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RESEARCH ARTICLE

ENVIRONMENTAL ATTITUDES AND CONSUMER PREFERENCE FOR ENVIRONMENTALLY-FRIENDLY BEVERAGE PACKAGING: THE ROLE OF INFORMATION PROVISION AND IDENTITY LABELING IN INFLUENCING CONSUMER BEHAVIOR

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KEYWORDS

China, consumer preference, food and beverage packaging, green identity label, information treatment, plastics

HIGHLIGHTS

- Consumer preference for environmentally-friendly beverage packaging was investigated.
- Consumers are willing to pay a premium for post-consumer recycled materials.
- Environmental information and green identity labels have synergistic effect on consumer willingness to pay.
- Product unit size seems irrelevant in most consumer decisions.

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GRAPHICAL ABSTRACT

ABSTRACT

This study examined whether urban Chinese consumers with stronger environmental values have higher valuations for plastic beverage bottles that are made of post-consumer recycled material (rPET) or that come in large sizes that use plastic more efficiently. It also assesses the effectiveness of environmental information provision and green identity labeling in increasing consumer willingness to pay for environmentally-friendly packaging. The results suggest that urban Chinese consumers are willing to pay a premium for rPET bottles, indicating that there is a potential market for rPET food and beverage packaging in China that calls for manufacturing guidelines, safety standards, or regulations. Providing environmental information and attaching green identity labels increases consumer valuations of rPET bottles, with their joint use exerting the largest effect. Pro-environmental consumers are more responsive to environmental information and green identity labeling and thus are willing to pay a higher premium for rPET bottles. However, in terms of choosing large bottles as a means to reduce plastic use in product packaging, consumers were found to be indifferent about plastic bottle sizes even after receiving environmental information. It is suggested that the inconvenience of carrying or storing large bottles might have offset their perceived environmental benefits.

1 BACKGROUND

Owing to their inexpensive, lightweight, strong and durable features, plastics have been used to produce a wide variety of goods and have become an integral part of human life[1]. Between 1950 and 2015, about 6300 Mt of plastic waste was generated, but only around 9% of this output was recycled and 12% incinerated, with the remaining 79% accumulating in landfills or the natural environment[2]. To date, plastic debris and microplastics have been found from the Alps to the Arctic[3], from land to the ocean[4,5], and most recently, in human lung tissue[6].

Plastic is commonly used as packaging for consumer goods in the form of bags, bottles and films. It is especially widely used as packaging for food and drink products due to its effectiveness in preserving food and drink characteristics, extending product shelf life, and maintaining food safety[7]. On the downside, however, plastic packaging is usually immediately discarded by consumers after they finish consuming food and beverage products[8]. According to an assessment by Jiang et al.[9], from 1978 to 2017, China, the largest plastics producer and user in the world, produced 348 Mt of post-consumer plastic packaging waste, which accounted for 66% of the total domestic plastic waste.

In response to the environmental crisis, in recent years, consumers around the world have grown to be concerned about the environmental consequences of their purchasing decisions[10]. A 2022 study on global consumers conducted by the National Retail Federation and IBM found that more than 60% of respondents were willing to change their purchasing habits in order to reduce environmental impact[11]. For tackling the single-use plastic crisis specifically, there is a rich body of literature reporting studies on plastic packaging avoidance behavior of consumers in food and beverage purchasing decisions[12,13]. For example, empirical studies have found that consumers are willing to pay a premium for environmentally-friendly packaging alternatives to plastic takeout food containers, plastic milk bottles, plastic-packaged cherry tomatoes and plastic egg crates[14–17].

2 LITERATURE REVIEW AND STUDY OBJECTIVES

In this study, we focused on plastic bottles used to contain water and beverages. Most plastic bottles on grocery store shelves worldwide are made of highly recyclable polyethylene terephthalate (PET), but current recycling efforts have failed to keep up with the soaring demand. For example, it has been estimated that a million plastic bottles were bought around the world every minute, but fewer than half of the bottles bought in 2016 were collected for recycling[18]. To reduce the generation of plastic waste from plastic bottles, consumers may shift their purchasing behavior by (1) choosing beverage products bottled in alternative environmentally-friendly packaging rather than standard PET packaging or (2) selecting bottle sizes that are more efficient at delivering beverage[1]. Also, as a response to consumer preference for environmentally-friendly packaging, manufacturers, bottlers and retailers may change their product design decisions and marketing activities as they strive to meet consumer demand, reduce corporate plastic footprints, and reach their environmental, social and corporate governance goals in order to attract investment.

[1] Although consumers could also reduce the generation of plastic waste by refraining from purchasing bottled beverage products altogether, this is not the focus of our study given the ubiquity of plastic in consumers' day-to-day lives and the limited feasibility of widespread abstinence in plastic use.

2.1 Alternative environmentally-friendly plastic materials

A number of recent studies specifically assessed consumer preference for alternative environmentally-friendly plastic packaging materials for bottled water and the effectiveness of environmental information provision. Orset et al.[19] found that French consumers would pay a significant premium for post-consumer recycled PET (rPET) and polylactic acid (a bio-based, biodegradable and compostable material) plastic bottles, and providing information on the characteristics and environmental impacts of alternative plastic packaging materials had a manifest effect on consumer willingness to pay (WTP). Grebitus et al.[20] found that providing a pro-environmental nudge message and allowing an information search on the internet increased US consumer WTP for environmentally-friendly plastic bottles. However, De Marchi et al.[21] found that while providing sustainability-related information on alternative plastic materials increased the likelihood of consumers choosing bio-PET (i.e., partly bio-based) bottles, it decreased their likelihood of choosing rPET bottles, potentially due to perceived contamination risks, low quality and low functionality of recycled plastic.

