

The Importance of Food Packaging Containers in Marketing

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Abstract—As food safety is tied up with the strength of the country and also associated with the protection of the individual's life, the materials used in packaging and the containers are of great importance. Not only has the plasticizer incident triggered a crisis in food additives, but it also induced the infiltration hazard of packaging containers. This study aims to explore the green business opportunities of food packaging containers and the impacts of different materials on packaging containers based on the circular economy. A comparative analysis was done between the environmentally friendly inks and traditional inks to emulate the advantages and disadvantages of plastic, paper, glass, and metal materials. Finally, R&D was carried out to discuss the overall results and benefits of creative edible tableware. The study found that we should follow and implement the experience of advanced countries and future trends. The consumers' desire for environmentally friendly, creative, and diversified food packaging containers is one thing that needs urgent consideration.

Index Terms—Plasticizer incident, food safety, Circular economy, Green packaging

I. INTRODUCTION

The hazardous plasticizer incident in 2011 had rocked the world. Some foods sold on the market were found to contain a plasticizer, and some upstream raw material suppliers had used cheap plasticizers (non-edible 1 additives) instead of the common legal food additive - "cloudy agent," to save costs. Besides initially revealing the contaminated beverages, the scope of influence had even extended to pastries, bakery products, medicines, etc. Scholars and experts pointed out that the toxicity of the plasticizer involved was 20 times that of melamine from the upper limit perspective of daily intake. It was the most severe food safety incident in 30 years [1]. The scope of influence was relatively broad as most of the contaminated products were exported to Europe, the US, China, Southeast Asia, Australia, New Zealand, etc. The

EU Commission pointed out that "the imported foods that were found to contain plasticizer were usually associated with packaging containers that came into contact with the foods." Therefore, the toxicity incident that has lasted for 20 years has led to people's concerns about the safety of food packaging and containers.

Food safety cannot rely solely on the food itself, but the crucial links of packaging and containers. Various factors may cause inferior materials to infiltrate into the food to harm not only the quality of the food directly, but also add more burdens to the earth environment and pollution threats. Furthermore, amidst the busy industrial and commercial society, more people are eating out. When everybody is pursuing the diversity and convenience of the dietary, the industry practitioners have seen business opportunities at the same time by stressing innovation, aesthetics, and diversified packaging and containers to attract consumers. Hence, not only are creative, attractive, and varied appearances of food packaging value-adding, but they also enhance people's appetite to create a win-win situation.

It is an important issue at present for food packaging and containers to pay equal emphasis on safety, environmental protection, and attractiveness to consumers. Not only should we explore to use materials that suit our ecosystem and health, but we should also learn from foreign experience to facilitate sustainable operation. In this study, a qualitative analysis was done to explore and analyze the impacts of materials on food packaging and containers, as well as future environmental trends.

II. LITERATURE REVIEW

A. The Concept of Food Safety

This study adopts the definition of "Food Safety Law of the People's Republic of China," considering that foods are a variety of finished products and ingredients for the human to eat and drink, and are things that traditionally known as foods and medicines, but do not include treatment-oriented items. Article 6 of the law

stipulates that: "Foods should be non-toxic, harmless, meet appropriate nutritional requirements, and have corresponding sensory traits such as color, aroma, taste, etc." [2].

In a broad sense, food safety includes the contents of food quantity safety, food nutrition safety, food hygiene safety, food quality safety, food production safety, food operation safety, etc. In a narrow sense, food safety refers to food safety for people and the safety of the food itself [3]. About the interpretation and definition of food safety and food quality, Liu (2006) [4] believes that food quality includes all other characteristics that can affect the value of product consumption. It consists of some unfavorable quality features, such as rotting, filth contamination, discoloration, staling, etc., as well as some advantageous properties, such as the place of origin, color, aroma, texture, and processing methods of the food. The focus of food safety concerns is the health of consumers who accept the food, and the focus of food quality is the value and traits of the food itself. The concept of food safety generally recognized by countries around the world was proposed by the World Health Organization (WHO) in 2003 in the article "Assuring Food Safety and Quality: Guidelines for Strengthening National Food Control Systems." It defines "food safety" as: "Acute or chronic hazards that are detrimental to the health of consumers, these hazards must be eliminated, and food safety is not negotiable." The definition of modern food safety has already included the nature of previous food poisoning [5].

