

Study on the Relationship between Yogurt Packages, Drinking Methods and Residues and the Countermeasures

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Abstract The aim of the study was to evaluate the relationship between different yogurt packages, drinking methods, and residues and the countermeasures. We chose 7 of the most common yogurt packages in the Chinese market, calculated the amount of residue left after yogurt consumption, compared the amount of yogurt residue left after using different methods of consumption from different types of packages, and conducted surveys in supermarkets, schools and other public places. After yogurt consumption, there are always residues left, and different packages and different drinking methods lead to different amounts of residues. The selection of yogurt package and the adoption of a good drinking method can clearly reduce the amount of residue. The solution that we suggest is to provide proper and clearly visible drinking instructions on the package to significantly reduce the amount of residue and wasted materials.

Keywords: *Yogurt; Drinking method; Residue; Package; Drinking tool; Drinking instruction*

1. Introduction

The globally one third of food produced for humans is lost or wasted throughout the entire supply chain [1]. Food waste occurs at every stage of the food system from farm to fork [2,3]. It is estimated that 1.3 billion tons of food for humans is lost and wasted each year [4], enough to feed more than one billion people. Current estimates for the EU show that 88 Million tonnes (Mt) (± 14 Mt) of food waste is produced, which is equivalent to 173 kg \pm 27 kg per capita and year [5]. Food waste is also a resource and sustainability issue. Food production and Food waste are connected with environmental damages [6-10]. The processes of food production consume vast resources of land, water, energy, fertilizer and other inputs, meanwhile engendering soil and water degradation, greenhouse gas emissions. In recent years, food waste and the determination of the quantity of food waste have become interesting subjects of study [11,12] According to various investigations, the term food waste may be divided into three subcategories: avoidable, partly avoidable, and unavoidable [13,14]. The highest quantity of food waste occurs in households [4,14,15,16]. England's "Waste and Resources Action Programmer" (WRAP) showed that in 2008 and 2009, British households wasted approximately 25% of their total food purchases each year, totaling approximately 122 billion pounds. In 2006, American households wasted approximately 483 billion US dollars on food

[16]. In Germany consumers are responsible for two thirds of the country's food waste [14]. Nearly two third of these wasted foods in German households are avoidable or partly avoidable [14].

The dairy products cause a lot of impacts in all environmental categories even if they are lower by mass compared to other products [7,15]. A reduction in dairy products in food waste would significantly reduce the environmental impacts. Many yogurt packages retain a large amount of yogurt residue after consumption, originating in a lot of waste. We aim here to study the residues remaining in different types of yogurt packages in China's current market, compare the amount of yogurt residues left after using different drinking methods from different types of packages, analyze the cause of residues, and recommend to consumers a method of consumption that is easy to learn to reduce yogurt waste.

2. Materials and Methods

2.1. Research materials and methods of measurement

2.1.1. Research materials

An electronic balance was purchased from *Wante Weighing Limited Company* and had a maximum weight of 2 kg and accuracy of 0.01g. The balance was calibrated before every use. Yogurt packages were made from a wide variety of packaging materials, including glass, plastics, metals and paper [17]. From August 2016 to June 2017, the 7 most common yogurt packages in the Chinese market were purchased at the supermarket. The type and net weight of the packages were as follows: glass bottle 200g, plastic bag 150g, plastic cup 90g, Ecolean package 180g, gable top carton 200g, Tetra Prisma package 200g, and Tetra top 250g (see [Figure 1](#)).

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Figure 1. 7 kinds of yogurt packages.

2.1.2. Measurement method

We explained the purpose and requirements of the experiment to the people who participated in the consumption of yogurt. We recorded the net content and weight of each package two times: the first weight after consumption using different methods and the second time weight after consumption and removal of remaining residues. For this, we used scissors to cut the yogurt package, completely removed the remaining residues, washed and drained the package, and then weighed it on an electronic balance. The amount of yogurt residues remaining after consumption was then calculated.

2.2. Research contents and methods

2.2.1. Relationship between common yogurt packages and yogurt residues

We observed and recorded whether there were drinking tools and instruction on the packages. The glass bottles were equipped with straws and were transparent, allowing consumers to visualize the amount of remaining residues as they consume so that they can adjust the straw; therefore, there was only one common drinking method for glass bottles. Ecolean packages were also equipped with a straw and were easy to deform, allowing consumers to squeeze the package while

drinking it; thus, there was only one common drinking method for this type of yogurt container. The other 5 types of packages were directly consumed with straws without adjustment.

2.2.2. Plastic bags and three drinking methods

Because there were no drinking tools or drinking instructions on the plastic bag packages, three commonly used drinking methods were analyzed: Group A: cut a corner and directly drink; Group B: drink with a straw; and Group C: pour it into a bowl and directly drink.