To date, however, there is limited information about the potential for these alternative packaging materials in the Chinese marketplace. We visited several chain supermarkets and found that all of the domestically-produced beverage products came in standard PET plastic bottles, while a few imported bottled water products came in rPET bottles. This discrepancy may be at least partially due to a somewhat murky policy environment. Based on a mapping of plastic food and beverage packaging policies in China over the years[22], the use of post-consumer recycled plastics in food and beverage packaging was strictly banned from 1990 until the 2010s over concerns about contaminated recycled material and the resulting food safety risks, but the related policies and regulations have either been annulled or replaced in recent years (see Appendix A in supplementary materials). At the moment, there is no law or regulation explicitly banning the use of rPET in food and beverage packaging, nor are there manufacturing guidelines, safety standards or regulations for food-grade rPET packaging materials. Given this policy vacuum and the ensuing ambiguities, domestic producers apparently prefer to maintain the status quo and continue using PET despite its environmental consequences. As a result, compared to North America and Europe where food and beverage packaging made with recycled plastic can be found in grocery stores anywhere, consumers in China who wish to purchase environmentally-friendly alternatives simply do not have this option. In addition, not being able to provide environmentally-friendly packaging alternatives such as rPET bottles hinders Chinese food and beverage manufacturers from fulfilling corporate environmental responsibility.

2.2 Larger and more efficient bottle sizes

There has been relatively little research into the potential for altering package sizes as a plausible means of reducing total plastic use in food and beverage packaging. Although choosing bottle sizes that are more efficient at delivering beverages yields similar effects in reducing plastic packaging waste, this characteristic is far less salient as a pro-environmental feature than alternative packaging materials. Becerril-Arreola and Bucklin[23] found that compared to small bottles (< 473 mL) and large bottles (> 3 L), midsize plastic bottles (473 mL to 3 L) were the most efficient at delivering beverages, where efficiency is the volume of beverage delivered relative to the mass of plastic package used to contain it. They estimated that holding the total volume of beverage sold constant, a 20% shift in consumption from small plastic bottles to midsize bottles could reduce the annual production of PET waste by over 10 kt in the USA alone. In this study, we propose that consumer preference for beverage products that come in different bottle sizes can be studied through a wholesale setting, where bottled beverage products are usually sold in bundles containing a certain number of bottles filled with a certain volume of beverage.

2.3 Green identity labeling as a strategy to shift consumer behavior

Green identity labeling (e.g., attaching a label on products announcing that this product is for green shoppers) is a strategy based on the self-perception theory that encourages environmentally-friendly consumer purchasing behavior by associating them with a green (i.e., environmentally conscious) self-image[24,25]. This strategy is relatively novel, and so far, there have been mixed findings on its effectiveness. While Schwartz et al.[25] found that green identity labeling increased the purchase of ecofriendly products such as light bulbs and reusable bags, Lin and Nayga[26] did not find an effect of green identity labeling on environmentally-friendly coffee.

2.4 Study objectives

In this study, we used a discrete choice experiment (DCE) to assess Chinese consumer preference and valuation for environmentally-friendly rPET plastic bottles relative to standard PET plastic bottles and large plastic bottle bundles relative to small plastic bottle bundles, holding the total volume of beverage fixed. We examined whether environmental attitudes of consumer affected their valuation of the environmentally-friendly characteristics of plastic bottles. Additionally, we evaluated how providing (1) information on the environmental benefits of rPET material, (2) information on the environmental benefits of large bottle bundles vis-à-vis small bottle bundles, and (3) green identity labels on rPET bottles affected consumer valuation of these different product packaging attributes. Finally, we investigated the differences in responsiveness to this information and labeling treatments between consumers based on their environmental attitudes. The findings of this study can be used to inform manufacturers and retailers in future product planning, design and marketing, and could have significant implications for future policymaking on rPET food and beverage packaging and education campaigns for pro-environmental consumer behavior and plastic packaging waste reduction.

3 MATERIALS AND METHODS

3.1 Survey design

Our survey consisted of three parts. The first part included questions about bottled non-carbonated beverage product purchasing behavior, waste sorting and recycling behavior, and knowledge and perception of rPET as food and beverage packaging material. The second part was a DCE, discussed in greater detail in Section 2.2. The final part consisted of questions on food safety concerns, basic sociodemographic information, and a set of questions developed by Haws et al.[27] to measure consumer environmental attitudes (i.e., green consumption values). The survey was administered in January 2022 using an online opt-in Chinese urban consumer panel drawn from Qualtrics. Qualtrics standing panel of Chinese urban consumers has been surveyed by a number of manufacturers and retailers for marketing research, so we believe that it is a reliable source of respondents to our study, perhaps representative of the target consumer, if not representative of all urban Chinese consumers. To qualify to be a member of the sample, individuals must have been 18 years of age, residing in mainland China and making household grocery shopping decisions. Responses of individuals who completed the survey in less than half of the median completion time were excluded by Qualtrics, and those who selected the opt-out option in all eight choice sets (n = 6) were excluded from our final analysis.

