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Willingness to Pay for Bioplastic Packaged Home Meal Replacement

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A B S T R A C T

The purpose of this study is to estimate the economic value of bioplastic packaged Home Meal Replacement (HMR) using respondents' willingness to pay (WTP). In particular, how much consumers are willing to pay if bioplastic packaging is used for HMR lunch boxes that commonly use plastic packaging was answered. A total of 208 respondents with experience in purchasing HMR were surveyed online using the Contingent Valuation Method (CVM). This study uses double-bounded dichotomous choice to reduce errors and increase statistics' efficiency. According to this analysis, the CVM estimates the consumer value of the bioplastic packed lunch boxes' premium is 11.4% higher than regular plastic packed lunch boxes. Additionally, the respondent's gender and the type of HMR products they frequently purchase affect the WTP value. This study's results serve as referential data on investments in eco-friendly materials for food enterprises marketing decisions.

Keywords: Bioplastic, Contingent valuation method, Home meal replacement, Willingness to pay

Introduction

Background and purpose

In 1997, an American yacht player discovered 80,000 tons of plastic garbage island (GPGP)while crossing from Los Angeles to Hawaii in the United States (Moore, 2009). In addition, in 2016, a young man who went on an ocean expedition fascinated by the blue whale faces a life-threatening world with plastic waste (Leeson, 2016). Plastic waste has gone beyond the problem of land reclamation and left a trail everywhere on Earth. In 2016, while exploring the Mariana Trench, Japanese scientists discovered plastic bag trash that would have been carried away after human abandonment on a floor 10,898 kilometers deep (No, 2018). Meanwhile, according to the Proceedings of the National Academy of Sciences (PNAS), the uninhabited Henderson island between Australia and Chile has about 38 million marine plastic waste, and 13,000 plastic waste is collected every day (No, 2018). This is only 30

years after it was designated as a World Natural Heritage site in 1988. Furthermore, according to a 2018 report by the international environmental group Greenpeace, Antarctica has no longer maintained a clean environment. Microplastics and harmful chemicals were detected in snow and water in Antarctica (No, 2018). Even where humans don't live, there is plastic.

Plastic waste, easily produced and discarded in modern society, has been steadily discarded for a long time, threatening the ecosystem, and eventually the effect of microplastics scattered in nature on the human body is obvious. As of 2010,according to Nature, it is estimated that the average amount of microplastic absorption per person in the world is about 212, with about 8 million tons of plastic entering the ocean every year (Rochman et al., 2013). Moreover, in the case of South Korea, the Incheon River and downstream of the Nakdong River ranked second and third in the world's most polluted areas by microplastics (Hurley et al., 2018). Plastic, which remains on Earth even after being abandoned, has a wide range of applications ranging from pharmaceuticals to semiconductors. According to a report compiled by the European Plastics and Rubber Machinery, South Korea's per capita plastic consumption is the world's No. 1 at 133 kg as of 2015 (EUROMP, 2016).

There are various environmental pollution factors caused by plastic, but the most noticeable keyword among them is packaging. According to a report released by the United Nations Environment, the largest industrial sector is plastic packaging, especially disposable materials designed for immediate disposal such as straw, shopping bag, PET bottle and so on (UNEP, 2018). In the same vein, increasing consumption of HMR, which is usually packaged in disposable plastic, is partly responsible for environmental pollution. Domestic shipments of HMR and instant foods increased 70.8% over the past five years from 1.6058 trillion won in 2013to 2.7421 trillion won in 2017, and overseas shipments reached $465.94 million in 2017, up 27.9 percent from $8.29 million in 2013 (aT, 2019). According to the Korea Rural Economic Institute (KREI), domestic instant food of HMR shipments is expected to exceed 5 trillion won in 2022 (aT, 2019). Meanwhile, according to the standard for HMR packaging, most of which are used as packaging materials are mainly polyethylene (PE) and polypropylene (PP). Both types are general-use plastic materials that have strength in terms of heat resistance, water resistance, durability, and ingredients, but they are slow to decompose themselves, and water resistance turns into fatal shortcomings that contribute to the destruction of marine ecosystems (KBMP, Web info).