2.2.3. Plastic cups and four drinking method

There were different types of plastic cups for yogurt. In the past, these cups were mainly equipped with straws, but currently, some brands also provide spoons. We analyzed four commonly used drinking methods: Group A: drink with a straw without adjusting it; Group B, drink with a straw with adjustment at the end; Group C: remove the package lid and use a straw to drink; and Group D: remove the package lid and use a spoon to eat.

2.2.4. Gable top carton package and three drinking methods

Because there were no drinking tools or drinking instructions on the gable top carton, three commonly used drinking methods were analyzed: Group A: open the package and directly drink the yogurt; Group B: open the package and use a straw to drink; and Group C: directly insert the straw and adjust it after drinking.

2.2.5. Tetra Prisma package and four drinking methods

All the Tetra Prisma packages were identical and provided a straw, and most brands came with drinking instructions, such as "after drinking, unfold the four corners, squeeze the remaining amount of yogurt". However, we found in our preliminary research that most people do not use this method, so we analyzed four commonly used drinking methods: Group A: insert the straw to drink without adjusting it; Group B, insert the straw to drink with adjustment at the end; Group C: insert the straw to drink and squeeze the package; and Group D: insert the straw and follow the instructions on the package box: "after drinking, unfold the four corners, squeeze the remaining amount of yogurt".

2.2.6. Tetra top package and three drinking method

There were different types of yogurt packages that came with a lid (cover), such as glass bottles, ceramic cans, Tetra top and plastic bottles. The common feature of these packages is that they can be consumed many times, but most of them were not labeled with drinking instruction nor did they provide drinking tools or could be squeezed or unfolded. We chose Tetra top out of this group of packages as our research object, and we analyzed three commonly used drinking methods: Group A: directly drink with the mouth; Group B: drink with a straw; and Group C: drink with a straw with adjustment.

2.2.7. Four most common methods used by consumers to drink yogurt, ratio and yogurt residue.

We collected all kinds of yogurt packages from the community; district, supermarket and other public places after random people had finished consuming the yogurt. First, we weighed the packages with residues, removed the residues and weighed the package again, and calculated the amount of yogurt residues. Because the number of collected glass bottles, plastic bags and gable top packages was very low, we chose to focus on plastic cup, Ecolean, Tetra Prisma and Tetra top packages. For each type of package, we analyze one brand. From the external appearance of the yogurt package, it was possible to analyze the consumer drinking habits and proportion. The plastic cup packages that we collected all provided straws, making it possible to analyze two drinking methods; based on whether the lid was uncovered or not, it was possible to see if the straw was directly inserted or if it was used after uncovering the lid. If the straw was directly inserted, there was no way of knowing if there was straw adjustment, so this method was classified as directly drinking with a straw. Ecolean packages came with a straw. Based on the external appearance of the Ecolean packages that we collected, we divided them into two different drinking methods: the package not showing signs of deformation and the package showing signs of deformation. The Tetra Prisma packages that we collected all provided straws, making it possible to analyze three drinking methods. Based on whether there was deformation of the package or if the four corners of the package were unfolded, it was possible to see if a straw was used, and there was no way of knowing if there was straw adjustment. These methods were classified

as directly drinking with straw; inserting a straw insertion and squeezing to drink; or following the instructions on the package box: "after drinking, unfold the four corners, squeeze the remaining amount of yogurt". The Tetra top package did not have various drinking methods, so there was only one way to drink.

2.3. Market survey

2.3.1. Objective: To understand the current drinking methods and assimilation of two drinking instructions.

2.3.2. Quality Control: Carry out a preliminary investigation before the formal investigation, train investigators before the investigation, and explain the purpose and significance of the survey.

2.3.3. Survey objects: Yogurt consumers.

2.3.4. Survey method: Questionnaire.

The fields of investigation were supermarkets, schools and public places, and a total of 331 people took the survey.

2.3.5. Survey content: The main investigation was consumer's methods of drinking yogurt. The survey was divided into five parts (Figure 2, Figure 3, Figure 4).



