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Contribution of Pet Bottles to Reduce Plastic Products in Japan

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ABSTRACT

As part of the reduction of plastic waste program, the free distribution of bags (i.e., plastic shopping bags) distributed at retail stores was discontinued, and bags started to be charged in July 2020. Plastic shopping bags may be reused for other purposes in the domestic environment. For this reason, many people think that similar bags are necessary regardless of the cost, which leads to the purchase of new bags. Similarly, polyethylene terephthalate (PET) bottles are one of the most prominent plastic products. In contrast to plastic bags, PET bottles are often discarded after use. In this paper, we introduce the history of PET bottles in Japan and provide our opinions on the contribution of PET bottles to the reduction of plastic products. Currently, PET-bottle manufacturers are focusing on improving the recycling and development of aluminum products. Conversely, as there are already technologies for recycling PET bottles from other PET bottles, the use of plastic products can be significantly reduced by reinforcing the usage of these technologies.

INTRODUCTION:

Currently in Japan, to reduce plastic waste, the free distribution of plastic bags (i.e., plastic shopping bags) at retail stores' cash registers has been suspended in July 2020; the customers are now charged for the bags. Plastic shopping bags are indeed used prominently, and reducing their employment may have some effect in stopping the spread of environmental pollution and reducing petroleum consumption. It is also true that plastic shopping bags are reused for other purposes after they are taken home[1)]; they are appreciated because of their size, shape, and easiness to transport when folded. In the domestic environment, people reuse plastic shopping bags for collecting trash and putting it out at a garbage collection point, or for storing daily use products such as clothing and cosmetics. In this context, plastic shopping bags have continued to be adopted after July; many people have been purchasing plastic shopping bags or new similar productsseparately[2)]. It is considered that the amount of plastic bags used is the same as before July 2020, and charging had no real impact. The Ministry of Economy, Trade, and Industry have a strong belief that charging for plastic bags is to ensure public awareness and that the problem can be solved by itself.

In 2020, a global epidemic of COVID-19 occurred, and people were very concerned about hygiene. In some countries, including Japan, eco-bags, i.e., reusable shopping bags, are recommended as an alternative to plastic shopping bags. From this perspective, it cannot be denied that more people may think that it is better to stop using the eco-bags.In California, United States, free plastic shopping bags have been redistributed at supermarkets and other stores because the reusable eco-bags may increase the COVID-19 infection rate. Considering these issues, it is difficult to solve environmental problems and petroleum consumption by considering plastic shopping bags alone, and it is necessary to acknowledge other plastic products as well.

In this context, as with plastic shopping bags, polyethylene terephthalate (PET) bottles are one of the most prominent plastic products. They are mainly used as containers for beverages, but they can also be used as vials for seasonings and cosmetics. Until the development of PET bottles, various liquids were often placed in glass bottles and cans, but owing to their lightness and durability, they are being replaced by PET bottles. Compared with plastic shopping bags, most PET bottles are reused less. Cosmetics and shampoo containers are sometimes refilled and used; however, beverage bottles are difficult to clean properly at home[3)]. PET bottles have the advantage of being recapped and carried anywhere, and they

can be easily thrown away on the go after drinking their content. This paper outlines the history of PET bottles in Japan and describes the authors' thoughts on reducing PET bottles.

History of PET bottles

Globally, it is believed that DuPont scientist Nathaniel Wyeth began developing plastic containers for sparkling beverages in 1967 and patented PET bottles in 1973. This PET bottle was adopted as Pepsi Cola's beverage container in 1974 and attracted attention as the world's first example of practicality. The name of PET bottles in Japan certainly comes from PET (polyethylene terephthalate) resin. Generally, in English-speaking countries, the materials are often collectively called plastic bottles without being subdivided into PE (polyethylene) and PVC (polyvinyl chloride).In Japan, containers of various materials are available for similar purposes. In this paper, containers made of plastic material are collectively referred to as plastic bottles. All are the same in that they can be made from petroleum.

