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Environmental Vision for the Egyptian Dry Food Packaging

Case Study of Cocoa packaging

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Abstract

The world's growing population has led to large amount of packaging waste, which further contributes to the problem of its disposal and other environmental issues. Package is the main key for reducing waste from the starting point and during product life cycle LC. The perfect package preserve food loss not only until it reaches consumer hands but also during use and after opening. Most of Egyptian dry foods packaging lacks to the environmental considerations. The paper pointed to add environmental value to packaging in the Egyptian market in dry foods sector. The dry food products vary in the Egyptian market, most of them packed on same packaging format and material. A case study was conducted to highlight the major dry foods packaging problems; over packaging material, unfriendly and inconvenience closing system were underlined. The study aimed to stimulate packaging design innovation considering format, closing system; and provide tools, examples and further information to support environmental optimization and save food and material through several simple steps.

Keywords: Sustainability, Bag in Box, LC, Seal Ends, Packaging Design, Re-sealable, Zip Pack, Gusset Pack

1. Introduction

The packaging, particularly of food products, is a key element and may be considered as an ingredient in all respects. As well as, it has multiple roles: to contain, protect and maintain unaltered the "taste" quality of the food product, communicate its goodness, serve as a vehicle of information, "anticipate" the content, win over the purchaser and be sustainable. (Allione et al 2011)

Egypt has the largest and most dynamic fast- moving consumer goods market in the Middle East. (Manalili, Dorado, & Otterdijk 2014) which means more packaging wastes. Consumers have direct environmental impact through the way they purchase and the packaging waste they generate. Consumers purchase packaging as part of the product and, over the years, the weight of packaging has declined relative to that of the product contained. However, consumption patterns have generated larger volumes of packaging due to changing demographics and lifestyles. It is the volume of packaging rather than, its weight that is attracting critical public attention. In addition, the trend toward increased pre-packaged foods and food service packaging has increased the amount of packaging waste entering the solid waste stream.(Coles, R. et al 2008) In order to help minimize food waste throughout the supply chain and save cost, an optimum level of packaging is required. Significant food waste occurs in many less developed countries – between 30% and 50% of food produced is wasted due to inadequate means of preservation, protection, storage and transportation (World Health Organisation).(Coles, R. et al 2011) Prevention of food losses in packaging design is a major environmental criterion. (Grönman et al 2013)

Packaging optimization is a main concern of the packaging development function. The aim is to achieve an optimal balance between performance, quality and cost, i.e. value for money. It involves a detailed examination of each cost element in the packaging system and an evaluation of the contribution of each item to the *functionality* of the system**. (**Coles, R. et al 2011)

The function of a food packaging is primarily geared at protecting the product (maintaining its properties), ensuring its transportability and storability as well as transmitting information. (J.Goossens, 2012) Now packaging needs to reply more requirements, environmental ones become a necessity. Packaging system is defined as the sum of components of a packaging combined into a functioning concept. The components can be

very different materials (packaging materials) which can consist of various intermediate products. (J.Goossens, 2012)

2. Packaging Functions from Environmental View

Present day innovations and responses to changing consumer preferences and demands have extended functions of packaging from mere protection to include promotion, information, convenience and handling. (Manalili, Dorado, & Otterdijk 2014)

The societal benefits of packaging may include the following:

- Prevents or reduces product damage and food spoilage, thereby saving energy and vital nutrients, and protecting the health of the consumer.
- It must ensure that the contents are delivered to the consumer or business end-user in good condition, whatever stresses and strains it undergoes during distribution and storage.(Envirowise n.d.)
- Requires less municipal solid waste disposal (Institute of Packaging Professionals, IOPP, USA).
- Lowers the cost of many foods through economies of scale in mass production and efficiency in bulk distribution. Savings are also derived from reduced product damage.
- Reduces or eliminates the risk of tampering and adulteration.
- Presents food in a hygienic and often aesthetically attractive way.
- Communicates important information about the food and helps consumers make informed purchases
- Provides functional convenience in use or preparation, freeing up more time and reducing food loss.
- Enables the use of the whole product (especially with food items). (Grönman et al 2013)
- Extends the shelf life with the benefit of prolonged product use, thereby reducing wastage
- Saves energy through the use of ambient packs that do not require refrigeration or frozen distribution and storage. .(Coles, R. et al 2008)

