

Study on the Recognition and Purchase Status of Eco-Friendly Oral Hygiene Products

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Background: Plastic waste generates pollutants in the process of incineration or landfilling, and accumulates in water or marine organisms, causing adverse effects on the environment and the human body. Recently, various eco-friendly oral hygiene products (Eco-OHPs) such as bamboo toothbrushes and biodegradable plastic toothbrushes have been developed. Therefore, this study aimed to investigate the current level of awareness and purchasing status of eco-OHPs among adults who are interested in eco-friendly products.

Methods: This study included adults aged >19 years who regularly visited eco-friendly shops and online sites; the online survey links were distributed during their visits to eco-friendly Internet cafés and companies. Of the 22 questions, seven assessed the participants' general characteristics, three assessed the general oral hygiene care products used, six assessed the level of awareness of Eco-OHPs, and six assessed the purchasing status of Eco-OHPs. Frequency analysis, chi-square test, and regression analysis were performed using SPSS software.

Results: Among the respondents, 108 (51.4%) were aware of Eco-OHPs, and 79 (37.6%) had experience purchasing Eco-OHPs. The most common reason for not purchasing was the lack of information about related brands or products (74, 56.5%). The most common platform used in obtaining information was the Internet (general: 31.5%, eco-friendly: 46.3%), such as Social Network Service, Internet cafes, and blogs. The experience in purchasing Eco-OHPs was affected by whether the respondents recognized the possibility of contributing to environmental preservation, availability of vendors, product safety, and the number of eco-friendly products purchased.

Conclusion: In order to expand the use of Eco-OHPs, various efforts such as promotion of eco-friendly characteristics, determination of related vendors, reliable analysis of product safety, and expansion of product experience opportunities are required.

Key Words: Environmental pollution, Oral hygiene, Plastic, Recognition

Introduction

1. Background

With the development of modern society, various plastic products are manufactured and used, and the amount of plastic waste generated is gradually increasing. According to the latest statistics from the Ministry of Environment¹⁾, the average daily amount of plastic waste in Korea has increased by approximately 14%, from 1,757 tons in 2019

to 1998 tons in 2020. Moreover, in the aftermath of the coronavirus disease 2019 pandemic, which started in 2020, the usage rate of food delivery and home delivery services has rapidly increased, and the amount of plastic waste is exponentially increasing²⁾. Plastic waste generates pollutants in the process of incineration or landfilling, accumulates in water or marine organisms, and adversely affects the human body³⁾. Owing to the recognition of plastic waste generation as an environmental pollution

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problem, Korea is also implementing a step-by-step policy to ban the import of plastic waste from 2022 and the use of single-use plastic products in all industries by 2030⁴⁾.

However, most oral hygiene products (OHPs) used in the actual setting are made of plastic and cannot be recycled because they are manufactured using various types of plastics. In addition, the replacement cycle is often short (less than 3 mo), which is one of the causes of increase in the use and disposal rates of plastics. According to the 2021 Greenpeace report²⁾, personal hygiene products such as shampoos and toothbrushes accounted for 14.6% of the types of disposable plastics discharged at home, the second highest after food packaging. Therefore, it is necessary to reduce the utilization of plastic products, and OHPs that are used several times a day should also be the target.

Recently, some companies such as “TePe,” “Doctor Noah,” “Brushlee,” “Jordan,” and “SugarLab” have started producing and selling eco-friendly OHPs (Eco-OHPs) such as bamboo toothbrushes and biodegradable toothbrushes. To promote the consumption of these products and further reduce the generation of plastic waste, it is necessary to understand the current status of Eco-OHPs.

2. Objectives

This study aimed to investigate the awareness and purchase status of Eco-OHPs among adults aged 19 years and older who were interested in eco-friendly products.

Materials and Methods

1. Ethics statement

This study was approved by the Institutional Review Board of Eulji University (IRB No. EU21-89).