B. The Concept of Circular Economy and Green Packaging

The essence of the circular economy theory is the theory of ecological economics, but the circular economy focuses on the circular application of materials for the whole society. It highlights on circular and environmental efficiency and the repetitive use of resources, emphasizing production, circulation, and resource conservation through the entire process of consumption. The traditional economy is a linear economy that flows in a one-direction pattern of "resources-products-polluting emissions," and is characterized by excessive exploitation, low utilization, and high emissions. The circular economy advocates an economic development model that is in harmony with the environment. It requires the economic activities to be organized into a "resources-products-renewable resources" feedback process characterized by low exploitation, high utilization, and reduced emissions [6].

Green packaging materials refer to new packaging materials with the least environmental burden and maximum recirculation utilization. They include the following types [7]:

1. Reusable and recyclable packaging materials.
2. Edible packaging materials.
3. Degradable materials.
4. Paper materials.

The development of green packaging should be developed from the perspective of the circular economy, bringing in the country's packaging industry into a

circular economy track. The comprehensive promotion of green packaging has become a social focus of public attention [8]. Thus, the future trends of food containers and packaging for the world's consumer market are: develop and utilize renewable resources, and produce low-consumption, non-polluting or less polluting, high-efficiency, recyclable, reusable, and degradable green packaging materials from waste materials [7].

III. SAFETY OF FOOD CONTAINERS AND PACKAGING

In addition to the ingredient contents, food safety is directly affected by packaging. As an industrial sector, packaging cannot avoid facing the environmental issue, and the source of pollution comes from the packaging materials. The commonly used packaging materials, such as plastic, paper, glass, metal, etc., tend to pollute the environment from the collection of raw materials, manufacturing processes, and waste disposal after use. Therein, the pollution caused by plastic and paper is more severe among the other materials [7].

A. Plastic Packaging Materials

By far, plastic is the most widely used food packaging material due to its lightweight, convenient to use, heat-resistant, cold-resistant, corrosion-resistant, and other features, and favorable to the industry and consumers. Chen (2001) [9] stated that as the plasticizer used in plastic materials does not undergo the polymerization of chemical bonds, it can be gradually disintegrated overtime when affected by temperature and pH value.

The plasticizers commonly used in plastics are DEHP, DEHA, BBP, DOP, DBP, DINP, DIOP, etc. Except for DEHA and DINP, all of the above plasticizers are acid salts. Due to different properties of various plasticizers, more than one type of plasticizer is added in plastics, depending on the properties of the plastics and product requirements. In terms of toxicity, acid salts and DEHA have shown to cause liver peroxidation in rats and mice. BBP, DBP, DEHA, and DEHP are also listed as environmental hormones, which refer to chemical substances secreted by organisms due to exogenous interferences. These substances can mimic hormones in the body, causing the body to produce excessive hormonal effects when combined with hormone receptors, or directly stimulate or inhibit the endocrine system, resulting in endocrine dyscrasia. Studies have found that acid salts may generate estrogenic activity, thus prompting many European countries to restrict the use of PVC materials in food packaging containers [9].

B. Paper Packaging Materials

Paper bags are lightweight, convenient to use, compact, and are commonly used by the public. However, in the papermaking process, certain additives are added to improve the paper quality index, such as enhancing the paper whiteness, colors, and luster. Still, they also increase health risks at the same time. For a long time, various natural plants (such as crop straws, wood, grasses, etc.), as well as different recycled waste papers (such as books, newspapers, magazines, etc.), cardboards (such as

cartons, paper boxes, etc.), rags and others are used as the papermaking raw materials. These recycled materials are often being severely contaminated [10].

