

The Role of packaging technology in reducing loss during the food product life cycle

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Summary:

Food packaging is an essential part of modern society. Commercially processed foods cannot be processed and distributed safely and efficiently without packing. The World Packaging Organization (WPO) estimates that more than 25% of food is lost due to poor packaging.

Packaging can reduce the large loss amount of food through the continuous development of packaging materials, closing techniques and methods.

Research problem:

Weak performance of food product packaging, which leads to increase of accidental loss during the life cycle of the product, as well as the absence of packaging role in reducing the loss in the food product until it reaches the consumers' hands safely.

Aims of the research:

To monitor the percentage of loss in the food product during the product cycle from the harvest stage to the consumer's hand. Reduce loss of food during the life cycle of the food product through the use of appropriate packaging technology and methods for each stage. Setting guidelines to the Egyptian packaging factories and the involved parts to reduce the loss of food product by perfect suitable packaging.

The paper results the identification of the appropriate packaging strategies to reduce waste of food during the product life cycle and setting guidelines to reduce food loss in different stages.

Finally, emphasis was placed on the role of packaging in reducing waste at each stage and the importance of adopting new packaging materials and technologies, to extend the shelf life of foods and recommend the need for continuous development by further research and development to understand the impact of different packaging materials on products.

Keyword:

food loss - product life cycle - packaging life cycle analysis - packaging technology - opening and closing methods.

There are many definitions for packaging in general and food packaging in particular, but they agree together in the features and function of packaging, the definition of packaging must contain the following distinguishing features:

- Protect the product during storage and transport operations as well as during its use and protect the environment from potential adverse effects of the product.
- Facilitate production, transportation and sale as well as the use of products.
- Necessary information about a product and its usefulness to the consumer.
- Psychological impact on potential customers through the appropriate presentation of the product.

The research paper sheds light on the role of packaging where it is possible to reduce the loss of large food through the continuous development of packaging materials and methods to suit the food product and the appropriate methods of welding and opening and closing and in turn during the product life cycle.

1- Food packaging and reduce waste of food product

Packaging has many definitions, including "packaging is the science, art and technology of preparing products and goods for transport and sale at the lowest cost." The packaging is the science and art of protecting the product until it reaches the consumer in the same condition, which is to protect it from both external and internal factors such as water resistance, moisture, oxidation, gases and odors as well as ensuring that the products are not tampered with. (2)

Food packaging is a food preparation system for transportation, distribution, storage, retail and end-use to satisfy the end-user at an optimal cost.

Loss and waste in food:

The loss and waste of food refers to the decrease in foods suitable for human consumption at any stage of the food chain (the life cycle of the food product) from harvest to consumer for whatever reason.

2- Food products classification:

Food products can be classified according to the physical image and general properties as follows:

- Processed meat products
- Unprocessed meat products
- Dry food grains
- Spices and herbs
- Various drinks
- Seeds (legumes, etc.)
- Other processed foods processed in different ways to facilitate handling or increase their shelf life.

3- The role of modern packaging techniques in reducing waste of food product:

Innovation and development in packaging materials have helped to extend the shelf life of a food product, and modern technologies have kept them fresh for longer periods and packaging has a key role to play.

Table (1) shows the application of many modern technologies to primary packaging in contact with the product. Secondary and third packaging is commonly used to facilitate transportation, stacking, etc. during the supply chain, rather than prolonging shelf life.

Table (1) Examples of primary packaging technologies to extend shelf life:

Technology	Description	Potential impact on food waste
Multi-layer barrier packaging	Packaging that contains multiple layers to provide the required barriers to moisture, gases (see MAP below) and odour. Specific requirements can be met using a combination of polymers, aluminium foil and/or coatings.	Keeping out moisture and oxygen delays product degradation.
Modified atmosphere packaging (MAP)	Gases are added to packaging before it is sealed to control the atmosphere within the pack, and then maintained by a high gas barrier film, e.g. through vacuum packaging. Carbon dioxide is added, alone or with nitrogen and sometimes oxygen, depending on the product (e.g. meat, cheese, fruit and vegetables).	Reduces respiration rates in the product and reduces growth of microorganisms.
Edible coatings	Based on a range of proteins, lipids, polysaccharides and their composites, they can be used on fruit, vegetables, meat, confectionary and other products.	Create a barrier directly around food products (rather than external packaging).
Ethylene scavengers	A range of different technologies that involve chemical reagents added to polymer films or sachets to absorb ethylene. Used for fruit and vegetables.	Removal of ethylene delays ripening and extends the shelf life of fresh produce.
Oxygen scavengers	Substances that remove oxygen from a closed package. They are often in powder form (e.g. rust powder) in a sachet. New technologies include oxygen scavengers in the film itself. Used for sliced processed meat, ready-to-eat meals, beer and bakery products.	Oxygen accelerates degradation of food by causing off-flavour, colour change, nutrient loss and microbial attack (bacteria and fungi). Removing oxygen slows the degradation process and extends the shelf life of the food.
Moisture absorbers	Pads made from super-absorbent polymers, which absorb moisture. Used for fresh meat, poultry, and fresh fish.	Maintain conditions that are less favourable for growth or microorganisms.
Aseptic packaging	Packaging that has been sterilized prior to filling with Ultra High Temperature (UHT) treated food. This gives a shelf life of over 6 months without preservatives. Formats include liquidpaperboard, pouches and bag-in-box.	High temperatures kill microorganisms and tight seals on the packaging prevent the entry of microorganisms, gas or moisture that could promote degradation.