2. Study design

1) Participants and sample size

The study included Korean adults aged 19 years and older who regularly visited eco-friendly shops and online cafés owing to their interest in using eco-friendly products; the required number of participants was calculated using G*power 3.1. The effect size was set for each

statistical test under the following conditions: significance level (α)=0.05 and power ($1-\beta$)=95%. In other words, the effect size (w) of the chi-square analysis of the level of awareness and intention of purchasing Eco-OHPs according to the general characteristics or experience of using eco-friendly products in the past six months was 0.3, and the effect size (f) of the multiple regression analysis of the factors influencing the intention of purchasing Eco-OHPs was set at 0.15. The minimum numbers of samples for each analysis were 191 and 206, and the final number of samples was 210, after considering those with omitted and insincere answers.

2) Material

The questionnaire used in this study was modified and supplemented according to the purpose of this study using the tools used in previous studies^{5,6)}. The questions were aimed at determining the level of awareness and use of oral supplements and eco-friendly products. It consists of four parts: seven questions assessed the participants' general characteristics, three questions assessed the purchase or use of general OHPs (G-OHPs), six questions assessed the level of awareness of Eco-OHPs, and six questions assessed the status or experience in purchasing Eco-OHPs. A total of 22 questions were answered (Table 1). The reliability of the questionnaire in assessing each domain was tested using Cronbach's alpha. Questions related to the G-OHPs obtained a score of 0.645, questions related to the level of awareness of Eco-OHPs obtained a score of 0.682, and questions related to the participants' experience in purchasing Eco-OHPs obtained a score of 0.703.

3) Method

In order to recruit the study participants, the researchers visited domestic eco-friendly Internet cafés and shops and cooperatives that sell eco-friendly products. The online questionnaire link was posted in the Internet sites and offline markets. The survey was conducted from March 21, 2022, to March 31, 2022 using a self-administered questionnaire, and a total of 214 questionnaires were collected. Among them, only 210 were used for the final analysis, while 4 were excluded due to incomplete entries.

Table 1. Composition of the Questionnaire

Division	Question	The number of questions
General characteristics	Gender	7
	Age	
	Residence district	
	Education	
	Job	
	Marital status	
Purchase/use experience of G-OHP	Experience in purchasing eco-friendly products in the last 6 months	3
	Types of products currently in use	
	Types of products purchased	
Recognition of Eco-OHP	Paths for acquiring relevant information	6
	Previous recognition about existence of Eco-OHP	
	Understanding about the differences from G-OHP	
	Previous recognition about where to buy for Eco-OHP	
	Understanding about the contribution possibility to environmental preservation of Eco-OHP	
	Reliability about safety of Eco-OHP	
Purchase experience of Eco-OHP	Willingness to future purchasing of Eco-OHP	6
	Existence of Eco-OHP purchasing experience	
	Paths for acquiring relevant information	
	Paths for acquiring relevant information about G-OHP	
	The reason for purchase/non-purchase	
	Types of Eco-OHP purchased	
Total	The reason for satisfaction/dissatisfaction	22

Eco-OHP: eco-friendly oral hygiene care product, G-OHP: general oral hygiene care product.

3. Statistical analysis

The data were analyzed using a professional statistical analysis program (SPSS version 26, IBM Corp., Armonk, NY, USA). Frequency analysis was conducted to determine the general characteristics of the respondents, while multiple response frequency analysis was used to analyze multiple response items. In addition, a chi-square analysis was conducted to analyze the general characteristics, level of awareness of Eco-OHPs according to the use and purchasing status of OHPs, and purchasing experience. Multiple regression analysis was performed for the factor analysis of the future purchase intention of Eco-OHPs. A p-value of 0.05 was considered significant.

Results

1. General characteristics

The general characteristics of the respondents are shown

in Table 2. Patients of “women” gender (146, 69.5%), aged “20~29 years” (81, 38.6%), who were living in “Seoul” (68, 32.4%), who were “university/college graduates” (123, 58.6%), who were “office workers” (81, 41.0%), who were “single” (121, 57.6%), and who “experienced purchasing eco-friendly products within 6 months” (156, 74.3%) had the highest proportion.