As the consumption of disposable using plastic increases in food industry, bioplastics are drawing attention as a sustainable circular material (Convergence Research Policy Center, 2019). Bioplastics, manufactured using biological resources such as biomass, are called eco-friendly plastic, green plastic, and environmentally conscious plastic, and are largely divided into bio-base plastics and biodegradable plastics (UNEP, 2018). Biodegradable plastic means 'corruptible plastic' that is completely decomposed into water and carbon dioxide after disposal. Its biodegradability is excellent through microbial decomposition, and its ability to reduce carbon is excellent too (Park, 2020). Not only is it harmless to the human body, but it is suitable as an oil-base plastic substitute in that it is relatively fast in biodegradation and has low environmental load in the process. In short, it satisfies both functionality and eco-friendliness at the same time, enabling responses to lung and micro-plastic problems, global

warming, and environmental hormones. Despite these many advantages, the expansion of the domestic market for bioplastics has been insufficient and the business has been reduced to competition. This is because the unit cost is higher than the existing oil-base plastic, which makes it less competitive for producers. However, if consumers are willing to pay for the environmental value of bioplastics, it will be an incentive for enterprises to adopt bioplastic packaging despite the rising costs for produce. Therefore, this study aims to serve as meaningful basic information to the management decision-making process related to bioplastics in the food industry by identifying consumers' willingness to pay for bioplastic packaging.

The Research Design

The environmental significance of bioplastics is difficult to be immediately visible and has future and environmental-oriented characteristics, so the value of individual consumers varies accordingly. Furthermore, there was a scientific study of the engineering aspects of bioplastics and international product specifications in prior studies yet lack research on consumer recognition and willingness to pay related to the replacement of food packaging to bioplastics. Due to this lack of detailed data, hypothetical situational settings were necessary for empirical analysis, so this study utilized the Contingent Valuation Method (CVM). CVM is a method of setting up hypothetical situations and estimating the value of nonmarket goods or services that are difficult to accurately measure through direct surveys or experimental surveys of consumers. To derive a practical price segment by adopting a double-bounded dichotomous choice that presents prices sequentially to consumers. The survey allows the analysis of potential consumer group characteristics and the willingness to pay of bioplastic packaged HMR.

The purpose of this study is to estimate consumers' willingness to pay for bioplastic packaging products with little commercialization and to see if there are any differences in the willingness to pay depending on whether bioplastics are aware of its impact on the environment. Therefore, the specific elements of the research design are: First, the team wants to know the average amount of willingness to pay for the entire subject matter for bioplastic packaging. It is expected to be able to estimate the utility and willingness to pay for bioplastic packaging materials by measuring the ratio of the amount consumers want to pay for bioplastic packaged HMR compared to conventional plastic packaged. Second, divide questionnaire A and questionnaire B and the only difference is that whether provide environmental information on plastic use in Korea in advance. Thus, examine there is a difference in the value they want to pay depending on whether they are aware of environmental pollution. Accordingly, it is possible to analyze how consumer awareness and education are related to the demand for eco-friendly products.

Empirical Analysis

Set up Empirical Analysis Target

Prior to this survey, the product selection was pre-investigated in relation to the "package", which has the highest plastic utilization among the, and instant foods, which accounts for 52.1% of the total domestic household

shipments, and lunch boxes were set for analysis (aT, 2019). The highest portion of domestic food shipments is instant foods that includes sandwich and food package bowl such as lunch boxes. Furthermore, lunchboxes are the most frequently mentioned keyword among consumers of food industry due to the recent trend of 'Eating alone' and 'Drinking alone'. In particular, lunch boxes received 51.8% of the attention from consumers of instant food, making them one of the most preferred instant foods (aT, 2019). In addition, as city workers were looking for convenient and inexpensive HMR at lunchtime for efficient meal, the number of people looking for lunchbox at convenience stores highly increased. It indicates that instant lunch boxes may continue to become popular and preferred because of the gradual decrease in household dining costs due to rising prices.

A representative example of bioplastics introduced in domestic food packaging is instant lunch boxes from 'GS25' and 'CU' companies. In May 2018, 'CU' carried out the industry's first lunch box container made of eco-friendly plastic materials. By utilizing biomass materials using coconut shells, the company pushed for the conversion of packaging materials into containers that reduced general plastic use by 40%. Similarly, 'GS25' attempted to change its lunch box container into bio-polypropylene (PP) material, which is an eco-friendly ingredient, and apply eco-friendly containers to a total of three products, starting with 'Sachun' Pork Fried Lunch Box (Baek, 2018). Although bioplastic technology for packaging has already been developed and some of the products have been commercialized using bioplastics, many companies are still hesitant to invest due to high costs.

Therefore, this study investigated how much more consumers would actually like to pay for lunch boxes with bioplastic packaging. Based on convenience store lunch box standards, respondents who had experience in purchasing them were surveyed on the status of plastic use, environmental information awareness, and whether bioplastics were recognized. The survey results were summarized by demographic factors, and the impact of bioplastic advantages and recognition of environmental information on consumers' willingness to pay for bioplastic packaged lunch boxes was analyzed.