Secondary packaging are still essential for the total functionality of the packaging or the packaging system. Due to their nature or functioning principle, they can also have an impact on the packed food. (J.Goossens, 2012)

Sustainable packaging is:

- Is beneficial, safe & healthy for individuals and communities throughout its life cycle.
- Meets market criteria for performance and cost.
- Is sourced, manufactured, transported, and recycled using renewable energy.
- Optimizes the use of renewable or recycled source materials.
- Is manufactured using clean production technologies and best practices.
- Is made from materials healthy throughout the life cycle.
- Is physically designed to optimize materials and energy.
- Is effectively recovered and utilized in biological and/or industrial closed loop cycles.(GreenBlue.2011)

Frequently, sustainable packaging definitions are complex, misunderstood and so technical that it's nearly impossible for anyone package to comply. However, despite the confusion, there are three standards that all sustainable packages share: environmental, social, and financial. This trio is referred to as the "Triple Bottom Line" and it represents the balance between profitability and responsibility that all sustainable packaging needs to be successful.(Blumer, T., 2010)

Figure 1. Sustainable package and the three shared standards

Sustainable Packaging Coalition (SPC) in the USA characterized sustainable packaging with the following arguments: sustainable packaging is beneficial, safe and healthy throughout its life cycle, meets market criteria for performance and cost, is based on renewable energy throughout its lifecycle. (Grönman et al 2013) Sustainable packaging initiatives offer multiple strategies to meet and even exceed market criteria for performance and cost, including: Improved package design, resource optimization, informed material selection, design for recovery, and source reduction.(GreenBlue.2011)

Packaging sustainability is defined as the endeavor to reduce the product's footprint through altering the product's packaging, for example, by using more environmentally friendly materials. (Magnier, Schoormans & Mugge, 2016) Furthermore, reducing the amount of packaging material for same amount of product should be considered.

3. Properties of Dry Food, Products Requirements and Packaging

Drying foods is an effective way for food preservation to keep it safe from deterioration. Dry food needs to be kept in dry place and conditions.

3.1 Drying and water activity control

Food drying is a method of food preservation that works by removing water from the food, which inhibits the growth of bacteria and has been practiced worldwide since ancient times to preserve food. Where or when dehydration as a food preservation technique was invented has been lost to time, however the earliest known practice of food drying is 12,000 BC by inhabitants of the modern Middle East and Asia regions.(Nummer, 2012) Microorganisms need water to grow.

Reducing the amount of water in a food that is available to the microorganism is one way of slowing or preventing growth. Thus, dried foods and ingredients such as dried herbs and spices will not support microbial growth and provided they are stored under dry conditions, can have an expected shelf life of many months if not years. Many staple foods are available in dried forms (e.g. cereals, pulses and rice), provided they remain dry, will be edible for a long period. (Coles, 2011) The shelf life of breakfast cereals is usually limited by texture changes caused by moisture ingress through the packaging, with the food losing its crispness and becoming soft. (Min, Kim & Han, 2010)

Most dried foods achieve moisture levels that are low enough to prevent chemical reactions from occurring, and in doing so, chemical deterioration is removed as a factor that affects shelf life. The moisture content of foods is measured by ERH. It represents the ratio of the vapor pressure of food divided by that of pure water, and is given the symbol *a*w water activity. Most bacteria cannot grow below *a*w levels of 0.91, yeasts stop growing at *a*w levels of 0.85 and molds at *a*w levels of 0.81. The target *a*w levels for dried foods are around 0.3, substantially below the value, which supports microbial growth. Whether there is a killing effect at such low *a*w levels is uncertain and probably depends on whether the microorganism can produce resistant spores in the time available when the moisture content is within growth limits. Choice of the drying method and the packaging format are dependent on the food and its intended use. (Coles, R. et al 2011)

3.2 Product nature and needs

Table (1) summarizes the product needs according to its nature.