2. Recognition of Eco-OHPs

1) Previous and detailed recognition of Eco-OHPs

Table 2 and 3 show the survey results of the respondents' level of awareness of Eco-OHPs. As a result of the survey on whether the participants had previous knowledge about Eco-OHPs, 108 (51.4%) responded “yes,” while 102 (48.6%) responded “no,” which showed similar rates for both responses. However, with regard to the general characteristics investigated, a significant difference was

Table 2. Previous Recognition and Purchase Experience of Eco-OHPs according to the Participants' General Characteristics

General characteristics	Total	Previous recognition about Eco-OHP (% out of all)		p-value	Purchase experience of Eco-OHP (% out of all)		p-value	
		Yes	No		Yes	No		
		Gender	Man		64 (30.5)	22 (10.5)		42 (20.0)
	Women	146 (69.5)	86 (41.0)	60 (28.6)		65 (31.0)	81 (38.6)	
Age (y)	Less than 20	20 (9.5)	3 (1.4)	17 (8.1)	< 0.001	1 (0.5)	19 (9.0)	<0.001
	20~29	81 (38.6)	35 (16.7)	46 (21.9)		23 (11.0)	58 (27.6)	
	30~39	47 (22.4)	28 (13.3)	19 (9.0)		24 (11.4)	23 (11.0)	
	More than 40	62 (29.5)	42 (20.0)	20 (9.5)		31 (14.8)	31 (14.8)	
Residence district	Capital area (Seoul)	68 (32.4)	33 (15.7)	35 (16.7)	< 0.001	23 (11.0)	45 (21.4)	0.019
	Capital area (Gyeonggi)	73 (34.8)	26 (12.4)	47 (22.4)		20 (9.5)	53 (25.2)	
	Metropolitan cities	39 (18.6)	27 (12.9)	12 (5.7)		20 (9.5)	19 (9.0)	
	Other provinces	30 (14.3)	22 (10.5)	8 (3.8)		16 (7.6)	14 (6.7)	
Education	High school graduate	15 (7.1)	6 (2.9)	9 (4.3)	0.002	2 (1.0)	13 (6.2)	0.002
	Undergraduate	72 (34.3)	26 (12.4)	46 (21.9)		15 (7.1)	57 (27.1)	
	University/college graduate	123 (58.6)	76 (36.2)	47 (22.4)		62 (29.5)	61 (29.0)	
Job	Student	71 (33.8)	21 (10.0)	50 (23.8)	< 0.001	13 (6.2)	58 (27.6)	< 0.001
	Officer worker	86 (41.0)	51 (24.3)	35 (16.7)		38 (18.1)	48 (22.9)	
	Housewife	26 (12.4)	20 (9.5)	6 (2.9)		17 (8.1)	9 (4.3)	
	Self-employed worker	6 (2.9)	4 (1.9)	2 (1.0)		4 (1.9)	2 (1.0)	
	Others	21 (10.0)	12 (5.7)	9 (4.3)		7 (3.3)	14 (6.7)	
Marital status	Single	121 (57.6)	50 (23.8)	71 (33.8)	0.001	33 (15.7)	88 (41.9)	< 0.001
	Married	89 (42.4)	58 (27.6)	31 (14.8)		46 (21.9)	43 (20.5)	
Purchasing experience of eco-friendly products	Yes (in the last 6 months)	156 (74.3)	96 (45.7)	54 (25.7)	< 0.001	79 (37.6)	77 (36.7)	< 0.001
	No (in the last 6 months)	54 (25.7)	12 (5.7)	48 (22.9)		0 (0.0)	54 (25.7)	
Total		210 (100)	108 (51.4)	102 (48.6)		79 (37.6)	131 (62.4)	

Values are presented as number (%).

Eco-OHP: eco-friendly oral hygiene care product.

Those statistical data were acquired from chi-square analysis ($p < 0.05$).

observed in the percentage of previous recognition according to each attribute (Table 2, $p < 0.05$). Among those who had previously known about Eco-OHP, many of the respondents were “women” (86, 41.0%), “aged 40 years and older” (42, 20.0%), were living in “Seoul” (33, 15.7%), completed a “university degree or higher” (76, 36.2%), were “employed” (51, 24.3%), were “married” (58, 27.6%), and had “experienced purchasing eco-friendly products in the past 6 months” (96, 45.7%).