Consumer Survey

Data collection and research tools

The data for empirical analysis were collected through surveys and preliminary surveys were conducted on a small number of samples (20 people, 10 men and women each) before the actual survey was conducted, supplementing and correcting any ambiguities in the scenario.

In this survey, a total of 240 men and women in their teens and 60s older who have experience in purchasing instant lunch box were surveyed, and 208 out of 240was considered as the effective responses that can be used for the study. Survey participants were recruited in consideration of gender, age, etc., but a questionnaire was conducted for those with experience in purchasing convenience store lunch boxes, and most of them live in cities. From July 31, 2020 to August 3, 2020, surveys were conducted non-face-to-face (online). The result of subjects was divided according to demographic variables gender, age, administrative division, household type, educational background, and household income (Table 1).

Table 1. Respondent's general characteristics

Factor		Amount	Ratio	Factor		Amount	Ratio
Gender	Men	116	55.8	Educational Background	High School	112	53.9
	Women	92	44.2		University	80	38.5
	Total	208	100		Grad School	16	7.6
Age	10s	24	11.5		Total	208	100
	20s	65	31.3	Income (10,000 KRW)	Under 100	20	9.6
	30s	21	10.1		100 – 200	15	7.2
	40s	59	28.4		200 – 300	22	10.6
	50s	34	16.4		300 – 400	36	17.3
	60s older	5	2.3		400 – 500	34	16.4
	Total	208	100		500 – 600	23	11.1
Administrative division	City	166	79.8		600 – 700	17	8.2
	Metropolitan city	25	12.0		700 – 800	12	5.8
	County	17	8.2		800 – 900	6	2.7
	Total	208	100		900 – 1000	8	3.9
House hold	Living alone	39	18.8		Over 1000	15	7.2
	Married couple with children	104	50.0		Total	208	100
	Married couple without children	19	9.1				
	Other family households	46	22.1				
	Total	208	100				

The survey looked at consumers' awareness of bioplastics, their attitudes toward bioplastics and the environment, and their willingness to pay for the sale of bioplastic packaged lunch boxes (Appendix). Meanwhile, we analyzed the impact of consumer awareness and education by dividing the subjects into groups survey Groups A that presented environmental significance of bioplastics in advance and Group B that did not. The Group A questionnaire, which included an explanation of the eco-friendly nature of bioplastics, simplified the explanation, so that the respondent did not spend much time on it. To learn about the impact of environmental information on the willingness to pay, we add environmental information only to Group A's questionnaire that Korea's plastic consumption ranks first.

Existing studies measuring the CVM show that the double-bounded dichotomous choice method uses several prices (Table 2). In general, when respondents respond positively to the first offer price for an analytical target, subsequently the researcher present a second price that doubles the price premium for the analytical target. in contrast, If the respondent is not willing to pay the first offer, the researcher suggests a price that has halved the premium. Due to this study is intended to measure consumer willingness to pay for changes in the price of plastic packaging materials included in the price of lunch boxes (aT, 2009), the premium price was set as much as the raw material value of the packaging material when it was changed to bioplastic material. Considering that the price range of convenience store lunch boxes was various from 4,000 won to 6,000 won on average, the initial standard amount was controlled at 4,200 won, 5,200 won, and 6,200 won.

Table 2. CVM measurement pricing and response

Regular lunch box	First offer price	Second offer price	Response	Number of respondents
4000 (A)	4200	4400 4100	YY	20
			YN	9
			NY	0
			NN	4
			Total	33
4000 (B)	4200	4400 4100	YY	21
			YN	8
			NY	3
			NN	4
			Total	36
5000 (A)	5200	5400 5100	YY	20
			YN	13
			NY	1
			NN	5
			Total	39
5000 (B)	5200	5400 5100	YY	19
			YN	8
			NY	3
			NN	2
			Total	32
6000 (A)	6200	6400 6100	YY	17
			YN	13
			NY	0
			NN	6
			Total	36
6000 (B)	6200	6400 6100	YY	19
			YN	7
			NY	4
			NN	2
			Total	32

CVM metrics modeling

There are two main models that can analyze representative values of WTP through the CVM model: the utility difference model proposed by Hanemann (1984) and the WTP function approach proposed by Cameron and James (1987) (Choi et al., 2018). Although there are opinions that one of the two approaches should be used according to the researcher' style, the utility gap model has been used in most empirical studies as many point out that the utility gap model is more consistent with utility theory. Common bifurcation-selective questions for CVM include single bound dichotomous choice (SBDC), asks the respondent if they want to buy a particular commodity byoffering the price only once, and double bound dichotomous choice (DBDC) which reflecting the response to the first offer, the respondent will be given another adjusted price.