3.2 Discrete choice experiment

We elicited consumer preference and willingness to pay for packaging attributes through a DCE. In our DCE, participants were presented with several hypothetical choice sets and asked to choose their preferred alternative in each choice set. Based on the Lancaster's theory of consumer demand[28] and random utility theory[29], DCEs allow researchers to estimate the tradeoffs consumers make when evaluating different attributes, as well as their willingness to pay for each attribute if product price is included as a product attribute. We used bottled juice as the product of interest for three reasons. First, it is a popular product among Chinese consumers across age groups, gender and location. Second, unlike carbonated beverages, bottled juice is less prone to a deterioration in taste if not finished in one sitting, thus making it a suitable product for the assessment of consumer preference over varying bottle sizes. Finally, unlike bottled water products with alternative options such as tap water and bottle refilling, juice product is not widely sold in a bring-your-own-bottle or bottle refilling fashion.

In this study, each choice set contained two hypothetical bottled juice products and an opt-out (no-purchase) option. Participants were asked to choose one preferred option in each choice task. The bottled juice products were described by three attributes: packaging material, bottle size and bundle, and price (Table 1), while other characteristics including, but not limited to, the type of juice, product brand and packaging visual designs were held constant across products. The packaging material attribute specified whether the juice was sold in PET bottles or rPET bottles. The bottle size and bundle attribute specified whether the 1.8 L juice product bundle, identical in all aspects except for unit size and the number of units per bundle, was sold in six by 300 mL or two by 900 mL bundles. The price attribute had four levels: 30, 45, 60 and 75 RMB, reflecting actual market price ranges for 1.8 L bottled juice products in China. The opt-out option allowed the hypothetical design in the DCE to resemble real-world purchasing scenarios where consumers may choose not to buy any product if the available

Table 1 Attributes and levels used in experimental design

Attributes	Levels
Packaging material	PET
	rPET
Bottle size and bundle	300 mL six-pack
	900 mL two-pack
Price (RMB)	30
	45
	60
	75

alternatives do not meet their preference.

Given the product attributes and levels, a full factorial design with two product alternatives in each choice set would require $(2^2 \times 4^1)^2 = 256$ choice scenarios, an unmanageable number for survey respondents. We obtained an optimal fractional factorial design using a user-written Stata command (dcreate), which creates efficient designs for DCEs using the modified Fedorov algorithm[30]. Subsequently, the ultimate experimental design was reduced to 24 unique choice sets, which were randomly assigned to three different choice set blocks such that each respondent will be randomly allocated to one of the blocks and required to evaluate eight choice sets. To avoid ordering effects, the order in which the eight choice sets were presented was randomized across participants. An example of a choice set is shown in Table 2.

Prior to entering the DCE, participants were given instructions on how to complete the experiment, informed about the product attributes and levels they should expect to see in the choice sets, and asked to read a cheap talk script (see Appendix B in supplementary materials) based on the one used in Van Loo et al.[31] to mitigate potential hypothetical bias[32].

3.3 Information treatment and green identity labeling design

We employed a between-subjects design to investigate the individual and combined effects of information provision and green identity labeling on consumer preference and WTP for environmentally-friendly attributes of plastic bottles. Respondents were randomly assigned to one of eight groups (Table 3). T1 was the control group, with respondents receiving no additional information nor exposure to any special labels. In T2, the pictures of rPET bottles shown to participants during the DCE were accompanied by a green identity label stating, "This product is for green consumers" (see Table 4 for comparison). Before beginning the DCE, participants in T3 and T4 were provided information on the characteristics and environmental benefits of rPET packaging as compared to standard PET packaging (i.e., rPET information treatment), while participants in T5 and T6 were informed of the additional 27% of plastic packaging used by a small bottle bundle than a large bottle bundle (i.e., size information treatment) (see Appendix C in supplementary materials)[2]. Additionally, participants in T4 and T6 received the green identity label treatment. Finally, participants in T7 received both the rPET information treatment and the size information treatment, while participants in T8 received both information treatments as well as the green identity label treatment.

3.4 Econometric model

To model consumer preference for environmentally-friendly characteristics of plastic bottles from the choice experiments, we specified an indirect utility function based on Lancaster's theory of consumer demand[28]. According to the random utility theory[29], the utility derived by individual n choosing

Table 2 Example choice set

	Option A	Option B	Option C
			If options A and B were all that were available, I would not purchase either product.
Packaging material	PET	rPET	
Bottle size and bundle	900 mL × 2 pack	300 mL × 6 pack	
Price	30 RMB	75 RMB	
I choose:	□	□	□

[2] Prior to initiating the survey, we determined that the 300 mL six-pack (i.e., small bottle bundle) used 186 g of PET plastic, 27% more than the 900 mL two-pack (i.e., large bottle bundle), which used only 147 g of PET plastic. The mass of plastic in each of the product bundles was determined using actual plastic bottles based on the procedures outlined in Becerril-Arreola and Bucklin[23], which entailed cleaning and drying the bottles before weighing them on a high-precision scale.