After surveying the level of Eco-OHP awareness among 108 respondents who had heard of Eco-OHPs using a 5-point scale (Table 3), the “Eco-OHP can contribute to environmental conservation” option obtained a score of 3.89 ± 0.849 points, which was the highest. Next, the “intention to continue purchasing for Eco-OHP” option

obtained a score of 3.77 ± 0.849 points; “confidence in Eco-OHP safety,” 3.66 ± 0.768 points; “understanding the difference with G-OHPs,” 2.53 ± 1.215 points; and “pre-awareness where to buy the Eco-OHPs,” 2.12 ± 1.082 points.

2) Information acquisition path for Eco-OHPs (multiple responses)

The platforms used to obtain information when purchasing Eco-OHPs were investigated using multiple response questions; results of the comparison between Eco-OHPs and G-OHPs are shown in Table 4. For both Eco-OHPs and G-OHPs, the most common platform was the Internet, such as Social Network Service (SNS), cafes, and information blogs. However, in the Eco-OHP group, 81 people (46.3%) answered “the Internet” as a source of information, which was

Table 3. Specific Recognition about Eco-OHPs (n=108)

Specific recognition about Eco-OHP	Value
Understanding about the differences from G-OHP	2.53±1.215
Recognition of the contribution possibility to environmental preservation	3.89±0.849
Previous awareness about where to buy for Eco-OHP	2.12±1.082
Reliability about safety of Eco-OHP	3.66±0.768
Willingness to continue purchasing of Eco-OHP	3.77±0.849

Values are presented as mean±standard deviation.
Eco-OHP: eco-friendly oral hygiene care product, G-OHP: general oral hygiene care product.

Table 4. Platforms Used for Acquiring Information on Eco-OHPs or G-OHPs (Multiple Responses)

Information acquisition path	Eco-OHP	G-OHP
The Internet (i.e., SNS, Internet cafe, blog)	81 (46.3)	104 (31.5)
Video media (i.e., TV)	26 (14.9)	65 (19.7)
Introduction of acquaintances (i.e., family, friend)	20 (11.4)	56 (17.0)
Education or promotion of environmental/civic groups	20 (11.4)	0 (0.0)
Sales display (i.e., mart, shop)	15 (8.6)	76 (23.0)
Print media (i.e., newspaper, magazine)	9 (5.1)	18 (5.5)
Related company promotion (i.e., exhibition, event)	4 (2.3)	11 (3.3)
Total	175 (100)	330 (100)

Values are presented as number (%).
Eco-OHP: eco-friendly oral hygiene care product, G-OHP: general oral hygiene care product.

much higher than the number of participants who used other platforms; in the G-OHP group, the participants answered that the information were acquired through various channels: “the Internet” (104, 31.5%), “sales display” (76, 23.0%), “video media” (65, 19.7%), and “introduction of acquaintances” (56, 17.0%).

3. Experience in purchasing Eco-OHPs

1) Experience in and reasons for purchasing Eco-OHPs

The different experiences in purchasing Eco-OHPs are shown in Table 2 and 5. For the eco-OHP purchasing experience, 79 people (37.6%) answered “yes,” while 131 people (62.4%) answered “no.” After comparing the pur-

Table 5. Experience in Purchasing Eco-OHPs and the Reasons for Purchasing or Not Purchasing

Purchasing experience of Eco-OHP	The reason for purchase or non-purchase		
Yes (existence, n=79)	Responsibility for environmental issues	63 (79.8)	
	Recommendations of acquaintance	8 (10.1)	
	Product safety	6 (7.6)	
	Product quality	2 (2.5)	
	Economic support from government	0 (0)	
	No (absence, n=131)	Lack of information about related brands or products	74 (56.5)
		Lack of information about where to buy	24 (18.3)
Lack of motivation to purchase		15 (11.5)	
High price		13 (9.9)	
Lack of product diversity		5 (3.8)	

Values are presented as number (%).
Eco-OHP: eco-friendly oral hygiene care product.

chasing experiences according to general characteristics, a significant difference was found in all related attributes (Table 2, $p < 0.05$). Most of the respondents who had purchased Eco-OHPs were “women” (65, 31.0%), “aged 40 years and older” (31, 14.8%), were living in “Seoul” (23, 11.0%), completed a “university degree or higher” (62, 29.5%), were “employed” (38, 18.1%), were “married” (46, 21.9%), and had “experienced purchasing eco-friendly products in the past 6 months” (79, 37.6%).