Figure 2. Drinking instructions on the yogurt box in a specific location



Figure 3. Drinking instructions, partial enlarged view

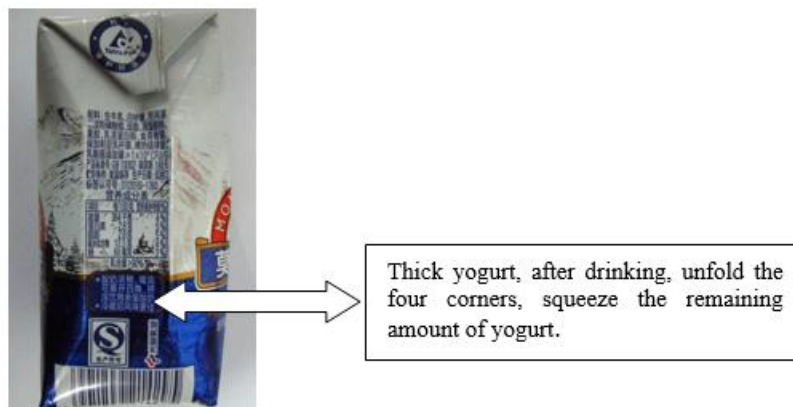


Figure 4. Drinking instructions on a yogurt box in a specific location

2.3.6 Questionnaire: A questionnaire on yogurt drinking method was administered (see Annex).

2.4. Statistical analyses

Because the weight of each package of yogurt was different, in order to facilitate comparison, the data were standardized, and the amount of yogurt remaining after each 100 grams of yogurt consumed was used as an indicator. Statistical software SPSS 11.5 and one-way ANOVA were used to test significance, and the groups were compared by Dennett's t test. The difference was set to $P < 0.05$.

3. Results

3.1. Drinking tools and drinking instructions for 7 different yogurt packages (Table 1)

Table 1. Drinking tools and drinking instructions for 7 different yogurt packages

Package:	Glass bottle	Plastic bag	Plastic cup	Ecolean	Gable top	Tetra Prisma	Tetra top
Drinking Tools	Straw	No	Straw	Straw	No	Straw	No
Drinking Instruction	No	No	No	Yes	No	Yes	No

3.2. Relationship between common yogurt packages and yogurt residues

We used a straw without adjustment to directly drink from the 7 different packages of yogurt. The data were standardized, as shown in Table 2. The Ecolean and plastic bag packages had fewer residues, followed by glass bottle and Tetra top packages. On the other hand, gable top carton, Tetra Prisma and plastic cup packages contained more residues (Table 2).

Table 2. Comparison of yogurt residues in different packages after using a straw ($n=22$, $\bar{x} \pm s$)

Packaging	Total amount(g)	sample size	Yogurt residues(g/100 g)
Group A plastic bottle	200	22	9.525 \pm 5.524
Group B plastic bag	150	22	2.875 \pm 0.930
Group C plastic cup	90	22	22.307 \pm 3.828
Group D Ecolean package	180	22	1.941 \pm 0.534
Group E gable top cartoon	200	22	13.073 \pm 1.230
Group F Tetra Prisma	200	22	16.292 \pm 1.619
Group G Tetra top	250	22	10.124 \pm 2.16

Note: there was no difference between any 2 groups, except between Group A and Group G ($P=0.480$) and between Group B and Group D ($P=0.272$). Comparison between the other two pairs showed a significant differences ($P < 0.05$)

3.3. Plastic bags and three drinking methods

The data were standardized, and Table 3 shows that the use of a straw resulted in minimum amount of residues, followed by pouring the yogurt into a bowl for drinking. Drinking directly with the mouth resulted in the most residues (Table 3).

Table 3. Comparison of yogurt residues in plastic bags after different drinking methods ($n=22$, $\bar{x} \pm s$)

Drinking method	Sample size	Yogurt residues(g/100 g)
Directly drinking with mouth	22	5.205 \pm 0.349
Directly drinking with a straw	22	2.875 \pm 0.930
Pouring into bowl	22	4.222 \pm 0.307

Note: Comparison between pairs with directly drinking with mouth, directly drinking with a straw and pouring into a bowl showed statistically significant differences ($P < 0.05$).

3.4. Plastic cups and four drinking method

The data were standardized, and [Table 4](#) shows that removing the package's lid and using a straw to drink or a spoon to eat resulted in the minimum amount of residue, followed by directly drinking with a straw with adjustment at the end. Directly drinking with a straw without adjusting resulted in the most residues ([Table 4](#)).

Table 4. Comparison of yogurt residues in plastic cups after different drinking methods (n=22, $\bar{x} \pm s$)

Drinking method	Sample size	Yogurt residues
Directly drinking with a straw without adjustment	22	22.307 \pm 3.828
Drinking with a straw with adjustment	22	13.372 \pm 1.657
Removing the package's lid and using a straw	22	5.312 \pm 0.870
Removing the package's lid and using a spoon	22	4.678 \pm 0.422

Note: Comparisons between pairs, except for removing the package's lid and using a straw to drink and removing the package's lid and using a spoon to eat, showed not statistically significant difference; the other differences were statistically significant ($P < 0.05$).

3.5. Gable top carton and three drinking methods

The data were standardized, and [Table 5](#) shows that directly inserting straw and adjusting it after drinking resulted in the minimum amount of residue, followed by opening the package and using a straw to drink the yogurt (without adjusting the straw). Opening the package and directly drinking the yogurt resulted in the most residues ([Table 5](#)).