Initially, in Japan, the Food Sanitation Law did not acknowledge PET resin, so it could not be used for soft drink containers. A container for soy sauce was first developed in 1977 and was subsequently approved for use for beverages in 1982; the sale of 1.5-L plastic bottled beverages began in the same year. Since then, it has been used by many beverage manufacturers, and plastic bottles have replaced large soft drink containers of 1L or more, which were mainly contained in glass bottles. In 1996, owing to the loosening of self-regulation, the ban on small containers of 500 mL or less (mainly 280 mL, 350 mL, and 500 mL) was lifted. At that time, there was also a debate about which to prioritize, the disadvantage of increased waste, or the advantage of portability. The plastic bottles were lighter, stronger, and more flexible than glass bottles and were more accepted by consumers. The number of plastic bottles shipped in 2017 was huge, 22.7 billion[4)]. Conventional glass bottles were sold with a bottle fee in consideration of recycling (the so-called deposit system, which is cashed back when the bottles are returned); such a thing was not considered for plastic bottles. Improvements have been made one after another, and products with excellent quality retention, safety, hygiene, economy, practicality, and environmental friendliness have been developed. The ability to suppress the deterioration of beverages is not as high as that of metal can containers. For this reason, even if the expiration date of a beverage in a metal can be one year, the expiration date of a beverage in a plastic bottle is set to be slightly shorter (six-nine months).

Position of plastic bottles in plastic waste

Among the garbage discharged at garbage stations by general consumers, PET bottles alone have the highest wet weight of 23% (Fig. 1)[5]. As for plastic shopping bags, the number of plastic shopping bags alone is unknown because they are only aggregated with similar bags. Also, among the composition of manufactured objects that arrive on the coast of Japan in one year, the total weight of plastic bottles is 244.1 kg out of 3883.6 kg, which is relatively high(The most common is 1122.2 kg of fishing gear). Food packaging materials such as plastic bags weigh only 75.3 kg. (Fig.2)[5]. Plastic bottles (74.2%) are the most common marine debris that the general public remember, followed by plastic shopping bags (67.3%; Fig.3)[6]. Regarding recycling, which will be described later, material recycling, which is a globally popular method, is performed in Japan for approximately 2 million tons of raw material weight per year. Of these, plastic bottles account for the largest proportion at approximately 500,000 tons (Fig. 4)[5].

How to recycle plastic bottles

To recycle, it is desirable that the bottle is clean and has no content left, and it is necessary to sort by material[7]. For this reason, in Japan, it is often the case that general consumers are requested to separate the garbage, wash it in advance, remove packaging films, separate the caps, and collect the plastic bottle alone as recyclable waste[7]. In Japan, the color of the bottle is currently being unified so that only colorless plastic bottles can be used. Plastic is easy to color, and colored plastic bottles are not uncommon outside Japan. Concerning bottles produced in Japan, with the revision of the voluntary design guidelines of the Council for PET Bottle Recycling in 2001, colored bottles were completely banned, and all were made colorless and transparent[8]. This is to prevent the original color of the plastic bottle from affecting the color of the recycled product. For example, white fibers made from colorless plastic bottles can often be used as raw material for clothing, but the demand for colored fibers made from colored bottles is limited; thus, rules have been established. In countries where colored bottles are distributed, a process of sorting colorless and colored products for recycling is also required. If bottles made of different materials or insufficiently processed are included, efficient processing will not be possible. It is also expensive to distinguish from other garbage and clean the inside of the bottles. In almost all cities in Japan, such separation is requested of consumers when collecting garbage. The recovery rate exceeds 90%, which is the highest in the world. Whether or not it is recycled as a resource depends on the city, and

plastic may not be recycled[9]. In this case, it is treated only as an incombustible waste. This is not well known to the public. In other words, citizens are asked to separate the garbage by the municipal garbage collector, but in some cases, the residues are not recycled.

Thermal, material, mechanical, and chemical recycling are performed in Japan as recycling methods, and waste plastic bottles are also exported overseas[5]. The recycling rate is very high at 85% (including the amount of overseas recycling)[10], but thermal recycling accounts for most of it. As this method does not reuse the material, it is controversial whether it can be called pure recycling[11]. Because there are circumstances in which only Japan includes thermal recycling as a recycling method, it is controversial that Japan's recycling rate is so much higher than that of other countries. Thermal recycling is a method of burning collected plastic waste bottles and using them as heat sources. It has the effect of indirectly reducing crude oil consumed by thermal power generation. Material recycling is generally accepted as recycling in foreign countries. The collected waste PET bottles are crushed and washed to remove foreign substances such as metals, and then made into flakes and pellets. This PET material will be remanufactured as an egg carton sheet or polyester fiber. The material recycling rate in Japan is 23%. Mechanical recycling is a method of recovering the material's physical properties, such as the viscosity of plastic as a polymer compound, by a chemical reaction called recondensation polymerization reaction. After crushing and washing waste PET bottles, the flakes are treated in a vacuum at >200°C at regular intervals, the chains of molecules that were cut by ultraviolet rays or heat are recombined, and the original physical properties are restored. Mechanical recycling is sometimes regarded as a synonym of material recycling[5].