Single bound dichotomous choice, which offers only one price, has the advantage of being relatively easy to respond to, but has the problem of low statistical efficiency with fewer samples. On the other hand, the double bound dichotomous choice model requires a “yes” or “no” response after first offer to the survey participants. The second offered price depends on the response to the first offer. If respondents are willing to pay for the first offer, the second offer is larger than the first offer, and if they do not want to pay for the first offer, the second offer is less expensive than the first offer. Double bound dichotomous choice is used when it is relatively difficult to obtain many samples in that it can improve the low statistical efficiency, a disadvantage of single bound dichotomous choice (Choi et al., 2018), and therefore we used double bound dichotomous choice in this study.

In this study, very few samples of the subject characters stated that they were not willing to pay for the second price, so the analysis was done with a double bound dichotomous choice model, excluding the SPIKE model. The questionnaire composition of the double bound dichotomous choice model is as follows.

$$I_i^{YY} = 1(The\ response\ of\ the\ i^{th}\ respondent\ is\ yes - yse)$$
$$I_i^{YN} = 1(The\ response\ of\ the\ i^{th}\ respondent\ is\ yes - no)$$
$$I_i^{NY} = 1(The\ responde\ of\ the\ i^{th}\ respondent\ is\ no - yes)$$
$$I_i^{NN} = 1(The\ responde\ of\ the\ i^{th}\ respondent\ is\ no - no)$$

Assuming that the probability that the i^{th} respondent would say ‘No’ for the amount presented is G (A_i), the log-like hood function can be expressed as follows Formula (1). The indicator function I (•) represents that I_i^Y for ‘Yes’, I_i^N for ‘No’ and 0 for others.

$$\log L = \sum_{i=1}^{i} \left\{ I_i^Y \in [1 - G(A_i) + I_i^N \in [G(A_i)] \right\} \quad (1)$$

As seen in Formula (1), asking respondents one question and receiving one response is called a single bound dichotomous choice. The double bound dichotomous choice is an extension of the single bound dichotomous choice to better analyze respondents’ willingness to pay, which can be expressed in the following Formula (2).

$$\log L = \sum_{i=1}^{i} \left\{ I_i^{YY} \in [1 - G(A_i^u)] + I_i^{YN} \in [G(A_i^u) - G(A_i)] + I_i^{NY} \in [G(A_i) - G(A_i^d)] + I_i^{NY} \in [G(A_i^d)] \right\} \quad (2)$$

A_i means the first offered price, A_i^u means twice of the first offered price, and A_i^d means $\frac{1}{2}$ of the first offered price. Moreover, upper subscript of indicator function I (•), YY, YN, NY and NN, respectively have value 1 when they indicates ‘Yes-Yes’, ‘Yes-No’, ‘No-Yes’ and ‘No-No’ and value 0 for others. If the probability distribution G (A_i) has a logistic distribution of G (A_i)=$[1 + \exp(a - bA_i]^{-1}$, the average payment willingness of the respondent can be calculated as a/b.

Survey results

To analyze whether consumer's awareness and education is impact to the consumer demand for eco-friendly products, this survey group was divided into questionnaires (A) and questionnaires (B) and only in questionnaires (A) present statistical environmental information with the benefits of bioplastics. The results are shown in the following Tables 3 and 4.

Table 3. Group A respondents' results

Factor		Plastic Usage	Environmental pollution severity	Most Plastic Used Item	Plastic consumption recognition	Bioplastics recognition
Gender	Men	Fine (47%)	Very serious (45%)	Lunchbox (78%)	No (81%)	No (57%)
	Women	Neutral (40%)	Very serious (60%)	Lunchbox (84%)	No (78%)	No (66%)
Age	10s	Fine (57%)	Somewhat serious (57%)	Lunchbox (100%)	No (100%)	No (86%)
	20s	Fine (42%)	Very serious (46%)	Lunchbox (77%)	No (88%)	No (54%)
	30s	Fine (40%)	Very serious (50%)	Lunchbox (80%)	No (90%)	No (60%)
	40s	Fine (46%)	Very serious (51%)	Lunchbox (83%)	No (71%)	No (63%)
	50s	Fine (44%)	Very serious (64%)	Lunchbox (76%)	No (76%)	No (60%)
	60s older	Fine (60%)	Very serious (40%)	Lunchbox (80%)	No (60%)	No (60%)
Household	Living alone	Very much (43%)	Very serious (50%)	Lunchbox (93%)	No (100%)	No (79%)
	Others	Fine	Very serious	Lunchbox	No	No