Table 5. Comparison of yogurt residues in Gable top cartons after different drinking methods (n=22, $\bar{x} \pm s$)

Drinking method	Sample size	Yogurt residues(g/100 g)
Opening the package and directly drinking the yogurt	22	28.569 \pm 3.968
Directly drinking with a straw (no adjustment)	22	13.073 \pm 1.230
Adjustment of the straw	22	7.727 \pm 1.360

Note: Comparisons between pairs with opening the package and directly drinking the yogurt, directly drinking with a straw (no adjustment) and drinking with a straw with adjustment were all statistically significant ($P < 0.05$).

3.6. Tetra Prisma package and four drinking methods

The data were standardized, and [Table 6](#) shows that the method of unfolding the four corners resulted in the minimum amount of residue, followed by inserting the straw to drink, squeezing the package and inserting the straw to drink with adjustment. Inserting the straw to drink without adjusting resulted in the most residues ([Table 6](#)).

Table 6. Comparison of yogurt residues in Tetra Prisma packages after different drinking methods

Drinking method	Sample size	Yogurt residues((g/100 g)
Drinking with a straw (no adjustment)	22	16.292 \pm 1.619
Squeezing the package	22	11.583 \pm 1.642
Drinking with a straw with adjustment	22	11.069 \pm 1.262
Unfolding the four corners	22	5.062 \pm 0.573

Note: Comparison between the pairs, except for drinking with a straw with adjustment and squeezing the package method, suggested not statistically significant differences ($P = 0.208$); the remaining pairs showed significant differences.

3.7. Tetra top packages and three drinking methods

The data were standardized, and [Table 7](#) shows that drinking with a straw with adjustment resulted in the minimum amount of residue, followed by drinking with a straw without adjustment, and directly drinking resulted in the most residues. There were significant differences in the residual amount of yogurt between the three drinking methods ($P < 0.05$) ([Table 7](#)).

Table 7. Comparison of yogurt residues in Tetra top packages after different drinking methods ($n=22$, $\bar{x} \pm s$)

Drinking method	Sample size	Yogurt residues(g/100 g)
Directly drinking	22	15.333 \pm 2.953
Drinking with a straw	22	10.124 \pm 2.164
Drinking with a straw with adjustment	22	8.188 \pm 1.147

Note: Comparison between pairs showed statistically significant differences ($P < 0.05$).

3.8. Different drinking methods for different yogurt packages used by consumers: ratio and relation to yogurt residues

The data were standardized, and Table 8 shows that when consumers removed the lid from a plastic cup and used a straw to drink, there were fewer residues, and when they used a straw without removing the lid, there were more residues. For the Ecolean package, drinking with a straw and squeezing the package resulted in fewer residues, and simple use of a straw to drink resulted in more residues. For Tetra Prisma packages, when unfolding the package corners, there were fewer residues, followed by squeezing the package for drinking, and simple use of a straw to drink resulted in more residues (Table 8).

Table 8. Different drinking methods from different yogurt package used by consumers: ratio and relation to yogurt residues ($n=22$, $\bar{x} \pm s$)

Drinking method		Sample size	(%)	Yogurt residues(g/100 g)
Plastic cup	use a straw without removal of the lid	127	85.81%	19.753 \pm 5.166
	remove the lid and use a straw	21	14.19%	5.375 \pm 1.771
Ecolean	drink with a straw and squeeze the package	94	89.52%	2.556 \pm 0.961
	simple use of a straw	11	10.48%	7.993 \pm 1.518
Tetra pack	simple use of a straw	139	65.88%	16.677 \pm 3.185
	squeeze the package	19	9.00%	11.742 \pm 1.641
	unfold 4 corners	53	25.12%	6.548 \pm 1.956
Tetra top Regular drinking		46		12.876 \pm 4.330

Note: Comparison between pairs showed that the differences between the two plastic cup groups were statistically significant ($P < 0.05$); the differences between the two Ecolean package groups were statistically significant ($P < 0.05$); and the differences between the three Tetra top groups were statistically significant ($P < 0.05$).

3.9. Comparison of yogurt residues in four kinds of packages after consumption

The data were standardized, and Table 9 shows that the Ecolean package had the fewest residues, followed by the plastic cup. The Tetra Prisma and Tetra top packages had the most residues (Table 9).