In most papermaking processes, the fluorescent whitening agent is added, which is a potent chemical carcinogen. Currently, Japan has banned the fluorescent whitening agent in food packaging paper. The fluorescent whitening agent also serves the purposes to allow the packaging containers, particularly the paper material, to have a glamorous appearance and stand out in printing. However, its quality may directly affect the interior food content. Food packaging film must meet the requirements of better bonding strength and wear resistance on the substrate, as well as resistance to sterilization, boiling, freezing, heating, etc., to ensure that the inks will not fall off, condense, or other phenomena during transportation. The traditional inks contain benzene. If its residual amount exceeds the standard, it may cause cancer and blood disorders. The undulating surface of printing can also express different degrees of luster. Flexo printing adopts the principle of embossing, which uses relatively fewer inks. So the prints will appear to be thinner, less colorful, and duller. Gravure printing, on the other hand, emphasizes brighter prints to give a thicker and heavier appearance. Most countries, such as Europe and the United States, have a preference for flexo printing. Although the dot performance of flexo printing is slightly inferior, and the quality is also somewhat poorer than gravure printing, it is, however, more environmentally friendly [10].

C. Glass Packaging Materials

Glass is made through the fusion of silica, sodium carbonate, limestone, and other additives at a high temperature of about 1,500 °C [11], adding that it has many advantages to use in packaging. They include non-corrosive, impermeable to water vapor, oxygen, and aroma, excellent barrier performance, high transparency, hygienic, odorless, recyclable, microwavable, can withstand high-temperature sterilization, etc. However, glass is brittle and heavier, and so it is restricted from being used in some applications.

D. Metal Packaging Materials

Jiang (2004) [11] pointed out that metal can packaging is a simple and effective way to preserve food. The two metals commonly used in canning are tinplate and aluminum. He also mentioned that tin can has the merits of excellent sealing property to protect the food completely. After sealing and sterilization, the food stored in a tin can will not deteriorate for several years. Listed below are the advantages of metal packaging containers [12]:

1. Excellent barrier performance.
2. Excellent mechanical properties.
3. Good thermal conductivity.
4. Good processing adaptability.
5. Easy to use.
6. Aesthetic appearance.
7. Hygienic and safety.
8. Easy disposable.

Disadvantages of metal packaging containers:

1. Poor chemical stability.
2. Poorer economic value, more expensive.

Metal tableware and packaging have come a long way. Large quantities of exquisite and noble metal tableware from ancient China, especially, have been highly appreciated by people even up to now. In today's modern age of advanced technology, we should preserve and extend the advantages of metal materials wisely, and continue to develop and improve higher quality metal tableware to make them last longer.

IV. GREEN BUSINESS OPPORTUNITIES IN THE FOOD PACKAGING INDUSTRY

Compared with traditional packaging containers, the near-zero pollution green packaging containers are more in line with modern requirements. Dou (2010) [13] pointed out that the proposal of the international green packaging concept has prompted many developed countries to adopt the green trade barriers of food packaging to restrict the exports of foods from Taiwan. The food packaging safety situation has thus become a grave issue, and it is of considerable significance to ensure food packaging safety to enhance international competitiveness in foods.

Regulations for environmentally friendly packaging containers of international companies and major countries [14]:

1. The European, American, and Japanese rules on environmentally friendly packaging are becoming more stringent.
2. Lightweight and reusable packaging materials are the main environmentally friendly measures for international companies. As the glass-packaged products predominate over others in packaging, Tesco has collaborated with WRAP (Waste & Resource Action Programme) to reduce the use of beverage glass bottles, thus indirectly encouraging its packaging makers to develop lightweight glass bottles. On the other hand, the company has used recycled raw materials in plastic packaging, helping it to reduce 210 metric tons of plastic landfill each year.
3. R&D is an essential basis for environmentally friendly packaging. There is a trend for foreign food companies to stress environmental packaging by changing the packaging design and recycling packaging materials. They adopt the following measures in improving the packaging designs: regulate the packaging structure or shape, use soy ink in printing, develop different packaging materials that ease separation, simplify the use of materials, increase the recycle frequency, etc.