On the contrary, the most common reason for purchasing Eco-OHPs was “consciousness of responsibility for environmental issues” (63, 79.8%), while the primary reason for not purchasing was “because I did not know about related brands or products” (74, 56.5%) (Table 5). The types of Eco-OHPs purchased were “eco-friendly toothbrush” (72, 65.5%), “eco-friendly dental floss” (33, 30.0%), and “eco-friendly interdental toothbrush” (5, 4.5%).

2) Level of satisfaction on the Eco-OHPs purchased

With regard to the level of satisfaction on the Eco-OHPs purchased among 79 participants, 12 (15.2%) responded “very satisfied”, 52 (65.8%) responded “moderately satisfied,” 8 people (10.1%) responded “normal,” and 7 (8.9%)

Table 6. Factors Influencing the Willingness to Purchase Eco-OHPs in the Future

Variable	Unstandardized coefficient		Standardized coefficient	t	p-value	Collinearity statistics	
	B	S.E	β			Tolerance	VIF
Constant	0.840	0.274		3.063	0.002		
Recognition about the contribution possibility to environmental preservation of Eco-OHP (X1)	0.426	0.066	0.401	6.418	<0.001	0.733	1.364
Previous recognition about where to buy for Eco-OHP (X2)	0.135	0.068	0.162	1.984	0.049	0.428	2.335
Understanding about the differences from G-OHP (X3)	0.148	0.060	0.199	2.476	0.014	0.444	2.254
Reliability about safety of Eco-OHP (X4)	0.167	0.074	0.142	2.241	0.026	0.713	1.402
$R^2=0.412$, Adjusted $R^2=0.401$, F-value=35.958 ($p<0.001$)							

Eco-OHP: eco-friendly oral hygiene care product.

Control variables: gender, age, residence district, education, job, marital status, purchasing experience of eco-friendly products in the last 6 months.

Those statistical data were acquired from multiple regression analysis, and the dependent variable was willingness to continue purchasing of Eco-OHP (Y).

responded “somewhat dissatisfied.” In terms of the reasons for satisfaction, 56 people (77.8%) answered “environmental conservation,” 12 people (16.7%) answered “non-harmful,” and 4 people (5.5%) answered “excellent quality”. On the contrary, the reasons for dissatisfaction among the seven respondents who answered “somewhat dissatisfied” were “quality” (4, 57.1%) and “design/convenience of use” (3, 42.9%).

4. Factors affecting the intention of purchasing Eco-OHPs

After determining the factors affecting the future intention of purchasing Eco-OHPs by multiple regression analysis, all the detailed factors for the awareness about Eco-OHPs demonstrated a significant effect (Table 6, $p<0.05$). The detailed factors and the influences were as follows: “awareness of possible contribution to environmental conservation” ($\beta=0.401$), “understanding the difference with G-OHPs” ($\beta=0.199$), “awareness of where to purchase Eco-OHPs” ($\beta=0.162$), and “trust in safety” ($\beta=0.142$).

Discussion

1. Key results and comparison with the results of previous studies

This study aimed to examine the current status of

Eco-OHPs, such as related awareness and purchase experience, targeting adults who are interested in eco-friendly products, and to identify which aspects related to Eco-OHPs affect future purchase intentions.

As a result of this study on awareness and purchase experience of Eco-OHPs, 51.4% of the participants responded that they had heard of Eco-OHPs, and the level of awareness of their “contribution to environmental preservation” was relatively high (3.89 out of 5 points). However, awareness about the “differences from G-OHPs,” “where to purchase,” and “product safety” obtained a score of 2.53~3.66 points out of 5 points; moreover, only 79 (37.6%) out of the 210 respondents had experienced purchasing Eco-OHPs. According to results of the 2019 public awareness survey⁷⁾, 91.5% of the respondents were interested in eco-friendly products, and 87.8% responded that they had a purchase experience. Approximately 78.8% of the participants responded sanitary products (1+2+3 cumulative) as eco-friendly products that promote environmental protection, thus showing a significant difference from the results of this study. This finding indicates that, although OHPs are classified as household and sanitary products, their impact on environmental friendliness has not yet been well considered, and supplementary efforts are needed to increase the awareness and purchase rate of Eco-OHP.