Table 4. Group B respondents' results

Factor		Plastic Usage	Environmental pollution severity	Most Plastic Used Item	Plastic consumption recognition
Gender	Men	Very much (43%)	Very serious (48%)	Lunchbox (86%)	No (71%)
	Women	Very much (43%)	Very serious (79%)	Lunchbox (86%)	No (71%)
Age	10s	Fine (41%)	Somewhat serious (53%)	Lunchbox (94%)	No (71%)
	20s	Very much (41%)	Very serious (59%)	Lunchbox (87%)	No (69%)
	30s	Very much (73%)	Very serious (73%)	Lunchbox (82%)	No (73%)
	40s	Very much (38%)	Very serious (79%)	Lunchbox (83%)	No (71%)
	50s	Very much (44%)	Somewhat serious (56%)	Lunchbox (78%)	No (78%)
	60s older	-	-	-	-
Household	Living alone	Very much (60%)	Very serious (72%)	Lunchbox (92%)	No (72%)
	Others	Very much	Very serious	Lunchbox	No

According to gender, in Group A, 47 % of men said they use so much plastic, while 40 % of women said their plastic use is normal. In questionary B, 43% of men and 43% of women said they used so much plastic, the frequency of plastic use between genders was the same. Meanwhile, when asked about the severity of environmental pollution, 45% and 48%, of men in questionnaires A and B respectively, were responded that it is in a very serious condition, while 60%and 79% of women were responded that it is in a very serious condition. As a

result, it can be inferred that they felt more seriously about environmental pollution than that of men if the gender is female.

In both Group A and B, “Lunchbox” was selected as the most frequently using the plastic packaging among instant food with a ratio of 81%and 86%, respectively. The seriousness of the environmental pollution was very serious for all ages except teenagers, and the percentage of consumers who recognize that the level of environmental pollution in Korea due to plastic is very serious was Group B was higher with ratio of 61%, compare to Group A with ratio of 51%.

In addition, most people said they did not know about bioplastics before with 62% of Group A and 71% of Group B respectively. According to the ratio of total respondents, only 28.2% of respondents knew about bioplastics in advance, while 71.8% of respondents did not know about bioplastics in advance which 150 people in total. Meanwhile, in the case of Group A there was additional information about environmental status in Korea. Then 62% of the respondents said they did not know the fact that Korea’s plastic consumption is ranked first place in the world, which is objectively high amount. The data shows that many consumers do not know information about bioplastics and are not aware of the high level of plastic consumption in Korea. This can infer that many consumers who were surveyed are do not aware of serious plastic consumption status and have lack information on eco-friendly materials to replace oil-based plastics.

Result

Through the Chi-square and Logistic Regression revealed the impact of demographic factors (gender, administrative division, educational background, income, household type) on respondents’ first and second choice of proposal price. Table 5 is the statistical information of the variables used in this analysis, and because there are not many samples, it is composed of dummy variables to minimize the number of independent variables.

Table 5. Covariant statistical information

	Variables	Mean	Standard deviation	Min	Max
	BID OFFER	283.4	106.8	100	400
	Response	0.724	0.448	0	1
Demographic variables	Gender (Female)	0.442	0.497	0	1
	Age	36.4	13.8	15	65
	Administrative division (City)	0.880	0.326	0	1
	Household (Living alone)	0.188	0.391	0	1
	Educational background (Univ.)	0.538	0.499	0	1
	Income (100KRW)	4.738	2.859	0.5	1.1
Propensity variable	Provide environmental information	0.481	0.500	0	1
	Frequency of use (At least once a month)	0.923	0.267	0	1
	Type of purchase (Lunchbox)	0.163	0.370	0	1

The estimated results are shown in Table 6 below. The findings suggest that significant variables in the covariate that affect the price of HMR instant food products are gender and certain types of purchases. In particular, income variables did not appear significantly in this study, unlike most studies that cite income variables as the main influencing factors. This is expected to require continuous research in the future.

For gender, the offer price represents a negative sign (−), which means that the higher the offer price, the lower the willingness to pay. This is seen as respondent's well-understanding to the law of demand that the higher the price, the lower the demand. In addition, the z-test with a variable of women, set as 1, in the STATA program showed a p-value of 0.001 indicating that female respondents are more likely to accept higher suggested prices than males.

For the type of purchase, the questionnaire asks, "Which type of HMR instant food do you eat the most?". The z-test was conducted with a lunchbox variable, set as 1, to examine the impact about the offer price of the respondents who chose the lunch box. As a result, the p-value is 0.035, which is significant for the offer price. This can be interpreted as the respondents who responded that they mainly buy lunch boxes among HMR instant foods having a higher willingness to pay than those who responded not.