Table 3 Treatment group assignment

Group	Treatment
T1	Control group
T2	Green identity label
T3	rPET information
T4	rPET information + Green identity label
T5	Size information
T6	Size information + Green identity label
T7	rPET information + Size information
T8	rPET information + Size information + Green identity label

alternative j in choice situation t was expressed as:

$$U_{njt} = V_{njt} + \varepsilon_{njt} = \alpha Price_{njt} + \beta_{n1} rPET_{njt} + \beta_{n2} Large_{njt} + \beta_{n3} rPET_{njt} \times GREENscore_{njt} + \beta_{n4} Large_{njt} \times GREENscore_{njt} + ASC_{Opt-out} + \varepsilon_{njt} \quad (1)$$

where V_{njt} is the systematic portion of the utility function depending on the experimentally-designed product attributes of alternative j, ε_{njt} is the random stochastic component, $Price_{njt}$ is a continuous variable populated with the four price levels in the experimental design, $rPET_{njt}$ is a dummy variable for rPET bottles; $Large_{njt}$ is a dummy variable for large bottle bundles, and $GREENscore_{\mathrm{njt}}$ denotes the mean-centered GREEN scores from the six-item green consumption value scale[27]. The interactions of $rPET_{njt}$ and $Large_{njt}$ with $GREENscore_{\mathrm{njt}}$ allow for differences in preference for the product attributes that can be explained by respondent green consumption values. $ASC_{Opt\text{-}out}$ is the alternative specific constant of the opt-out option that equals one when it is chosen, and zero otherwise.

We estimated mixed logit models with the choice experiment data and with Eq. (1) providing the underlying linearly additive utility function being modeled, using 10,000 Halton draws for simulations. The marginal WTP values for each attribute were calculated as the negative ratio of the coefficient of each non-monetary attribute (β) and the price coefficient (α) per standard practice[3].

3.5 Data

Our effective sample size was 634 respondents, with 71 in T1, 78 in T2, 79 in T3, 80 in T4, 79 in T5, 87 in T6, 84 in T7, and 76 in T8. The median survey completion time of our effective sample was approximately 7 min, and 90% of respondents finished the survey within 17 min.

Overall, 63% of our sample were female with as average age of 32 years old, 67% married, and 93% holding a three-year college, undergraduate or postgraduate degree (Table 5). On

Table 4 rPET bottles with and without green identity label

	rPET bottles with green identity label	rPET bottles without green identity label
300 mL × 6 pack	 This product is for green consumers	
900 mL × 2 pack	 This product is for green consumers	

[3] Given the random utility framework underlying our econometric specification, the coefficients can be readily interpreted as marginal utilities, and the ratio of two marginal utilities provides the marginal rate of substitution of one product characteristic for another. Under the assumption that the marginal utility of product cost is a valid approximation for the negative marginal utility of income, the negative ratio of the marginal utility of a product attribute to the marginal utility of price yields a measure of the amount of money a consumer would willingly sacrifice for an increase in the expression of the attribute in the numerator.

Table 5 Sociodemographic characteristics as a proportion (%) of the sample

Variable	T1 = Control	T2 = Green label	T3 = rPET info	T4 = rPET info + Green label	T5 = Size info	T6 = Size info + Green label	T7 = Both info	T8 = Both info + Green label	Overall
Gender									
Male	38.03	32.05	45.57	32.50	46.84	29.89	35.71	38.16	37.22
Female	61.97	67.95	54.43	67.50	53.16	70.11	64.29	61.84	62.78
$X^2 = 11.5$, $df = 7$, $P = 0.12$									
Age (years)									
18–24	25.35	16.67	22.78	22.50	25.32	18.39	25.00	23.68	22.40
25–34	47.89	52.56	43.04	41.25	46.84	54.02	45.24	57.89	48.58
35–44	22.54	21.79	25.32	21.25	18.99	20.69	23.81	11.84	20.82
> 45	4.23	8.97	8.86	15.00	8.86	6.90	5.95	6.58	8.20
$X^2 = 22.65$, $df = 21$, $P = 0.36$									
Marital status									
Married	64.79	73.08	67.09	68.75	65.82	72.41	66.67	56.58	67.03
Single/separated/divorced	35.21	26.92	32.91	31.25	34.18	27.59	33.33	43.42	32.97
$X^2 = 8.32$, $df = 7$, $P = 0.31$									
Educational attainment									
High school or below	4.23	5.13	8.86	6.25	7.59	4.60	14.29	6.58	7.26
Three-year college/diploma	11.27	16.67	16.46	17.50	11.39	19.54	8.33	14.47	14.51
Undergraduate	73.24	71.79	64.56	65.00	62.03	64.37	63.10	64.47	65.93
Graduate	11.27	6.41	10.13	11.25	18.99	11.49	14.29	14.47	12.30
$X^2 = 26.90$, $df = 21$, $P = 0.17$									
Number of adults in the household									
1 or 2	33.80	47.44	43.04	33.75	37.97	45.98	41.67	35.53	40.06
3	30.99	25.64	26.58	35.00	29.11	32.18	25.00	23.68	28.55
4	25.35	19.23	20.25	23.75	21.52	14.94	27.38	28.95	22.56
5 or more	9.86	7.69	10.13	7.50	11.39	6.90	5.95	11.84	8.83
$X^2 = 19.28$, $df = 21$, $P = 0.57$									
Number of children under 18 in the household									
0	19.72	28.21	24.05	33.75	27.85	25.29	26.19	26.32	26.50
1	63.38	61.54	56.96	52.50	58.23	60.92	58.33	48.68	57.57
2 or more	16.90	10.26	18.99	13.75	13.92	13.79	15.48	25.00	15.93
$X^2 = 15.73$, $df = 14$, $P = 0.33$									
Monthly household income (RMB)									
⩽ 7000	7.04	6.41	11.39	6.25	11.39	12.64	13.10	9.21	9.78
7001–11,000	16.90	12.82	15.19	13.75	17.72	10.34	14.29	13.16	14.20
11,001–15,000	18.31	25.64	16.46	17.50	17.72	18.39	15.48	25.00	19.24
15,001–19,000	15.49	12.82	11.39	25.00	13.92	16.09	19.05	11.84	15.77

