists in this field are outlined.*

**Keywords:** food waste, innovative packaging, active packaging, smart packaging, shelf life, sustainability, food technology.

Have you ever thought about the fact that every time we throw away a rotten tomato or a piece of dry bread, we are not just throwing away food, but also the water, energy, and labor spent on its production? Today, food waste is a global tragedy. According to statistics, about one-third of all food produced in the world for human consumption is lost or wasted. In Ukraine, this problem is also acute, especially during the challenges of transportation and storage in modern conditions. As a future food technologist, I believe that we cannot just produce more food; we must learn how to save what we already have. This is where innovative packaging comes in as a "silent hero" [1].

**Causes of Food Waste.** Why do we lose so much food? First of all, it is due to improper storage and long transportation routes. Many products spoil before they even reach the store shelves. Secondly, the short shelf life of fresh products makes them very "fragile" in the market. Finally, we must admit that a large part of waste happens in our homes. We buy too much, forget about products in the back of the fridge, or misunderstand the "use by" dates [2].

**Innovations in Packaging.** To solve these problems, science offers us amazing solutions:

**Active and MAP Packaging:** Vacuum and Modified Atmosphere Packaging (MAP) act like a "protective shield", slowing down the oxidation and growth of bacteria. This significantly extends the life of the product without losing its quality [4].

**Smart (Intelligent) Packaging:** This is my favorite part. Imagine a package that changes color if the product inside starts to spoil. These sensors inform the consumer about the real state of the food, so we don't have to guess if the milk is still good [5].

**Eco-friendly Materials:** Using biodegradable materials or waste-based films (circular economy) helps reduce plastic pollution while protecting the food [6].

**Portion Control:** Sometimes, smaller or resealable packages are the simplest way to prevent people from throwing away leftovers at home [7].

**Positive Impact.** The introduction of such technologies is a "win-win" situation. For businesses, it means lower losses and higher profits. For us, as consumers, it means fresher products and saved money. But most importantly, it is a huge step for our planet. By reducing waste, we reduce the load on landfills and save natural resources [3].

**Challenges and Limitations.** Of course, it is not all easy. Innovative packaging is often

expensive, which can increase the price of the final product. Also, not all countries have the equipment to produce these materials yet. Another big challenge is teaching people how to use this packaging correctly — for example, how to recycle it or how to read “smart” indicators.

To wrap up, I want to say that innovative packaging is much more than just a wrapper; it is a vital tool in the fight against hunger and environmental crisis. As a student of the Food Technology department, I see my mission in creating and implementing such safe and effective solutions. The future of our food system depends on how we combine science, economy, and care for nature. Let’s make sure that our technology works for the benefit of every person and the entire planet.

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#### DETECTION OF PESTICIDES AND NON-DIOXIN-LIKE POLYCHLORINATED BIPHENYLS BY CHROMATOGRAPHIC METHODS

*У статті розглядаються хроматографічні методи (газова та рідинна хроматографія) для виявлення та кількісного визначення пестицидів і поліхлорованих біфенілів у харчових продуктах і об’єктах довкілля. Особлива увага приділяється їх чутливості, ефективності та ролі у забезпеченні безпечності продукції.*

**Ключові слова:** пестициди, поліхлоровані біфеніли (ПХБ), газова хроматографія, рідинна хроматографія, мас-спектрометрія, харчова безпечність, аналіз.

*The article discusses chromatographic methods (gas and liquid chromatography) for the detection and quantification of pesticides and polychlorinated biphenyls in food products and environmental samples. Special attention is given to their sensitivity, efficiency, and role in ensuring food safety.*

**Keywords:** pesticides, polychlorinated biphenyls (PCBs), gas chromatography, liquid chromatography, mass spectrometry, food safety, analysis.

The detection of pesticides and non-dioxin-like PCBs using chromatographic methods is an important process for ensuring food safety. In practice, gas chromatography (GC) and liquid chromatography (LC) are most commonly used, particularly in combination with mass spectrometric detectors (GC-MS, LC-MS) [1].

Modern chromatographic methods are diverse and lack a unified classification. One of the most common approaches is classification based on the type of phases. According to this, gas chromatography involves a gaseous mobile phase (gas-solid and gas-liquid chromatography), while liquid chromatography uses a liquid mobile phase (liquid-solid or liquid-liquid chromatography) [2].

Gas chromatography is characterized by high sensitivity and is widely used for detecting and quantifying trace amounts of pesticides in food products, biological samples, and environmental objects. However, its application may be limited due to the low volatility or thermal instability of certain compounds. The efficiency of the method depends on the detector type, properties of the analytes, and column characteristics [3].