A. Environmentally Friendly Food Packaging Containers

According to a survey on new global food and beverage products by Mintel, 524 new items in Europe that claimed to be environmentally friendly have adopted to use environmentally friendly packaging in 2007, a 10 times increase over 2006 [14]. She also noted that 57%

of global consumers said they would purchase environmentally friendly foods, indicating that environmental awareness has gradually become an essential choice for consumers to buy products.

In today's growing consciousness on environmental protection issues for food packaging, the use of environmentally friendly inks has already become a trend [15].

1. The food packaging inks will cause environmental problems.
2. UV inks are energy-saving and environmentally friendly. UV inks have become a more mature ink technology, its pollutant emissions of which are almost zero.
3. The water-based UV inks are currently a new R&D direction in the UV ink domain.

If the raw paper is used as packaging containers for food, we must pay special attention to hygiene and safety. The guidance on recycled paper for tableware in Japan deserves our study and reference. Also, the paper industry and the processing industry should provide the conditions for use and other information for the end-users, such as food makers and consumers, drawing their attention to prevent misuse and excessive use. Although this guideline cannot be guaranteed, it is worth emulating.

B. Creative Food Packaging Containers

A Belgian couple has invented the edible verrines, which have the dual benefits of not washing them after eating and are environmentally friendly. This kind of tableware can be eaten together with the food, thus avoiding dishwashing and preventing the detergent from polluting the environment. After many attempts, they succeeded in making the verrines made from a combination of starch, water, and oil. This material is strong enough to hold a variety of foods and sauces and is easy to digest. The verrines are biodegradable, microwavable, odorless, and able to hold sweet or salty foods. They have also set up a small company to continue developing relevant products, such as a calendar to taste different flavors every day. They hope to promote the products to other countries [16]. Also, Japanese designers have used flour, water, and salt to make materials such as hard bread and biscuits. These biscuit bowls can be preserved for several months as long as they are kept dry.

KFC has also developed an edible coffee cup, its main body of which is a cup-shaped biscuit wrapped in sugar paper to ease holding, and lined with a layer of white chocolate. While drinking the coffee in the cup, the white chocolate lining will begin to melt slowly into the coffee, making the coffee taste better. It is hoped that such creative and environmentally-friendly tableware can be developed and improved continuously. If they can replace the disposable tableware in the future, it will be a significant contribution to prevent pollution and increase environmental burdens to the earth, and a new milestone to green environmental protection. Meanwhile, if the production of this tableware can be developed to use in the delicacy direction, it will enhance the joy of feasting.

V. CONCLUSIONS

The most significant transformation for enterprises and organizations in developing the circular economy is to convert the sales of goods into a sustainable service and the operating profits into a rental service to maintain the incomes. If we can integrate the on-site services with the functionalities of designers and change the product functionalities, the future community values will no longer be limited to original product essence but a continuous value-added technology.

Under the premise of the circular economy, not only can we implement environmentally friendly packaging to protect the earth and enhance the international competitiveness of the food packaging industry, but it can also directly affect the international development of the food industry. Therefore, we should follow the relevant food packaging regulations under the guidance of the circular economy and continuously revise and update them to integrate into the global community. The development of environmentally friendly packaging represents an essential trend of international packaging, and the diversified foreign R&D on environmentally friendly packaging deserves our full attention, tracking, reference, and learning. Although the safety of traditional food containers and packaging may be doubtful, some of them have revealed the long-term wisdom and good intentions of the predecessors. We should preserve the good traditions and integrate them with future environmental trends, and continue to innovate and develop. Then, the future development of food containers and packaging will be worth looking forward to creating a beautiful vision altogether.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Pei-Yu Chen wrote the paper and developed the idea the paper; Shun-Hsing Chen outlined and revised the manuscript and made substantial contributions to the design of this study; Hsiao-Ming Chang presented the paper; All authors had approved the final version.

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