Table 6. Covariate analysis of WTP for HMR

	Variables	Coef	$p > \|z\|$
	BID OFFER	−0.0037	0.001
Demographic variables	Gender (Female)	0.8524	0.001
	Age	0.0059	0.580
	Administrative division (City)	0.5319	0.132
	Household (Living alone)	0.3520	0.313
	Educational background (Univ.)	0.3032	0.289
	Income (100KRW)	0.0253	0.576
Propensity variable	Provide environmental information	0.3097	0.212
	Frequency of use (At least once a month)	0.2765	0.575
	Type of purchase (Lunchbox)	0.7087	0.044

The estimated consumer average WTP for bioplastic packed lunch boxes is shown in Table 7 below. Based on the acceptance responses for the first and second prices of the survey, the following values were calculated, which is interpreted as consumers' intention to pay an additional 569.76 won on average when the lunch boxes in the 4000, 5000 and 6000 won range were converted into bioplastic packaging.

Table 7. WTP for bioplastic packaged lunchbox

Factor	Estimation result
WTP	569.76
LB	458.64
UB	953.38
Premium versus average offer price (5,000 KRW)	About 11.4%

Discussion and Conclusion

In this study, analyzed the consumers' willingness to pay (WTP) for the product when it was changed from a conventional plastic packed lunchbox to a bioplastic packed lunchbox through the contingent valuation method (CVM). Furthermore, we divided questionnaires (A), which including environmental information and eco-friendliness of bioplastic, and (B), which not added extra information, to analyze how providing information about the eco-friendly factor of bio materials could affect consumers' willingness to pay, however it was not shown to be significant. The average consumer's willingness to pay for bioplastic packaging was 569.76won for lunch boxes from 4,000 won to 6,000 won.

Furthermore, we classified survey respondents into demographic characteristics such as gender, age group, household type, and so on, then further analysis of plastics and environments according to consumer characteristics was conducted. An analysis of the impact of demographic variables on consumers' average willingness to pay for bioplastic packages showed that gender had the greatest impact, and the type of product they usually purchase was also significantly analyzed. In the case of gender, women are more likely to accept the offered price than men, so it can be interpreted that women have higher willing to pay for bioplastic packaged lunchbox than men. In addition, majority of the respondents purchased lunch boxes most frequently among the HMR instant food types, without difference between dependent variables group. Due to there is statistically significant value, it shows that consumers who frequently buy lunch boxes can be interpreted as willing to pay higher for lunch boxes using bioplastic packaging than those who do not. This means that consumers' additional willingness to pay for lunch boxes using bioplastic packaging in the actual market may be higher than the average willingness to pay 569.76 won which (weighted equally for individual respondents) derived from this analysis.

Contrary to the original intention of the study, when two divided questionnaires, one of them was inserted with ecological information and echo-friendliness of bioplastic and the other are not, are used as variables the result was not statistically significant. However, given that the average amount of willingness to pay of the group that information was presented is relatively higher than the other groups' average amount of willingness to pay, it is speculated that if the number of respondents' samples is large enough it is possible to derive a significant value as a variable of environmental information difference. Moreover, the survey found that many consumers had a high awareness of environmental pollution, while there was a lack of information on eco-friendly materials that could replace petroleum-derived plastics. Therefore, further research needs to be used to verify that whether spread of eco-friendly perceptions and accurate environmental information education can increase consumers' willingness to pay. Due to external and internal factors such as the threat of depletion of oil resources and increased interest in ecosystem and environmental policies, it is speculated that demand of eco-friendly materials such as bioplastic will surge. Thus, if consumers' willingness to pay for bioplastics gradually increases further, consumption can lead the supply in the future.

The finding has advantages that they can contribute to the industry academically and practically along with minor limitations. First, the contingent valuation method (CVM), which has been essentially used to environmental

economics, has been expanded to consumer research to explore applicability to willingness to pay. However, we did not combine the SPIKE model, which considers samples that have no intention of paying premium. Thus, there is a limit to the fact that the bias problem of double bound dichotomous choice has not been completely resolved.

Second, our works allows to convey unfamiliar information to the food industry in that it has identified consumers' opinions on bioplastic packaging and willingness to pay. Therefore, it is expected that food companies planning the bioplastic packaged HMR product will be able to refer to our works as far as pricing the launch or setting the marketing direction. For example, women are more likely to accept the offered price than men, so they can be set as the main target and explore the diffusion strategy of bioplastic packed lunchboxes. However, it was not possible to provide a clear solution to the high unit cost of the bioplastic packaging material that burden supplier in the transition phase before consumption led the supply. In addition, the number of 208 respondents is considered to be close to the minimum number of people that can lead to CVM results. Due to these characteristics such as small samples and exclusion of inflation, there is a limit to being an exact sample of values to be derived in the future. Therefore, using the demographic characteristics, environmental information, and HMR consumption patterns of this work, resetting the offer price considering a point in time prices and investigating a larger number of respondents would yield more significant values other than the gender and consumption patterns.