Chemical recycling is a method of chemically decomposing a plastic polymer into monomers and completely returning it to the state of the raw material. A typical example is to polymerize the monomers and aim for PET-to-PET recycling (recycling plastic bottles from plastic bottles). To conduct monomerization, there are problems of cost and input energy. A manufacturer put the facility into practical use in 2003 but stopped production in 2005 because of cost issues and problems with securing raw materials. This may be due to the difficulty in procuring raw materials owing to soaring prices of waste plastic bottles, and a drop in demand for bottles that were being recycled[5]. Currently, another manufacturer has taken over the business, but not on a large scale. Chemical recycling is often introduced as a recycling method, but we are not sure exactly how much is recycled.

Finally, we examined the export of waste PET bottles. Because of the soaring price of raw materials due to the high price of crude petroleum since 2006, it has become possible to sell waste PET bottles for a fee, and the export volume has increased significantly[12]. In other countries, PET export has become difficult owing to the saturation of the plastic bottle recycling capacity and spread of environmental pollution[4]. In this context, it is necessary to recommend much PET-bottle recycling or disposal only in Japan. Unlike Japan, plastic bottles can be reused, although the production volume is small overseas. The reuse of plastic bottles was introduced in Germany in 1986 and has been implemented in the Nordic countries as well; currently, only in Germany, it has become a major system. However, even in Germany, the number of plastic bottles has been decreasing since its peak in 2003, and the number of one-way PET bottles (the same as in Japan, used only once) is increasing. Recycling is indispensable when considering global environmental issues. If economic activity is prioritized, it is undeniable that the cost will increase, and it will be more efficient to continue manufacturing new products than to recycle them. It is difficult to recommend economic development at the same time, considering petroleum resources and ecological issues.

SUMMARY

Among plastic products, we focused on plastic bottles and discussed recycling them. Plastic bottles comprise a large proportion of plastic products manufactured in Japan and are well established as daily necessities. Naturally, it also accounts for a large proportion of waste plastic treatment. So, recycling and recovering plastic bottles is important, especially considering the marine debris problem and the immediate solution desired. From the perspective of preventing environmental pollution, many manufacturers are already trying to solve the garbage problem. In 2011, a beverage manufacturer announced that it would aim to use 100% of the raw materials for mechanical and chemical recycling of plastic bottles for beverages. Another beverage manufacturer has begun to use all-bioplastic bottles (biodegraded by microorganisms in the environment) that use plant-derived ingredients as part of their beverage containers.

In terms of saving petroleum resources, we think that the technology of recycling plastic bottles from plastic bottles, called PET-to-PET, which is not currently mainstream, should be greatly utilized. The reason why recycling was stopped in the past was that the rise in the price of raw materials. Currently, it is difficult to export plastic waste bottles, and the prices

are falling. It seems that now is the time to do it as the mainstream of domestic recycling. Considering the effective use of practical technology and the future of the Earth, cost issues should be ignored and recycling, promoted. Recently, metal processing technology has been developed and also the technology for manufacturing beverage bottles from aluminum instead of plastic. It is already on the market as a beverage container in Japan[13]. Regarding overseas, India is investing in bottles made of bamboo[14]. In this context, it is now often considered that bottles can be manufactured from materials other than plastic, and the time may come when plastic bottles are no longer mainly made of plastic.