Table 9. Comparison of the yogurt residues in four kinds of yogurt packages ($n=22$, $\bar{x} \pm s$)

Package	Sample size	Yogurt residues(g/100 g)
Plastic cup	148	17.713 \pm 6.974
Ecolean	105	3.125 \pm 1.961
Tetra Prisma	211	13.688 \pm 5.193
Tetra top	46	12.876 \pm 4.330

Note: Comparison between pairs, except for Tetra Prisma and Tetra top, showed no significant differences ($P = 0.344$); the others pairs showed a significant differences ($P < 0.05$).

3.10. Market research results:

Among the 331 participants, 161 were male (48.6%) and 170 were female (51.4%). Considering age, 3 people were 12-14 years old (0.9%), 163 people were 15-17 years old (49.2%), 28 people were 18-22 years old (8.5%), 35 people were 23-29 years old (10.6%), 42 people were 30-39 years old (12.7%), 48 people were 40-59 years old (14.5%), and 12 people were 60 years old or older (3.6%). All the participants drank yogurt, and 314 (94.9%) observed yogurt residues.

For results, see Table 10. A survey on consumer perceptions of residues in the 8 most common types of yogurt packages in the Chinese market was administered. For each type of yogurt, we investigated the number and proportion of consumers, the number and proportion of consumers observing residues, and the number and proportion of consumers observing the most residues. The results show that ceramic pots were less common in the market, with the fewest consumers, and plastic cups or bottles had the most consumers. The proportion of consumers observing residues in each type of packaging was high: plastic bags and Ecolean packages reached 40%+. More than 70% of consumers observed residues in 6 other types of packages. Tetra top had the highest proportion, reaching 79.8% (Table 10), showing that there were more yogurt residues after drinking, and that consumers generally perceived these residues. Tetra top had the most people who perceived the most residues, while plastic bags and Ecolean packages had the fewer people. From this, we can say that consumers might believe that plastic bags and Ecolean packages are the containers that retain the fewest residues. These two types of packages are flexible containers. When consumers drink, they will subconsciously squeeze the package, which can significantly reduce the residue amount. The other 6 types cannot be squeezed, as the packaging does not deform, and it is not easy to reduce the residue amount.

Table 10. Consumer perception of yogurt residues in the 8 most common packages in Chinese markets

Packages	Consumers (%)	Consumers (%) who observed residues	Consumers (%) who observed maximum residue amounts
Glass bottle	214(64.7)	145(72)	38(17.8)
Ceramic can	73(22.1)	57(78.1)	8(11)
Plastic bag	162(48.9)	66(40.7)	11(6.8)
Plastic cup or plastic bottle	282(85.2)	213(75.5)	32(11.3)
Ecolean package	154(46.5)	71(46.1)	6(3.9)
Gable top carton	212(64.0)	169(79.2)	60(28.3)
Tetra Prisma	257(77.6)	194(75.1)	83(32.3)
Tetra top	198(59.8)	158(79.8)	70(35.5)

Proportion of consumers observing residues=consumers who observed residue/total consumers×100%;proportion of consumers observing maximum amounts of residues=consumers who observed maximum residues/total consumers×100%

When yogurt residue was found, 97 people (29.3%) directly discarded it, 208 (62.8%) adjusted the position of the straw, 218 people (65.9%) squeezed the package, 51 people (15.4%) cut open the package, 8 people (2.4%) rinsed the package with water, and 18 people (5.4%) chose other ways.

For the results from Figure 2 and Figure 3, see Table 11. A survey on the “drinking instructions” on the Tetra Prisma yogurt box was administered (Figure 2 and Figure 3). The Tetra Prisma package had detailed instructions; however, only 34.4% of people who consumed Tetra Prisma yogurt observed those drinking instructions on the yogurt box, only 56% of those who saw these instructions read them carefully, and only 31.7% followed those instructions. The results are similar to the results of our previous experiments. A total of 82.5% thought that the drinking instructions on this package were unclear and not easy to see. It can also be seen from the figure that the “drinking instructions” are on the inside of the top cover of the box, which is difficult to see. After opening the outer layer of the box, these instructions do not attract the attention of consumers. Moreover, 80% of consumers also indicated that this type of drinking instruction was easy to learn and simple to use (Table 11), indicating that the reason that most consumers chose methods that led to large amounts of residues was in the “drinking instructions” of the box.

For the results from Figure 4, see Table 12. The results of the survey in Figure 4 are similar to those in Figure 1 and Figure 2. Of the people that were not aware of drinking instructions (220), 192 people (87.3%) said that if they had known of these drinking instructions, they would drink in accordance with them.