In this study, the primary reason for not purchasing Eco-OHPs was “because I don’t know about related brands or products” (56.5%); the proportion of participants who provided this response was much higher than that of participants who answered “cost burden” (9.9%) or “lack of purchase motivation” (18.3%). However, according to a public awareness survey⁷⁾ on eco-friendly products, the reasons for not purchasing eco-friendly products were “cost burden” (40.2%), “lack of trust in its quality” (29.5%), and “lack of information about the products” (15.6%), which was slightly different from those reported in the present study. This is due to the fact that the awareness on Eco-OHPs is not relatively high and has more influence compared with other factors. In a previous study⁷⁾, “providing reliable information on eco-friendly products” (30.1%) was the most preferred measure to promote the widespread use of eco-friendly products; hence, if more and better information about related brands or products are provided, the percentage of purchasing or using Eco-OHPs will increase. In addition, previous surveys about intentions for purchasing eco-friendly products⁷⁻⁹⁾ also found that women aged 30 years and older and with higher education had higher awareness of eco-friendly products and purchasing experience, which was similar to the findings of this study. Therefore, when preparing future projects and policies for Eco-OHPs, it is necessary to consider the characteristics of the target population.

As regards the platforms used in acquiring information about Eco-OHPs, 46.3% of the respondents in this study answered that they obtained information through the Internet, such as SNS, Internet cafés, and blogs; for G-OHPs, the information was obtained through various platforms: the Internet (31.5%), retail stores (23.0%), video media (19.7%), etc. In Byun’s study⁶⁾, sales outlets (30.2%) and the Internet (16.2%) were suggested as major information delivery channels for G-OHPs, suggesting that several ordinary people obtain OHP-related information through the Internet or sales outlets. Publicity or information provision through the Internet and sales outlets will be effective in raising awareness and expanding purchases. However, since most of the current Eco-OHPs are sold or provided through the Internet, diversification of information provision routes through the ex-

pansion of offline sales outlets is necessary.

As a result of this study investigating the factors that affect the future purchase intention of Eco-OHP, the perception of the possibility of contributing to environmental preservation ($\beta=0.401$) was investigated as the most influential factor, followed by “recognition of differences with G-OHPs,” “awareness of the selling company,” and “perception of safety.” Han’s study¹⁰⁾ also found that eco-friendly consciousness, ethical consumption consciousness, and trust in eco-friendly products had a positive effect on the purchase intention for eco-friendly products, and these factors could decrease the “price sensitivity,” which restricts the purchase of eco-friendly products. Therefore, when providing and promoting information on Eco-OHPs, if the focus is distinguishing their differences from those of G-OHPs, various vendors, and product safety based on their positive impact on environmental preservation, it could lead to the expansion of its sales and use.

2. Limitations

The survey tool in this study was made by modifying several questionnaires used in previous studies; therefore, the direct validity verification was overlooked. This study only targeted those who visited eco-friendly shops and online sites; hence, it is difficult to generalize our results to the entire Korean population. Moreover, since Eco-OHPs have just begun to be popularized, the related awareness and purchase experience rate are low. Therefore, it was difficult to determine the performance or effect of the Eco-OHPs, and a detailed investigation was not conducted. However, this study was considered meaningful in that it investigated the current overall perception and purchase status of Eco-OHPs and provided baseline data for the development of related businesses.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

This study was approved by the Institutional Review Board of Eulji University (IRB No. EU21-89).

Author contributions

Conceptualization: Im-hee Jung, Su-min Jeon, Jae-kyeong Kim, Jae-ui Lee, Su-hyeon Lee, and Seong-eun Park. Data acquisition: Su-min Jeon, Jae-kyeong Kim, Jae-ui Lee, Su-hyeon Lee, and Seong-eun Park. Formal analysis: Su-min Jeon, Jae-kyeong Kim, and Jae-ui Lee. Supervision: Im-hee Jung and Do-Seon Lim. Writing—original draft: Im-hee Jung, Do-Seon Lim, and Su-min Jeon. Writing—review & editing: Im-hee Jung and Do-Seon Lim.

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Data availability

The supporting data of this study are available from the corresponding author upon reasonable request.

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