There are several reports on the adoption of a deposit system as plastic bottle reduction plans[15,16]. We agree with this idea. Just as the collection rate for glass bottles is raised, the collection rate will be further increased if the container fee is included in the price and the cash is returned by returning the container to the store. The act of throwing it away on the roadside should be dramatically suppressed. In Japan, some large-scale stores have already introduced store-specific recycle redemption points that can be used to purchase products. Because of the limited number of such stores and the low monetary value of the redemption points, not all people are using this system. The deposit system has already been adopted in many countries, such as parts of the United States and Europe[16]. In our opinion, the plastic bottle manufacturing industry should work to use only a single material so that it is not necessary to separate each material for collecting waste. Thus, the recycling efficiency after use may be improved in terms of time and cost. We also want to promote reuse by unifying the shape of plastic bottles and developing special cleaning tools (brushes, detergents, etc.).We would like to ask related organizations for a comprehensive study.

In Japan, there used to be a culture of saving and reusing, in which people brought their only pot and bottles to buy tofu and soy sauce, and sake, respectively. It is the same as bringing a bottle from home and having the wine sold by weight overseas. Conversely, in pursuit of convenience, disposable containers have been introduced in recent years. A large amount of plastic is usually part of containers. Lunch boxes and water bottles to take to schools and workplaces are brought in containers that can be used many times, but at convenience stores and other stores nearby, you can buy disposable plastic lunch boxes and drinks. Therefore, we are currently in a situation in which we can choose between saving and consuming. If we look at environmental issues and the future of human life, we need to curtail convenience and pay attention to the reduction and reuse of plastic products.

REFERENCES

1) Jun Kobayashi, Mamoru Tanaka, Keiichi Ikeda. (2018) Free distribution of plastic bags and consideration of global environmental problems in Japan. International Journal of Pharmacy & Pharmaceutical Research, 13(1), 187-197.
2) What are the reasons, advantages and disadvantages of charging for plastic shopping bags? -Why make it mandatory?Drawer of desk, published August 12, 2020,https://desk-drawer.com/rejibukuro-yuryoka(browsed November 2020).
3) Miho Yoshii, Miki Yatsuzuka, Tomomi Yasuda. (2009) Bacteriological study on the safety of small-plastic-bottled beverages. Journal of Japan Society of Nursing Research, 32(1), 125-129.
4) WWF Japan. (2018) About the marine plastic problem. WWF Activities, published July 26, 2018, https://www.wwf.or.jp/activities/basicinfo/3776.html(browsed November 2020).
5) Plastic Waste Management Institute. (2020) Basic knowledge of plastic recycling. https://www.pwmi.or.jp (browsed November 2020).
6) The Nippon Foundation. (2019) Is it true that there will be more garbage in the sea than fish in 2050? -Two actions we can do now. The Nippon Foundation Journal, published February 12, 2019, https://www.nippon-foundation.or.jp/journal/2019/20107(browsed November 2020).
7) Environmental Policy Division, Kochi City. PET bottles. Kochi City Official Homepage,https://www.city.kochi.kochi.jp/soshiki/63/gomi-pet.html(browsed October 2020).
8) The Council for PET Bottle Recycling. Recycled products. Basic knowledge, http://www.petbottle-rec.ry.jp/basic/product.html(browsed October 2020).
9) Yasoi Yasuda. (2001) Evaluation and policy analysis on the recycling system of PET bottles. Journal of the Japan Society of Waste Management Experts, 12(5), 229-234.
10) What is the current state of PET bottle recycling in Japan? Gooddo Magazine, Information media specializing in social issues and SDGs, published October 18, 2019, https://gooddo.jp/magazine/sustainable-consumption-production/recycling/4660/(browsed October 2020).
11) The current state of recycling in Japan is terrible! -Problems with plastic “PET bottles are recycled even if they are burned!?” 2020, https://22nd-century.jp/environment-issues/japan-3type-recycling/ (browsed October 2020).
12) Ministry of the Environment. (2020) Domestic and overseas situations regarding recycling of waste plastics, etc. https://www.env.go.jp/recycle/yugai/conf/base1_r02610/0r020610_03.pdf(browsed December 2020).
13) “From PET bottles to cans”Marine plastic waste problem movement acceleration -Aluminum cans with excellent convenience and environmental friendliness.published January 12, 2020,https://www.zakzak.co.jp/soc/news/200112/dom2001120005-n1.html(browsed December 2020).
14) 100% bamboo -Invented a replacement for PET bottles in India.published September 12, 2019, https://www.epochtimes.jp/p/2019/09/46981.html(browsed December 2020).
15) Ryosuke Matsumura. (2003) Introduced a deposit system to improve the collection rate of PET bottles -The goal of "establishing a recycling-oriented society". Onuma Lab, Keio University Faculty of Economics Graduation Thesis, https://onumaseminar.com/assets/GraduationPapers/03th/matsumura.pdf (browsed December 2020).
16) What is the “deposit system” to reduce PET bottle waste? (2020) Less Plastic Life, published April 2, 2020, https://lessplasticlife.com/marineplastic/responses/deposit_return_scheme/(browsed December 2020).