Table 11. Results of the “Drinking Instructions” questionnaire on the Tetra Prism package

Questionnaire	Number of people	Proportion/%
Had seen drinking instructions on this type of yogurt box	114	34.4
Carefully read the drinking instructions on this package	64	19.3
Followed these instructions for drinking yogurt	105	31.7
Thought that the instructions were clearly visible	58	17.5
Thought that these instructions were easy to understand	280	84.6
Thought that these instructions were easy to follow	265	80.1

Table 12. Results of the “Drinking Instructions” questionnaire on the Tetra Prism yogurt box

Questionnaire	Number of people	Proportion/%
Had seen drinking instructions on this type of yogurt box	120	36.3
Carefully read the drinking instructions on this package	68	20.5
Followed these instructions for drinking yogurt	109	32.9
Thought that the instructions were clearly visible	55	16.6
Thought that these instructions were easy to understand	264	79.8
Thought that these instructions were easy to follow	248	74.9

4. Discussion

According to the Food and Agriculture Organization of the United Nations (FAO) statistics, every year the world wastes approximately 1.3 billion tons of food, which means that approximately 1/3 of food is lost or wasted in production and consumption [4], resulting in direct economic losses of up to 750 billion dollars. From 2015–2020, China's yogurt market compound growth rate was approximately 18%; yogurt in liquid state has increased year by year; in 2015, exceeded 30%; and in 2020, is expected to reach 190 billion. The presence of residues after consuming yogurt is clearly visible; therefore, there is an urgent need to study the yogurt residues and come up with a solution to reduce the huge waste.

4.1. Comparison of yogurt residue between common yogurt packages

Our survey results suggest that 94.9% of consumers are aware of yogurt residues, and most think that the Tetra Prisma package retains the fewest residues (25.1%), followed by Tetra top packages, gable top cartons, plastic cups or bottles, glass bottles, plastic bags, and ceramic cans, while the Ecolean package retains the fewest residues (1.8%). We also consulted domestic and foreign information and did not find any article mentioning yogurt residue after consumption. In fact, there is no report on which type of packages retain residues or the amounts of residues retained. Thus, we compared the residues

in seven of the most common types of yogurt packages in the Chinese market. The common method for drinking yogurt is with a straw. The results show that after standardization, the Ecolean package and plastic bags had the fewest residues, followed by glass bottles, Tetra Prisma packages, gable top cartons, and Tetra top packages, while the plastic cups retained the most residues. The last four type of packages listed retained more than 10g of residue (for every 100g of yogurt, the same below), while plastic cup retained up to 22.307g, a surprising amount of waste. These values were measured using the method of drinking with a straw without adjustment.

4.2. The relationship between different drinking methods and yogurt residues

In fact, most packages had a variety of drinking methods. Further analysis of each yogurt package's common drinking method and residual relationship is needed. We used the drinking tools from the seven types of package and drinking instructions on the packages (see [Table 1](#)), combined with the actual drinking methods of consumers, and we summarized the common drinking methods of each yogurt package. The glass bottles and Ecolean package both only had one common drinking method; therefore, they were not included in the experiment.

In this study, we compared 5 kinds of packages (plastic bags, plastic cups, gable top cartons, Tetra Prisma, and Tetra top), common and different drinking methods and remaining residues. The results showed that the three common drinking methods from plastic bags resulted in fewer residues. Among these methods, drinking with a straw resulted in fewer residues. Thus, so the plastic bag is a container that wastes very little. Plastic cup results showed that opening the lid and using a straw to drink or a spoon to eat resulted in a minimum amount of yogurt residues, followed by adjusting the straw without removing the lid and directly drinking with a straw (without removing the lid or adjusting of the straw), which produced up 22.307g of residues. Different drinking methods resulted in more residues. In recent years, some plastic cups have become equipped with spoons as drinking tools. With a spoon, it is possible to significantly reduce the amount of yogurt residue. On the other hand, equipping the package with a spoon significantly increase the cost of packaging, and opening the lid and using a straw to drink had the same result as when using a spoon. The common drinking methods from gable top cartons included drinking directly with the mouth, which left the most residues (28.569g) and adjusting the straw after drinking, leaving the fewest residues (7.727 g). The difference in the amount of yogurt residues between the two was 20.842 g. Gable top cartons did not provide any tools or any drinking instructions. For Tetra Prisma packages, when using the conventional drinking method, the yogurt residue could reach 16.292g, followed by adjusting the straw for drinking and squeezing the package. Unfolding the four corners of the package resulted in of the fewest residues (5.062g). The above methods were more wasteful, while unfolding the four corners was the best one to reduce residues. Tetra top package results showed that when adjusting the straw to drink the yogurt, the residue amount was 8.188 g, followed by drinking with a straw without adjustment (15.333 g). According to the above results, the correct drinking method can significantly reduce the amount of yogurt residues, reducing waste. Comparison of the seven types of yogurt package with the best drinking method suggested that the Ecolean package had the fewest residues, followed by plastic bags, plastic cups, Tetra Prisma, gable top cartons, Tetra top, and glass bottles, which produced the most residues. The packages that could be squeezed, such as the Ecolean, plastic bag, and Tetra Prisma packages, could result in substantial residue reduction, as could plastic cups with a lid. On the other hand, Tetra top packages, gable top cartons, and glass bottles could not be squeezed, resulting in large amounts of residues. From the above, we conclude that the yogurt container can affect the amount of yogurt residue, and good packaging can significantly reduce the residue amount, reducing the waste of yogurt.