(*Continued*)

Variable	T1 = Control	T2 = Green label	T3 = rPET info	T4 = rPET info + Green label	T5 = Size info	T6 = Size info + Green label	T7 = Both info	T8 = Both info + Green label	Overall
19,001–23,000	14.08	15.38	17.72	11.25	17.72	19.54	17.86	19.74	16.72
23,001–27,000	7.04	5.13	3.80	10.00	13.92	8.05	5.95	7.89	7.73
> 27,000	21.13	21.79	24.05	16.25	7.59	14.94	14.29	13.16	16.56
$X^2 = 47.72$, $df = 42$, $P = 0.25$									
Region									
North	22.54	16.67	26.58	20.00	18.99	28.74	22.62	21.05	22.24
North-east	2.82	5.13	5.06	8.75	7.59	6.90	1.19	9.21	5.84
East	40.85	42.31	27.85	32.50	35.44	28.74	39.29	28.95	34.38
South Central	23.94	25.64	32.91	27.50	22.78	26.44	27.38	36.84	27.92
North-west & South-west	9.86	10.26	7.59	11.25	15.19	9.20	9.52	3.95	9.62
$X^2 = 34.29$, $df = 28$, $P = 0.19$									
Place of residence									
First-tier cities	49.30	50.00	55.70	51.25	40.51	48.28	53.57	42.11	48.90
New first-tier cities	22.54	33.33	24.05	36.25	41.77	29.89	26.19	34.21	31.07
Others	28.17	16.67	20.25	12.50	17.72	21.84	20.24	23.68	20.03
$X^2 = 21.48$, $df = 14$, $P = 0.09$									
N	71	78	79	80	79	87	84	76	634

Note: Pearson’s chi-square tests were conducted to test the null hypothesis of no difference in the distribution of variables across treatment groups.

average, households consisted of three adults (typically a married couple and at least one of their surviving parents) and one child under the age of 18, and 57% of the sample had a monthly household income higher than 15,000 RMB[4]. In terms of region and place of residence, 85% of the respondents resided in the North, East and South Central regions of China, and 80% live in first-tier[5] or new first-tier cities. In general, our sample was composed of more female, younger, well-educated, higher-income respondents who reside in developed urban areas in the densely-populated eastern part of China. This is not surprising considering that participant recruitment and data collection were conducted online, which requires basic internet literacy of participants. Although our sample is not representative of the Chinese population, it is the population of interest for manufacturers and retailers hoping to pilot new products and technologies such as rPET food and beverage packaging material in China, since pro-environmental products are often introduced in metropolitan and large cities first. The results of balance tests show that there are no statistically significant differences in sociodemographic characteristics across the treatment groups, except for the place of residence ($P = 0.09$).

4 Results

4.1 Bottled beverage purchasing behavior and waste recycling behavior

Respondents in our study considered packaging to be very important in their food and beverage purchasing decisions with an average score of 3.77 on a five-point Likert scale (1 = not at all important to 5 = extremely important) and the average respondent reported purchasing 300–600 mL of

[4] About 2380 USD at the prevailing exchange rate of 6.37 RMB/USD at the time of the survey.

[5] First-tier cities are premier cities and economic powerhouses, which include Beijing, Shanghai, Guangzhou, and Shenzhen. New first-tier cities are up and coming cities with rapid urban development, including Chengdu, Hangzhou, Chongqing, Xi’an, Suzhou, Wuhan, Nanjing, Tianjin, Zhengzhou, Changsha, Dongguan, Foshan, Ningbo, Qingdao, and Shenyang.

bottled non-carbonated beverage 2–3 times a week (see Table D1 in supplementary materials). In terms of waste sorting and recycling behavior, respondents on average reported sorting waste most of the time and almost always recycling plastic bottles, with average scores of 4.86 and 5.12, respectively, on a six-point Likert scale (1 = never to 6 = always) (see Table D2 in supplementary materials).

4.2 Knowledge and perception of rPET and food safety concerns

The majority of respondents (85.5%) reported knowing about the use of rPET plastic as packaging material for food and beverage products and indicated a strong preference for rPET packaging with an average score of 4.35 on a 5-point Likert scale (1 = "I would never buy it" to 5 = "I prefer rPET packaging to standard plastic packaging") (see Table D3 in supplementary materials). These results were unexpected, considering that rPET food and beverage packaging is not yet widely available in China, and appears to be only used by companies outside mainland China. When asked about their knowledge of laws, rules, or regulations concerning the use of rPET in food and beverage packaging in China, 70.0% of respondents reported that they believed that it is encouraged in China, while 3.8% believed that it is banned and 11.7% were unsure. Considering that the use of recycled plastic material in food and beverage packaging was, until recently, banned in China over concerns about contamination and food safety risks, the proportion of respondents who reported believing that the use of rPET material in food and beverage packaging is encouraged is surprisingly high.