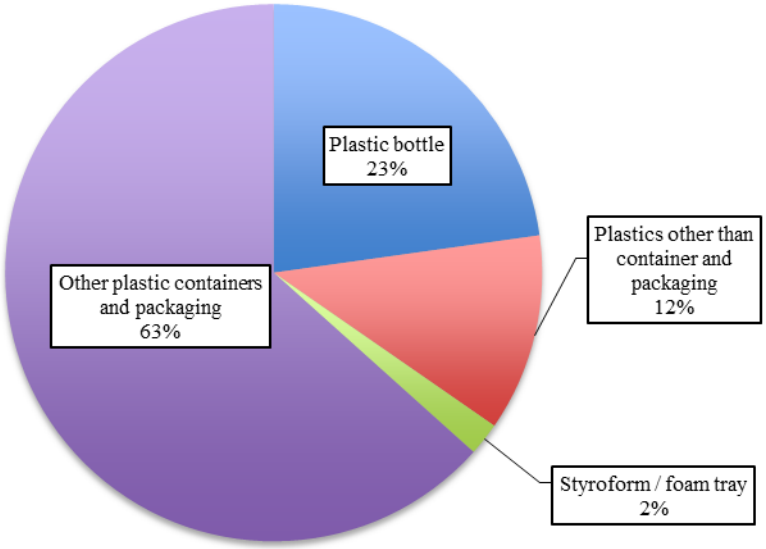
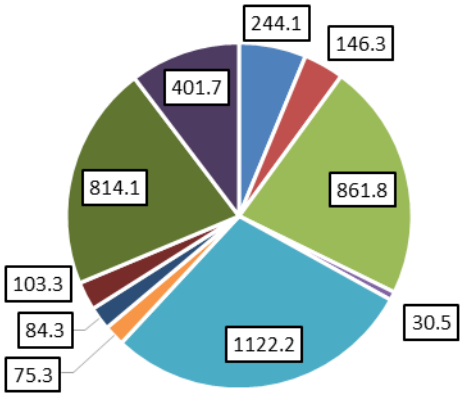


Figure no. 1 Contents of plastic waste (ratio)

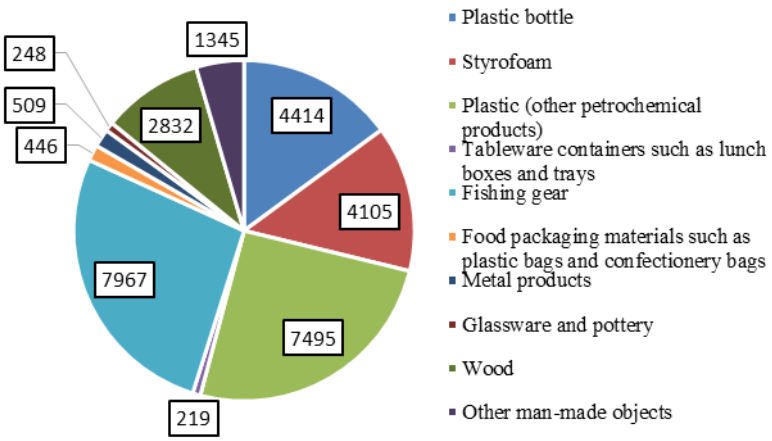
Breakdown of plastics in the garbage composition analysis (wet weight ratio) discharged at the garbage station.

Based on the data in Reference 5).