Table (1) Product Needs

Nature of the product	
Physical nature	Solid blocks, granules, free-flowing powders, .etc.
Chemical or biochemical nature	Ingredients, chemical composition, nutritional value, corrosive, volatile, odorous etc
Dimensions	Size and shape
Volume, weight & density	Method of fill, dispense, accuracy, legal obligation etc.
Damage sensitivity	Mechanical strength properties or fragility/weaknesses
Product deterioration: essential mechanism(s) including changes in	
Organoleptic qualities	Taste, smell, color, sound and texture
Chemical breakdown	For example, vitamin C breakdown in canned guavas
Chemical changes	For example, staling of bread
Biochemical changes	For example, enzymatic, respiration
Microbiological status	For example, bacterial count
Product shelf life requirement	
Average shelf life needed	
Use-life needed	For example, is migration within legal limits?
Technical shelf life	

3.3 Environmental Packaging Needs

Packaging needs to be of the specified dimensions, type and format within specified tolerances.The properties of the material will need to take account of the requirements of the packing and food processing operations. They will, therefore, need to have the required properties such as tensile strength and stiffness, appropriate for each container and type of material.(Coles, R. et al 2011)

Physical environment : is the environment in which physical damage can be caused to the product during warehouse storage and distribution that may involve one or more modes of transportation (road, rail, sea or air) and a variety of handling operations (pallet movement, case opening, order picking etc.). (Robertson 2016) These movements subject packs to a range of mechanical hazards such as impacts, vibrations, compression, piercing, puncturing etc. .(Coles, R. et al 2011)

Packaging Material selection

Most packaging operations in food manufacturing businesses are automatic or semi-automatic operations. Such operations require packaging materials that can run effectively and efficiently on machinery. .(Coles, R. et al 2011) Table (2) summarizes the key properties of paper, paperboard, and plastics, which are common packaging materials for dry food products in the Egyptian market.

Table 2. Key properties of common Packaging material (paper and paperboard)

Key properties of paper and paperboard	Key properties of plastics
Low-density materials	Wide range of barrier properties
Poor barriers to light without coatings or laminations	Permeable to gases and vapors to varying degrees
Poor barriers to liquids, gases and vapors unless they are coated, laminated or wrapped	Low density materials with a wide range of physical and optical properties
Good stiffness	Usually have low stiffness
Can be grease resistant	Tensile and tear strengths are variable
Absorbent to liquids and moisture vapor	Can be transparent
Can be creased, folded and glued	Functional over a wide range of temperatures depending on the type of plastic
Tear easily	Flexible and, in certain cases, can be creased
Not brittle, but not so high in tensile as metal	
Excellent substrates for inexpensive printing	

While light weighting of primary packaging provides an obvious environmental benefit in reduced material use, it is very important to recognize that the key factor is the amount of material used in the total packaging system (i.e., including secondary and tertiary packaging. (Robertson 2016) Small cardboard regular tubes are used for breakfast foods, cocoa powder and spices. They are light in weight, reasonably crush-proof and ecologically sound since they are manufactured from wood pulp, a renewable resource.

4. Dry Foods in the Egyptian Market

Common dried food in the Egyptian market might be classified as:
Dry grains: rice, ads, beans...etc.
Dry powders: cacao, species, flour, starch...
Dry aromatic seeds and plants: Anise,
Breakfast dry food: cereals and fruit loops
Others: processed food; Sugar, etc..(Nummer, 2012)

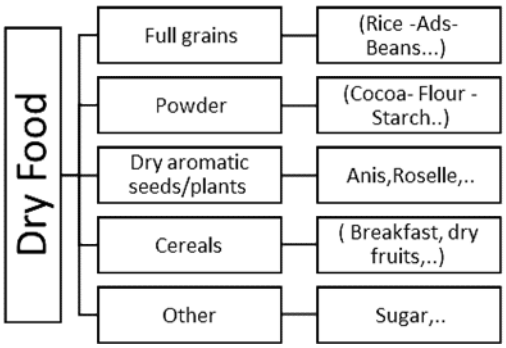


Figure 2. kinds of dry Foods in the Egyptian Market

5. Types of Egyptian Dry Foods Packaging

Selection of suitable packaging materials is critical in extending the shelf life of dried foods. Laminated paperboard with a plastic moisture barrier, such as polyethylene, is a common pack format for dried foods such as pasta, fruit and breakfast cereals, although alternative pack formats include moisture barrier bags and pouches. Shelf life for dried foods can extend to several years. (Coles & Kirwan 2011)

Dry foods are packed in paperboard and plastic packaging. Polyethylene plastic bags (rice, beans, sugar..) as a primary package. However, folded seal paper bags are used as a primary package for sugar, flour and other few dry products in the Egyptian market. Paperboard packages are used as a secondary one for dry products like cacao, cereals, .. Table (3) represents some of Egyptian dry foods packaging.