Finally, if further research is done on detailed willingness to pay according to the respondent population, it could be helpful in future policy design or consumer education or corporate decision making. For example, intensive education and campaigns may be developed for teenagers who respond to questionnaires (B) that are relatively less aware of eco-friendly products importance and utility.

Food cannot be considered separately from human life. The food industry accounts for a very large portion and role today, due to it has entered deep into our lives it is an industry sensitive to the values and trends that consumers are paying attention to. Similarly, according to ecological trends, movement to reduce the use of petroleum-derived plastics and ease environmental load has increased significantly in recent years. The improvement as eco-friendly industries in line with trends has become an industry challenge. Therefore, asa positive alternative to petroleum-derived plastic, bioplastics were presented, and the feasibility was examined through a study of consumer willingness to pay for bioplastic packaged lunch boxes. Bioplastics are natural materials that consider environmental preservation and sustainability. Amid the continued emphasis on bioplastics' importance and global research, the food industry deserves to discuss replacing packaging materials to protect the environment.

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Appendix

A Survey to Measure the Consumer's Willingness to Pay for Bioplastic Packaged Home Meal Replacement Lunchboxes; To learn about the impact of environmental information on the willingness to pay, we add environmental information only to Group A's questionnaire that Korea's plastic consumption ranks first. Similarly, in Group A's questionnaire, there is more detailed information about Bioplastic than Group B. The survey forms are as below.

1. Survey Group A

Ⅰ. Here are some general questions. Please mark the corresponding space. (Your personal information will be kept strictly private.)

1. What is your Gender? □ Male □ Female

2. What is your Age? □ 10s □ 20s □ 30s □ 40s □ 50s □ 60s older

3. Where is your administrative division? □ City □ Metropolitan city □ County

4. What type is your household? □ Living alone □ Married couple with children
□ Other Family households □ Married couple without children

5. What is your average monthly household income? (10,000 KRW) □ Under 100 □ 100~200 □ 200~300
□ 300~400 □ 400~500 □ 500~600
□ 600~700 □ 700~800 □ 900~1000
□ Over 1000

6. What is your final academic record? □ High school □ University □ Graduate School

7. How often do you consume HMR foods? □ Over twice a week □ Once a week
□ Everyday □ Do not consume

8. Which kind of HMR foods do you consume usually? □ Lunch boxes □ Instant rice and porridge
□ Sandwiches □ Frozen dumplings

9. Why do you consume HMR foods? □ Fast meal preparation available □ Too busy to cook proper meal
□ Convenient when eating alone □ Cost-effective
□ Others

10. How much plastic do you use? □ Very much □ Fine □ Neutral □ Barely use

11. What do you think is the seriousness of environmental pollution caused by plastic in Korea?
□ Very serious □ Somewhat serious □ Not very serious □ Not at all serious

12. Which of the following item do you think is the most plastic used?
□ Lunch boxes □ Instant noodles □ Instant rice □ Beverage

13. According to Ministry of Environment, the annual consumption of plastic per person in Korea is 98.2kg. The record is much larger than that of the United States (97.7 kg), Japan (66.9 kg), and France (73 kg), accordingly Korea ranked first in the world in plastic consumption. Did you know this fact? □ No □ Yes

14. Bioplastics are manufactured using biological resources such as biomass, which are environmentally friendly as they completely decomposed into water and carbon dioxide after disposal. Moreover, it can minimize adverse effects on the human body by solving micro-plastics problems caused by oil-based plastics. Did you know about this fact?
□ No □ Yes

Ⅱ. The following are questions about willingness to pay for a bioplastic lunchbox. Please mark the corresponding space.

Precautions for Selecting the Price of Bioplastic Packaged Lunch boxes

Bioplastics are currently used on a trial basis in GS25, CU's few types of lunch box packaging. It is expected that the production cost of bioplastic packaged lunch boxes will be 20 to 30 percent more expensive than general lunch boxes. As a result, there is a possibility that its prices will be higher than the average price of the existing lunch boxes when it is commercialized in the future. However, as the proportion of bioplastic packaging increases, the risk of physical health due to endocrine disruptors and environmental pollution will be decreases. Please consider the fact that your income is limited, your income should be spent for various purposes besides food expenses and answer the following questions with only the purchase of bioplastic packaged lunch boxes in mind.

15. How often do you consume lunch boxes? □ Do not consume □ Once or twice every three months
□ Once or twice a month □ Once or twice a week
□ Others

16-1. Suppose that the cost of a general plastic packaged lunch box is 4,000 KRW.
If the cost of the lunch box using bioplastic package is 4,200 KRW, would you like to buy it?
□ Yes → Go to no.16-2. □ No → Go to no.16-3.