(A) Weight (kg)



(B) Volume (L)



(C) Quantity

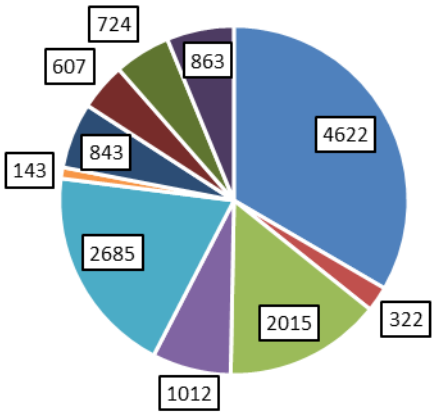


Figure no. 2 Composition of manufactured objects arriving on the coast of Japan.

In 2015–2017, the Ministry of the Environment surveyed 10 points along the coast of Japan every year.

The total weight was 3883.6kg, the volume was 29580L, and the number of objects was 13836.Based on the data in Reference 5).

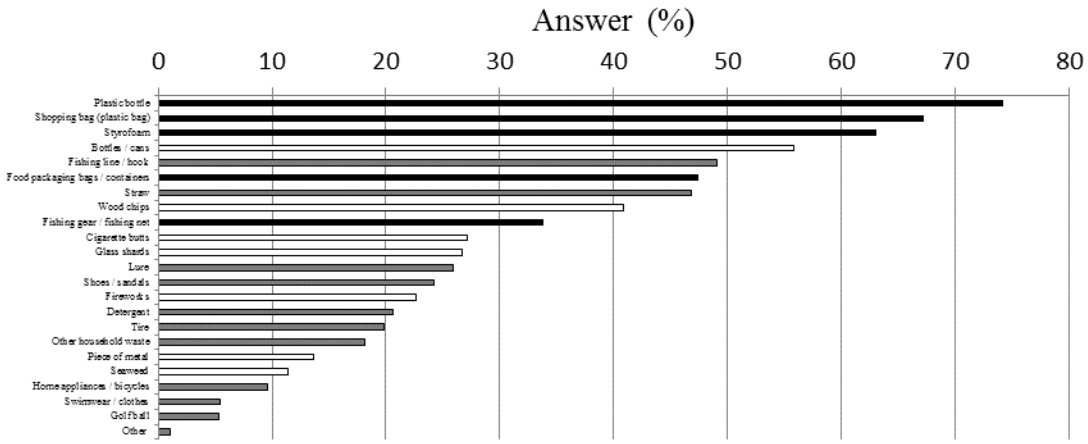


Figure no. 3 What comes to mind when you hear marine debris.

This is a part of the results of the "Awareness Survey on Marine Debris", conducted by the Nippon Foundation in November 2018.

The black bars are for those that seemed to be mostly made of plastic, white for those that were almost non-plastic, and gray for those that seemed to be intermediate. Based on the data in Reference 6).

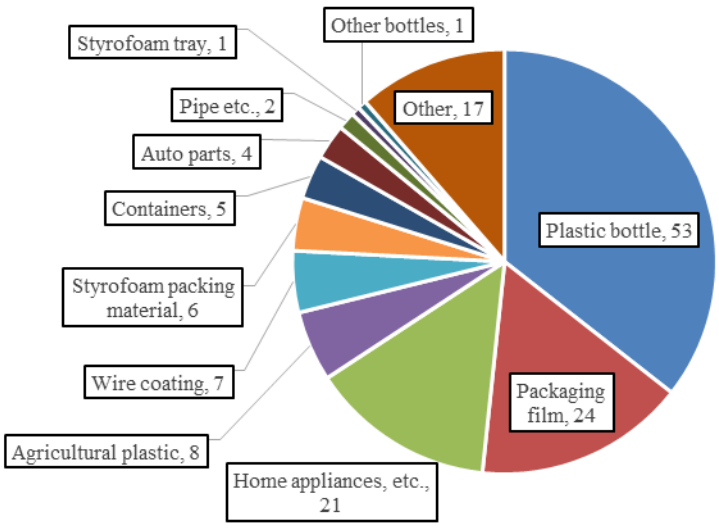


Figure no 4 Breakdown of raw materials for material recycling (10000 tons).

Material recycling is the most recognized recycling method in the world.

In 2018, the total amount of raw materials was 2.08 million tons, of which 0.62 million tons were production processing loss products, and the rest were used products (derived from used garbage, 1.47 million tons).

The figure is a breakdown of used products only.

Based on the data in Reference 5).