Table 3. Types of Egyptian Dry Food Packaging

Package		Representative sample image		
Format	Primary plastic package (PE / PP)			
Products	Dry grains and sugar			

Format	Common bag in a box format; Secondary Paperboard Package - laminated paper or plastic primary bag			
Products	Dry Powder products			
Format	Common bag in a box format; Secondary Paperboard Package - laminated paper or plastic primary bag			
Products	Dry breakfast cereals - products			
Format	Primary Paper /Plastic single use sachet			
Products	Dry products; Sugar, Vanillin, baking powder, one use sugar packet.			
Format	Primary paper/paperboard package			
Products	Dry Products; Pasta, Rice, Flour			

From the previous descriptive study, dry foods packaging in the Egyptian market. The researcher found:

- None of these packaging offer re-closable systems.
- The common designs are primary plastic or paper bag or bag in a box formats.
- Inconvenient dispensing method.

Reducing food waste is Key role of consumer behavior, but also of packaging; Packaging enables companies to extend the shelf life of the product as well as provide better product dispensing, thereby reducing waste.(J.Goossens, 2012)

6. Cocoa Packaging Analytical study

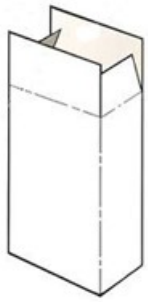
Cocoa Packaging "bag in a box" is the common food-packaging format in the Egyptian market, two kinds of packaging materials are mainly used in this sector; plastics and paperboard.

Reasons for Selecting Cocoa Packaging for the applied study

- It is a common packaging format for dry powder products and breakfast cereals as well.
- It Conclude two packaging levels primary and secondary ones.
- The closing system used is the same for most dry food packaging in the Egyptian market.

*Package Size***:** Generally, the size of the product should dictate the amount of packaging required. Packaging should reflect honest view for product volume. Table (4) gives description of common cocoa packaging in the Egyptian market (90-100gm)

Table 4.Egyptian Cocoa Package design Analysis

Cocoa Package design Analysis				
Package level	primary		Secondary	
Package material	Laminated paper or plastic		Paperboard	
Package format	Three seams bag		Regular Tube with seal ends	
Dimension	H=15cm, w=12cm/ L17cm w 11cm		H=15, L= 10 w= 5 cm H=15.5, L= 8.5 w= 4.5 cm	
Closing system	Triple Seams (top+end+ in between)		Seal Ends	

The strength and weakness points of the Egyptian Cocoa Packaging "bag in a box" format:

- The dominant packaging format bag in box has served its purpose for just as long. It's easy to stack in cabinet or in a desk drawer.(Sheaffer, E., 2010)
- They are light in weight, reasonably crush-proof and ecologically sound since they are manufactured from wood pulp, a renewable resource. (Pence 2016)

- Non re-closable systems are used; which affects product quality after opening. It is unfriendly and inconvenient user system.
- Only 30-40 % of the packages are filled. Over size, packages are used for both level primary and secondary.
- The package does not offer any dispensing method; this might result in increasing food waste.

7. Discussion

Packaging designer, play a central role in making the vision of sustainable packaging a reality. As a trend towards keeping product fresher, longer and to reduce food waste, new closing system should be added. As well as, reducing the packaging material used for dry powder and breakfast products or even introducing new packaging formats.

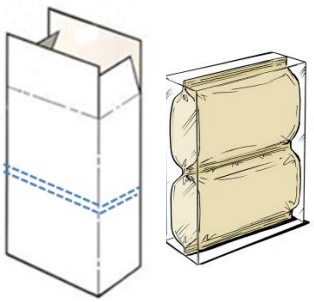
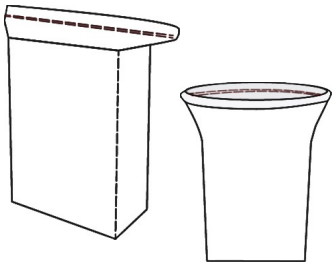
However, finding innovative solutions for sustainable packaging is possible by:

A. *Working with the packaging to see if there are simple changes that could result in a decrease or elimination over packaging.*
   - Eliminating unnecessary materials in the packaging design.
   - Reducing the size, weight or thickness of the package (e.g., light weighting).
   - Optimizing void space within the package design.
   - Optimizing the amount of necessary packaging with regard to primary and transport packaging.