To understand whether food safety concerns factor into consumers' plastic bottle purchasing decisions, we also asked respondents to indicate the extent to which they agreed with the statement "I am concerned about food safety" on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Our results suggest that respondents in our study are very concerned about food safety, with an average score of 4.63 (see Table D4 in supplementary materials). However, judging from their reported strong preference for rPET packaging, respondents may not have associated post-consumer recycled materials like rPET with contamination or food safety risks.

4.3 Green consumption values

We used the six-item GREEN scale developed by Haws et al.[27] to measure consumers' environmental attitudes. Respondents were asked to rate the extent to which they agreed with the following six statements on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree): "It is important to me that the products I use do not harm the environment"; "I consider the potential environmental impact of my actions when making many of my decisions"; "My purchase habits are affected by my concern for our environment"; "I am concerned about wasting the resources of our planet"; "I would describe myself as environmentally responsible"; and "I am willing to be inconvenienced in order to take actions that are more environmentally friendly." Responses to all items are aggregated, with scores ranging from 5 to 30. Higher scores indicate stronger green consumption values. The GREEN scale exhibits good internal consistency (Cronbach's α = 0.81). The average GREEN score of our sample is 24.9, with 95% of respondents scoring between 18 and 30 (Fig. 1). The result of the Kruskal–Wallis test suggests that there are no statistically significant differences in GREEN scores across the eight experimental groups (P = 0.22).

4.4 Consumer WTP estimates for plastic bottle attributes

We estimated mixed logit models for all treatment groups separately (see Table D5 in supplementary materials). Using the results, we computed the marginal WTP values for each plastic bottle attribute across the eight groups (Table 6). To test whether differences in marginal WTP estimates across treatment groups are statistically significant, we followed a complete combinatorial procedure proposed by Poe et al.[33] that addresses the biased estimates of the significance of the difference between two distributions provided by methods such as normality assumptions and the non-overlapping confidence interval criterion. To be specific, we used the mded package in R with 1,000 draws from each WTP distribution to perform these complete combinatorial tests[34]. Table 7 shows the P-values from these tests.

Tables 6 and 7 reveal several important points in terms of WTP

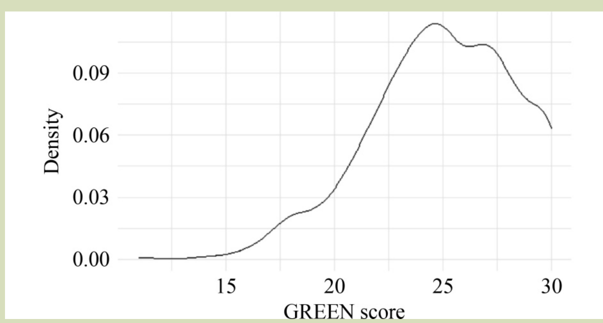

Fig. 1 Distribution of GREEN scores.

Table 6 Marginal WTP means and 95% confidence intervals across treatment groups

Variable	T1 = Control	T2 = Green label	T3 = rPET info	T4 = rPET info + Green label	T5 = Size info	T6 = Size info + Green label	T7 = Both info	T8 = Both info + Green label
rPET	22.557*** [12.184, 32.930]	39.542*** [26.277, 52.807]	37.605*** [27.618, 47.592]	60.666*** [43.466, 77.866]	30.006*** [22.356, 37.656]	38.129*** [26.095, 50.163]	31.614*** [19.183, 44.046]	59.770*** [38.482, 81.057]
Large	–	−7.191* [14.634, 0.252]	–	–	–	–	–	–
rPET × GREEN score	–	5.979*** [2.223, 9.734]	5.970*** [2.478, 9.461]	8.473*** [4.588, 12.358]	–	5.942*** [2.575, 9.309]	–	8.155*** [3.822, 12.488]
Large × GREEN score	–	–	–	–	–	2.902* [−0.323, 6.128]	–	–

Note: *, ** and *** indicate 10%, 5% and 1% significance levels. 95% confidence intervals are given in brackets. Cells with "–" indicate that the WTP estimates are not significantly different from 0.

Table 7 Probability (*P*)-values from complete combinatorial tests for the equivalence of WTP estimates

Row	Comparison	rPET	rPET × GREEN score
1	**WTP** (T2) green label – **WTP** (T1) control	0.030**	–
2	**WTP** (T3) rpet info – **WTP** (T1) control	0.032**	–
3	**WTP** (T4) rpet info + green label – **WTP** (T1) control	0.001***	–
4	**WTP** (T5) size info – **WTP** (T1) control	0.153	–
5	**WTP** (T6) size info + green label – **WTP** (T1) control	0.037**	–
6	**WTP** (T7) both info – **WTP** (T1) control	0.152	–
7	**WTP** (T8) both info + green label – **WTP** (T1) control	0.001***	–
8	**WTP** (T4) rpet info + green label – **WTP** (T2) green label	0.047**	0.199
9	**WTP** (T4) rpet info + green label – **WTP** (T3) rpet info	0.022**	0.193
10	**WTP** (T6) size info + green label – **WTP** (T2) green label	0.551	0.490
11	**WTP** (T7) both info – **WTP** (T3) rpet info	0.748	–
12	**WTP** (T8) both info + green label – **WTP** (T4) rpet info + green label	0.540	0.550