4- Applying Reducing Crop Loss and Wastes and Developing the Value Chain to Ensure Food Security in Egypt:

- While food needs in Egypt are increasing, the rate of food losses and waste is increasing, especially in relation to the most vulnerable products. The problem can be monitored in the following points:
- Losses and waste of vegetables and fruits are expected to represent 45-55% of the annual production, the percentage of loss in the grape harvest in Egypt by more than 45% and more than 50% for the tomato crop, in the production stages, retail and wholesale markets, in addition to a significant loss on Product quality level.
- According to agricultural experts, the percentage of losses in horticultural crops, vegetables and fruits, ranges from 20 to 30% annually due to the handling of the crop from transport,

storage and volatile weather conditions, including frost, temperature and humidity, and poor packaging methods, as these factors lead to Negative effects on the national economy.

- According to agricultural experts, the percentage of losses in the green bean crop is about 17% and the cucumber is 18%, the loss is estimated at about 25% in wheat, while the loss in pepper crop is 13%, onions 10%, oranges 9%, apple 17%, and 7%. Loss of banana and grape production and 12% of mango yield.

- The 2030 Sustainable Agricultural Development Strategy indicated that losses may exceed 30% in vegetables and fruits, about 20% in tubers and about 10% in cereals, in addition to another qualitative loss that confuses prices and increases farmers' losses. 10-15% of agricultural income.

5- Guidelines for reducing food losses at different stages:

First: To evaluate the packaging performance at different stages of monitoring wastage ratios, researchers suggest using a questionnaire that includes answering a set of questions as shown in Table (2) Each stage.

Table (2) A form as a first stage to evaluate the packaging performance to reduce the loss:

Stage in the post-harvest series	Questions to evaluate packaging performance	YES	NO
At the farm level	Are packaging designs based on crop type and target market?		
	Are crops filled in the field for sensitivity and in order to minimize damage during the trading process, especially during shipping?		
	Does the packaging of some crops in the field reduce the costs of sorting and packaging centers?		
	Are some post-harvest operations such as washing and waxing performed?		
At the transport level	Are products transported to the market in refrigerated and product-friendly tankers?		
	Is the packaging suitable for transportation and cooling used?		
	Is the packaging used proportional to the infrastructure in the post-harvest processing and marketing chain of agricultural products to protect the product during transportation?		
At the consumer level	Are products packaged in different weights to meet different consumer needs?		
	Does the product pack handle the opening, closing, handling and storage of the product without damage?		
	Are the dates of validity and data placed on the package correctly and understandably?		

Second: what should be considered at each stage as key recommendations for packaging in the post-harvest chain?

Table (3) shows the most important recommendations and guidelines during the different stages to reduce the loss of food product.

Table (3) shows the most important recommendations and guidelines:

Stage in the post-harvest series	Key recommendations for packaging
At the farm and transport level	<ul style="list-style-type: none"> - Fill the product in the field in a shaded place. - No excess packaging for ventilation. - Transport products to the market in refrigerated and appropriate tankers. And choose the appropriate packaging with shamrock and cooling. - Transportation and infrastructure should be ensured in the post harvest and marketing chain of agricultural products. Packaging, stacking, packing and temperature control methods are determined throughout the transportation period as well as air circulation and good ventilation.
At the retailer level	<ul style="list-style-type: none"> - Put products in packages of different weights to meet the diversity of the wishes of consumers. - Put perishable crops on refrigerated shelves. With the choice of suitable packaging with the display temperature.
At the consumer level	<ul style="list-style-type: none"> - The food must be properly handled in the opening, closing, handling and storage of the product. - Clarity of validity dates, and understand the data on the package correctly.

Conclusions and Recommendations:

- 1- Improve secondary packaging design to ensure that it is suitable for its purpose and adequately protects food products as they move across the supply chain. Packaging developers should understand the distribution process, where and why waste and loss occur.
- 2- Adoption of new packaging materials and technologies, such as climate-adjusted packaging, for example to extend food shelf life, etc., and use smart packaging and data sharing to reduce excess or obsolete stocks.
- 3- Teach manufacturers, retailers and consumers about the meaning of the marks used on the packaging such as (used-by date, use in the date, and preferably before best before) on the package.
- 4- Food and packaging companies should undertake further research and development to understand the impact of different packaging materials and packaging configurations (primary, secondary, etc.) on specific categories of fresh produce.

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