B. *Correctly adapting the closing system to the product for optimal conservation*
   Marketing a food product in a reclosable packaging requires several adaptations to the production process. In most cases, the basic plastic packaging is the same, but a special machine is required to apply the self-adhesive systems. 'These amendments make the process slightly more complex and entail a cost premium estimated at about 5% of the cost of a normal packaging. 'On the other hand food waste is reduced and greater customer satisfaction can be gained. (J.Goossens, 2012)

The researcher suggested three possible amendments for sustainable cocoa packaging. These views are figured in table (5)

Table 5. Suggested Cocoa Package Modification

Possible Suggested Package Modification		
		
1- Reducing package size	2- Doupling bags inside	3- Attaching zip to the package

New Packaging solutions can help to provide added consumer convenience and reduce the environmental impact compared to traditional bag in a box formats.

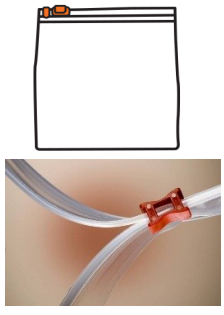
- Re-sealable flexible bag pouches have lower energy consumption and solid waste generation than bag in a box. (Sheaffer, E., 2010)
- Reducing the amount of materials used in manufacture of product packaging and minimizing the product- to- package ratio are among most efficient ways to enhance the sustainability of a package.

New closing system techniques may include:

- Zip-Pak is a global leader for resealable packaging solution. The study conducted by Franklin Associates, Inc. confirmed that resealable flexible pouches had lower energy consumption, green gas emissions and solid wastes.
- Semi-flexible container is also innovative solution for convenience and sustainability.
- Slider technology: environmentally friendly and sustainable slider closure could be an effective solution. This technology consists of ergonomically designed slider clips, which can be easily applied to premade cereal pouches, creating a convenient, resealable package. (Sheaffer, E., 2010)
- Pour-spout zipper help to dispense product directly from the bag.

The shorter zipper means less material. The zipper then acts as a built-in pour-spout. With less material needed for each package, costs are reduced. (Sheaffer, E., 2010) Table (6) shows new closing techniques that might be used with dry food products.

Table 6. New closing techniques for food packages

			
Re-sealable tape	Gusset pack	Slider technology	Pour spot zipper

8. Results and Recommendations

- Sustainable packaging designed to be effective and safe throughout its life cycle, meets market criteria for performance and cost. (GreenBlue.2011)
- The integration of physical design, material selection, and end of life considerations into an effective design process will help to minimize the negative impacts while at the same time optimize the positive benefits of design solutions; Design is certainly a critical point to develop products that incorporate sustainability principles.(Ernest, K., 2015, GreenBlue.2011)
- By thinking about the entire life cycle of a product during the design phase and identifying critical aspects, it is possible to anticipate impacts and minimize problems and waste up front.(GreenBlue.2011)
- Re-sealable packaging is extremely user friendly and flexible, since consumer can take out precisely the amount he wants, less product waste, which is a major environmental gain.(J.Goossens, 2012)
- Making the environmental vision, a reality begins with small steps. An entire system change can only happen when a wide network of people can begin to ask questions and make informed decisions. Questions asked should include:
    - Are the package's dimensions optimized to best fit the product?
    - Have you considered the entire packaging system - primary, secondary and tertiary packaging and various transportation and distribution modes - to determine how a material reduction in one part will affect the system, and where you can achieve the greatest net material reduction?
    - How will the design impact my supply chain and the manufacturability of the package?
    - Are there local sources of packaging materials? (Ernest, K., 2015)
- Over-packaging by 10% means that 10% of the resources needed to produce the packaging are wasted, and extra fuel will be needed to distribute it.(Envirowise n.d.)

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