Note: *, ** and *** indicate 10%, 5% and 1% significance levels. $P > 0.5$ indicates the difference between WTPs is negative.

estimates for rPET bottles. First, consumers in the control group (T1) were on average willing to pay 22.6 RMB for 1.8 L rPET bottled juice relative to standard PET bottled juice of the same volume without receiving any form of information or nudge. Next, respondents in T2 (green identity label) and T3 (rPET information) were willing to pay 39.5 and 37.6 RMB, respectively, for rPET bottled juice relative to PET bottled juice. This implies that the individual treatment effects of green identity labels and rPET information on rPET bottles were 17.0 RMB (75% increase in valuations compared to the control group) and 15.0 RMB (67% increase in valuations compared to the control group), respectively. Consumers in T4 (rPET information and green identity label) were willing to pay 60.7 RMB for rPET bottles, suggesting that the combined effect of rPET information and green identity label on rPET is 38.1 RMB (169% increase in valuation compared to the control group). Comparing the estimated WTP for rPET bottles in T4 with those in T2 and T3 (Table 7; rows 8 and 9 for rPET), these results suggest a synergistic effect between the green identity label and rPET information in increasing consumer WTP for rPET bottles.

When examining WTP among members of T5 (size information), T6 (size information with green identity labeling), T7 (size information with rPET information) and T8 (size information, rPET information and green identity labeling), the non-significant differences in WTP estimates between T5 and T1, T6 and T2, T7 and T3, and T8 and T4 (Table 7; rows 4, 10, 11 and 12 for rPET) were not unexpected considering that providing size information should not likely affect consumer WTP for rPET bottles. Given the difference in WTP estimates for rPET bottles between T7 and T1 (Table 7;

row 6 for rPET) was no longer statistically significant, we can, however, say that providing both the rPET information and the size information to consumers diminished the effects of providing rPET information by itself (T3).

As for WTP for large bottles, no statistically significant WTP is found across the eight experimental groups, except for T2 (green identity label), where consumers on average had a negative WTP for large plastic bottles, but only at the 10% significance level. From these results, we conclude that consumers across the spectrum of our experimental treatments are essentially indifferent about plastic bottle size. The size information detailing the environmental benefits of choosing large bottle bundles over smaller bottle bundles (namely, that the larger bottle bundles use 27% less plastic than the small bottle bundles with the same total volume) failed to yield the expected effect of shifting consumers toward placing a higher value on large bottles.

4.5 WTP estimates by consumers with varying levels of environmental values

Looking at the interaction term between rPET and the GREEN score in Tables 6 and 7, in the control group (T1), pro-environmental consumers did not differ from their counterparts in their valuation of rPET bottles. However, we found that in the treatment groups, individuals with stronger green consumption values were more responsive to rPET information and the green identity labels, and thus had higher WTP for rPET bottles than individuals with weaker green consumption values. Specifically, with each one-unit increase above the average GREEN scores, respondents in T2 (green identity label), T3 (rPET information) and T4 (rPET information and green identity label) were willing to pay a premium of 6.0, 6.0, and 8.5 RMB for rPET bottles, respectively. Looking at the WTP for rPET among T6 to T8, which are analogous to T2 to T4 with the addition of size information, the results of the complete combinatorial tests showed that the differences in WTP estimates for rPET bottles per one-unit increase above the average GREEN scores were not statistically significant between T6 and T2 and between T8 and T4 (Table 7; rows 10 and 12 for rPET × GREEN). However, the WTP results in Table 6 revealed that adding size information to rPET information (T7) completely overrides the effect of rPET information (T3) on the interaction term between rPET and the GREEN score.

Finally, we found only one positive and significant WTP estimate for the interaction term between large bottles and GREEN score in the size information and green identity label group (T6), but the estimate was quite small and was only significant at the 10% level.

5 DISCUSSION

Although some research has been conducted on consumer preference and willingness to pay for alternative plastic packaging materials for bottled beverage products and the effects of providing environmental information in nudging individuals toward putting higher valuations on pro-environmental plastic bottles, similar research had not previously been conducted with Chinese consumers. In addition, there was no published research on consumer preference for plastic bottle sizes as a manifestation of pro-environmental attitudes. Also, there have been mixed findings in terms of the effectiveness of green identity labeling in promoting green consumption. Our study bridges these research gaps and contributes to the existing literature on reducing plastic waste through shifting consumer purchasing behavior.

Our results indicate that consumers are on average willing to pay a premium for rPET bottles relative to standard PET bottles. Although our sample was younger, more well-educated, wealthier and resided in urban areas in eastern China, our results provide concrete evidence that there is a potential market for rPET bottles, or more generally, rPET food and beverage packaging in China. Considering that no domestically-produced plastic bottles contain post-consumer recycled plastic at the moment, our finding could be meaningful for any manufacturer or retailer interested in producing alternative, environmentally-friendly packaging materials and piloting in Chinese metropolitans and large cities before introducing them to the rest of the country.