16-2. Suppose that the cost of a general plastic packaged lunch box is 4,000 KRW.
If the cost of the lunch box using bioplastic package is 4,400 KRW, would you like to buy it?
□ Yes → End of survey □ No → End of survey

16-3. Suppose that the cost of a general plastic packaged lunch box is 4,000 KRW.
If the cost of the lunch box using bioplastic package is 4,100 KRW, would you like to buy it?
□ Yes → End of survey □ No → Go to no.16-4.

16-4. Do you have no intention of paying for the purchase of bioplastic packaged lunch boxes?
□ Yes → Go to no.16-5. □ No → End of survey

16-5. Why are not you willing to pay for a bioplastic packaged lunch box?
□ There is no financial leeway to pay □ Not enough information was provided to judge.
□ Not felt the problems caused by oil-base plastic □ Others

1. Survey Group B

Ⅰ. Here are some general questions. Please mark the corresponding space. (Your personal information will be kept strictly private.)

1. What is your Gender? □ Male □ Female

2. What is your Age? □ 10s □ 20s □ 30s □ 40s □ 50s □ 60s older

3. Where is your administrative division? □ City □ Metropolitan city □ County

4. What type is your household? □ Living alone □ Married couple with children □ Other Family households □ Married couple without children

5. What is your average monthly household income? (10,000 KRW) □ Under 100 □ 100~200 □ 200~300 □ 300~400 □ 400~500 □ 500~600 □ 600~700 □ 700~800 □ 800~900 □ 900~1000 □ Over 1000

6. What is your final academic record? □ High school □ University □ Graduate School

7. How often do you consume HMR foods? □ Over twice a week □ Once a week □ Everyday □ Do not consume

8. Which kind of HMR foods do you consume usually? □ Lunch boxes □ Instant rice and porridge □ Sandwiches □ Frozen dumplings

9. Why do you consume HMR foods? □ Fast meal preparation available □ Too busy to cook proper meal □ Convenient when eating alone □ Cost-effective □ Others

10. How much plastic do you use? □ Very much □ Fine □ Neutral □ Barely use

11. What do you think is the seriousness of environmental pollution caused by plastic in Korea?
□ Very serious □ Somewhat serious □ Not very serious □ Not at all serious

12. Which of the following item do you think is the most plastic used?
□ Lunch boxes □ Instant noodles □ Instant rice □ Beverage

13. Bioplastics are manufactured using biological resources such as rice, corn, and another microorganism. Did you aware of bioplastics in advance? □ No □ Yes

Ⅱ. The following are questions about willingness to pay for a bioplastic lunchbox. Please mark the corresponding space.

> **Precautions for Selecting the Price of Bioplastic Packaged Lunch boxes**
>
> Bioplastics are currently used on a trial basis in GS25, CU's few types of lunch box packaging. It is expected that the production cost of bioplastic packaged lunch boxes will be 20 to 30 percent more expensive than general lunch boxes. As a result, there is a possibility that its prices will be higher than the average price of the existing lunch boxes when it is commercialized in the future. However, as the proportion of bioplastic packaging increases, the risk of physical health due to endocrine disruptors and environmental pollution will be decreases. Please consider the fact that your income is limited, your income should be spent for various purposes besides food expenses and answer the following questions with only the purchase of bioplastic packaged lunch boxes in mind.

14. How often do you consume lunch boxes? □Do not consume □Once or twice every three months □ Once or twice a month □ Once or twice a week □Others

15-1. Suppose that the cost of a general plastic packaged lunch box is 4,000 KRW.
If the cost of the lunch box using bioplastic package is 4,200 KRW, would you like to buy it?
□Yes → Go to no.15-2. □No → Go to no.15-3.

15-2. Suppose that the cost of a general plastic packaged lunch box is 4,000 KRW.
If the cost of the lunch box using bioplastic package is 4,400 KRW, would you like to buy it?
□Yes → End of survey □No → End of survey

15-3. Suppose that the cost of a general plastic packaged lunch box is 4,000 KRW.
If the cost of the lunch box using bioplastic package is 4,100 KRW, would you like to buy it?
□Yes → End of survey □No → Go to no.15-4.

15-4. Do you have no intention of paying for the purchase of bioplastic packaged lunch boxes?
□Yes → Go to no.15-5. □No → End of survey

15-5. Why are not you willing to pay for a bioplastic packaged lunch box?
□There is no financial leeway to pay □Not enough information was provided to judge.
□Not felt the problems caused by oil-base plastic □Others