4.3. The relationship between consumer drinking methods and yogurt residues

In fact, most packages had a variety of drinking methods. Further analysis of each yogurt package's common drinking method and residual relationship is needed. We used the drinking tools from the seven types of package and drinking instructions on the packages (see [Table 1](#)), combined with the actual drinking methods of consumers, and we summarized the common drinking methods of each yogurt package. The glass bottles and Ecolean package both only had one common drinking method; therefore, they were not included in the experiment.

In this study, we compared 5 kinds of packages (plastic bags, plastic cups, gable top cartons, Tetra Prisma, and Tetra top), common and different drinking methods and remaining residues. The results showed that the three common drinking

methods from plastic bags resulted in fewer residues. Among these methods, drinking with a straw resulted in fewer residues. Thus, so the plastic bag is a container that wastes very little. Plastic cup results showed that opening the lid and using a straw to drink or a spoon to eat resulted in a minimum amount of yogurt residues, followed by adjusting the straw without removing the lid and directly drinking with a straw (without removing the lid or adjusting of the straw), which produced up 22.307g of residues. Different drinking methods resulted in more residues. In recent years, some plastic cups have become equipped with spoons as drinking tools. With a spoon, it is possible to significantly reduce the amount of yogurt residue. On the other hand, equipping the package with a spoon significantly increase the cost of packaging, and opening the lid and using a straw to drink had the same result as when using a spoon. The common drinking methods from gable top cartons included drinking directly with the mouth, which left the most residues (28.569g) and adjusting the straw after drinking, leaving the fewest residues (7.727g). The difference in the amount of yogurt residues between the two was 20.842g. Gable top cartons did not provide any tools or any drinking instructions. For Tetra Prisma packages, when using the conventional drinking method, the yogurt residue could reach 16.292g, followed by adjusting the straw for drinking and squeezing the package. Unfolding the four corners of the package resulted in of the fewest residues (5.062g). The above methods were more wasteful, while unfolding the four corners was the best one to reduce residues. Tetra top package results showed that when adjusting the straw to drink the yogurt, the residue amount was 8.188g, followed by drinking with a straw without adjustment (15.333g). According to the above results, the correct drinking method can significantly reduce the amount of yogurt residues, reducing waste. Comparison of the seven types of yogurt package with the best drinking method suggested that the Ecolean package had the fewest residues, followed by plastic bags, plastic cups, Tetra Prisma, gable top cartons, Tetra top, and glass bottles, which produced the most residues. The packages that could be squeezed, such as the Ecolean, plastic bag, and Tetra Prisma packages, could result in substantial residue reduction, as could plastic cups with a lid. On the other hand, Tetra top packages, gable top cartons, and glass bottles could not be squeezed, resulting in large amounts of residues. From the above, we conclude that the yogurt container can affect the amount of yogurt residue, and good packaging can significantly reduce the residue amount, reducing the waste of yogurt.

4.4. Tetra Prism drinking methods

After collecting Tetra Prisma packages, the findings show that only using a straw to drink the yogurt resulted in the most residues; unfolding the four corners of the package resulted in of the fewest residues, similar to our previous experiment (see section 3.6). However, only 25.12% of the consumers unfolded the four corners of the package, 9.00% squeezed the package, and 65.88% only used straw, similar to the results from the plastic cup package. Most consumers did not use the most economical method of drinking, instead choosing the method that resulted in a large amount of residue. The Tetra Prisma package came with drinking tools and drinking instructions: “after drinking, unfold the four corners, and squeeze the package”. These drinking instructions could be found on the large box (usually containing 12 units of tetra prisma package) and also on every individual unit. On the large box, they could be found on the inner layer of the top cover of the box. On the individual units, they could be found on the top of the package, with the exception of one brand, where they could be found on the side. Our survey questionnaire (Figure 1 and Figure 3) showed that only approximately 17% of the participants thought that these instructions were clearly visible, 45% knew of this drinking method, approximately 23% had seen and understood these drinking instructions before, while the other participants were told other instructions. Although there were drinking instructions, they were not clear, the location was not ideal, and the font was very small, making it not easy for consumers to find these instructions. A total of 35% of participants had seen the drinking instructions on the box, and only approximately 20% of consumers carefully read it. Further proof that consumers do not drink in accordance with the instruction is that they could not see them clearly, they did not consider them to be important content, or they turned a blind eye. Thus, only about 30% of consumers drink in accordance with the instructions, which is close to the data that we collected from consumers in the field (25.12%). Most people think that these drinking instructions are easy to learn and easy to follow, and 87.3% of participants said that if they had been aware of these drinking instructions, they would drink in accordance with them. Thus, we can see that the main problem is in the packaging.