In contrast with the rPET food packaging ban in the 1990s through 2000s over contamination and food safety concerns, respondents in our sample do not appear to have associated post-consumer recycled material with contamination risks, even though on average they reported to be quite concerned about food safety. This finding challenges the notion held by some researchers such as De Marchi et al.[21] and some Chinese experts in the recycled material arena that there is strong public resistance to the use of post-consumer recycled material in food and beverage packaging. For instance, Junshi Chen, a pioneer in food toxicology and advisor for the Joint Working Group on Sustainable Development of Food Contact Materials in China said in a September 2020 interview, “If we conduct a consumer survey now to ask people whether they would buy cola in rPET plastic bottles, the majority would shake their heads.” Our findings suggest that these conclusions are not evidence-based. Rather, we provide evidence that there is demand for recycled food and beverage packaging, and thus laws, regulations, and production standards should be in place to support the introduction and development of rPET food and beverage packaging material in China.

Additionally, consistent with prior findings by Orset et al.[19], Grebitus et al.[20], and De Marchi et al.[21], we found evidence that providing targeted environmental information can nudge consumers toward purchasing environmentally-friendly rPET bottles. In fact, since the enforcement of a series of plastic bans and restrictions by the Ministry of Ecology and Environment, and National Development and Reform Commission in 2018, plastic reduction has been the center of government and public attention in China. Taking the forms of public service announcements and ubiquitous billboard campaigns, over the past 5 years, government-released plastic reduction information has widely informed and educated the Chinese public about the importance and urgency of plastic reduction.

Also, our findings suggest that attaching green identity labels (i.e., “This product is for green shoppers”) was similarly effective in shifting consumer behavior, while the joint use of rPET environmental information and green identity labeling yielded the largest effect. Our findings are in line with Schwartz et al.[25], who found that adding a green identity label increased the purchase of a number of environmentally-friendly products. As a consumer behavior-shifting measure, green identity labeling is relatively novel and its effectiveness needs to be further studied and tested in real-world settings, but the results so far can be seen as a positive signal. We suggest that manufactures and retailers interested in promoting environmentally-friendly products experiment with green identity labels.

Our results also indicate that although more environmentally-conscious consumers do not differ from their counterparts in their valuation of rPET bottles in the control condition, they are more responsive to information treatments and green identity labeling than their less environmentally-conscious counterparts in treatment conditions and show a higher willingness to pay for rPET bottles. This suggests that providing environmental information and attaching green identity labels can set green individuals who have higher WTP for rPET products apart from the rest of consumers. This would not be true if no additional environmental information or nudges were provided.

However, we found some puzzling results in terms of consumer selection of bottle sizes and the effectiveness of the size information treatment. Not only control respondents, but also those in the treatment groups were on average indifferent about plastic bottle size. An explanation for this might be that the inconvenience associated with carrying large bottles around or storing them in small refrigerators might have offset their environmental benefits. This could be the reason why choosing large bottles sizes is rarely promoted in plastic reduction, reuse and recycling campaigns when it is, in theory, effective in reducing the amount of plastic used and plastic waste generated.

6 CONCLUSIONS

This study examined Chinese consumer preference for environmentally-friendly plastic bottles that are made of post-consumer recycled material (i.e., rPET) and those that are of larger sizes and thus are more efficient in their use of plastic than smaller bottles, holding the total volume of beverage contained fixed. We found that despite a ban lasting over 20 years on the use of post-consumer recycled plastic in food and beverage packaging (ending in the 2010s), consumers in our study prefered rPET plastic bottles to standard PET bottles and were willing to pay a premium for the environmentally-friendly rPET alternative. However, although rPET food and beverage packaging is no longer expressly prohibited by existing policy in China, as Junshi Chen, an expert in the field puts it in the September 2020 interview, “If there is no law or standard saying it is allowed, then it is not [allowed].” By revealing that there is demand for rPET plastic bottles in China, our study aims to motivate policymakers in the development and implementation of food-grade rPET packaging standards and regulations, which serve as stepping stones to the introduction and production of rPET, and potentially other environmentally-friendly material, in food and beverage packaging throughout China.

We also study the effectiveness of targeted environmental information and green identity labeling in increasing consumer valuations of environmentally-friendly characteristics of plastic bottles and find that their joint use yielded the largest effect in increasing consumer willingness to pay for rPET plastic bottles. Also, our findings suggest that consumers with stronger pro-environmental attitudes would be willing to pay even more for rPET bottles when receiving environmental information or green identity label treatment. These results are of particular relevance for brands and manufacturers exploring the options of promoting pro-environmental packaging, namely using both environmental information and green identity labeling measures to shift consumer behavior and target environmentally-conscious consumers.

In contrast to the positive findings on rPET packaging, even after informing consumers of the more efficient use of plastic in larger bottles, we failed to find evidence of consumer preference for large bottle sizes, though in theory choosing larger bottles over small bottles delivers similar effects in reducing plastic waste as choosing bottles made of environmentally-friendly material. One possible explanation for this could be that the inconvenience associated with carrying or storing large bottles have offset the utility individuals would enjoy from the perceived environmental benefits of larger bottles. The viability of promoting larger plastic bottles among consumers as a means to reduce environmental impact remains a question to be answered.

Supplementary materials

The online version of this article at https://doi.org/10.15302/J-FASE-2022478 contains supplementary materials (Appendixes A–D).

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Compliance with ethics guidelines

Yingchen Xu and Patrick S. Ward declare that they have no conflicts of interest or financial conflicts to disclose. This article does not contain any studies with human or animal subjects performed by any of the authors.

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