4.5. Countermeasures

When consuming yogurt, there is a serious problem with its adhesion to the wall of the container. Residues are not only common, but the amount is surprising. What can we do to reduce residues? Packages that help reduce residues have been produced [18,19], and patents on straw inventions are available [20,21]; however, there are few practical applications. One strategy is to employ bio-inspired super hydrophobic films to [22-24]. One method is to construct the super hydrophobic surfaces by an electrostatic spinning technique to manufacture micro/nano scale structures using a hydrophobic polymer [25-28]. The other method is the use of long-chain fluorocarbon materials with low surface energy [29,30]. However, the electrostatic spinning technique is prohibitively expensive. The long-chain fluorocarbon material has toxic effects. Therefore, an ideal superhydrophobic surface material should be nontoxic and edible [31-35]. It is a great challenge to design and develop an ideal superhydrophobic interface.

There are two keys leading to the resulting of residue. The first one is the package, the second one is the consumer, and the former is the greater problem. Companies pay more attention to sales, often turning a blind eye to yogurt residue. This research proves that different containers and different drinking methods result in different amount of residues, so choosing a good package and a good drinking method could significantly reduce residues.

However, consumers do not usually choose the most economical drinking method. Consumers, when purchasing yogurt, are able to find drinking tools attached only to some type of packages, such Tetra_Prisma and plastic cups. For most packages, the drinking tool is provided at the cash out at the supermarket, such as for gable top cartoons, glass bottles, and plastic bags, making it easy to forget to take them home. However, if the drinking tool is attached to the package or the package box, the result might be completely different; a simple straw can clearly reduce the amount of residue production, and each package should be equipped with a straw. An inexpensive straw could significantly reduce the amount of residue, thus reducing waste. Drinking instruction should be printed on each package, informing the best method to reduce residues; these instructions should be placed in an obvious position, and the font should be large and eye-catching. We found that only the Tetra Prisma and Ecolean packages were equipped with drinking tools and instructions. However, both package instructions were found in difficult-to-spot locations and were not clear; eye-catching positions were usually given to promote the brand. It is recommended to leave a side of the package for drinking instructions so that the font can be larger and eye-catching at a glance. The company should design the new package for avoiding wastage [36,37]. A responsible company should have marketing ethics and social responsibility. A company also should have a sales marketing strategy and through the company, media, and community inform consumers about yogurt residues and the best drinking methods. Then, the majority of the consumers should start to follow the drinking instructions. Plastic bags produced the fewest residues and were cheaper, but they also had few buyers, possibly because there were no drinking tools or instructions. To drink the yogurt, scissors were needed to cut a corner, as the bags were difficult to tear with bare hands. An easy-to-open package should be designed, if possible, equipped with drinking tools and instructions, which would be more convenient for consumers. Plastic cups should come with a spoon or a straw and instruction, and a long edge should be left at the corner of the lid to help the consumer open the package. Gable top cartoons and packages that come with a cover, such as glass bottles, ceramic cans, Tetra top packages, and plastic bottles, usually come without drinking tools or instructions, and these types of containers cannot be squeezed or unfolded, resulting in a large amount of residue. The best method here is to repeatedly adjust the straw; these containers must have straw and drinking instructions to reduce residues. Our research shows that there is no need to develop new products and almost no need to increase costs if the packaging company provides drinking tools and printed instructions in an eye-catching position on the package to guide consumers to choose the best drinking method. This will reduce the amount of residue and waste and will also give consumers a deep impression that the fundamental function of packaging is to protect the product, reduce waste, and put the consumer and consumer's interests at first, which is the most important factor in modern marketing. It is conducive to companies to establish a positive long-term brand effect to promote sales; the media should also inform consumers of the best drinking methods and criticize the irresponsible behavior of companies. The government and relevant departments should provide assistance and supervision and should urge to comply, or even pass legislation requiring that they do. They should be given a deadline for rectification, and those with a great amount of waste that cannot be corrected should be forced to stop production and leave the market.

5. Conclusion

Our results show that of the 7 most common packages, 4 have 10% or more residue remaining, and the greatest is more than 20%. In 2015, China's yogurt retail market reached 82.1 billion. Although we cannot accurately calculate economic losses, from the data, it can be roughly estimated that the amount of waste is staggering. Our solution should also be simple and practical.

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