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## Plastic To Plant-Based: The Evolution Of Oral Care

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### Abstract:

**Introduction:** Plastic waste poses significant environmental and health challenges due to pollutants generated during incineration, as well as its accumulation in water and marine life. Eco-friendly oral hygiene products (Eco-OHPs) such as bamboo toothbrushes, Neem-based toothpaste, Charcoal-based toothpaste, Eco-friendly dental floss, are introduced instead of plastic toothbrushes to promote the consumption of these products and further reduce the generation of plastic waste. So it is necessary to understand current status of Eco-OHPs for environmental benefit as well as oral health care.

**Aim:** This study aimed to investigate the current level of awareness and purchasing status of eco-OHPs among adults who are aware about eco-friendly products.

**Methodology:** The study surveyed adults aged from 18 to 55 years. A structured google questionnaire including 13 questions were designed and distributed to general population covering, oral hygiene product usage, awareness of Eco-OHPs, and use of sustainable oral hygiene products. Statistical analysis was performed using SPSS v.28 software.

**Results:** Among the respondents, 31.6% were aware of Eco-OHPs, and 19.3% had experience purchasing Eco-OHPs. The mode of information mostly was through social media (Internet). The most common reason for not purchasing was the lack of awareness (88.3%), limited availability (66.30%). The experience in purchasing Eco-OHPs was affected by whether the respondents recognized the positive impact on oral health, availability, clear environmental benefits, greater price as compared to traditional products.

**Conclusion:** According to responses, the rationale of the study was to expand the use of Eco-OHPs, various efforts such as promotion of eco-friendly characteristics, awareness of using sustainable OHPs, and expansion of product experience opportunities are required. Despite the study's, it highlights the need for sustainable oral care practices, taking into account both environmental impact and positive impact on oral health. So it serves as a call to prioritize eco-friendly choices in healthcare.

**Key Words:** Environmental pollution, oral hygiene, plastic waste, awareness, Eco-friendly products.

## I) INTRODUCTION:

**Plaque** is a specific but highly variable structural entity resulting from colonization and growth of microorganisms on surfaces of teeth and consisting of numerous microbial species and their products embedded in a extracellular matrix. WHO (1978)

Dental plaque appears as a pale yellowish, adhesive substance adhering to tooth surfaces either above (supragingival plaque) or below (subgingival plaque) the gum line. These plaque deposits are typically found in areas such as the spaces between teeth, along the gum line, and on tooth defects or restorations <sup>2</sup>. If left untreated, dental plaque on tooth surfaces can cause stagnation in surrounding tissues, leading to the breakdown of protective tissues and the development of gingivitis and periodontitis. Lekholm et al. have demonstrated a direct correlation between the amount of dental plaque present and an increase in probing depth, indicating the significance of plaque accumulation in oral health <sup>2</sup>.

Maintaining healthy oral hygiene hinges greatly on plaque control. This can be achieved through two main methods: Mechanical and Chemical. Among these, proper tooth brushing stands out as the most straightforward and cost-effective approach <sup>2</sup>.

The history of the toothbrush stretches back to the early 1600s, aiming to enhance dental cleanliness and oral health. Before the advent of the modern toothbrush, individuals in India utilized "chewing sticks" for oral hygiene. The initial toothbrush was crafted from an ox thigh bone with bristles fashioned from cow tail hair. Over time, toothbrush design evolved, introducing nylon bristles and plastic handles. Various toothbrush with diverse handle, bristle, and neck designs have emerged since then. Electric and sonic toothbrushes were later developed to assist those with limited dexterity in maintaining oral hygiene<sup>2</sup>. Regardless of their design, toothbrushes commonly feature a plastic body with nylon bristles. Nylon bristles are preferable as they are reusable and degrade more quickly than plastic <sup>2</sup>. Conversely, plastic, being non-biodegradable, often persists in landfills for years, contributing to environmental issues. Plastic will degrade in the ocean into tiny particles known as microplastics (< 5 mm) and nanoplastics (< 100 nm) <sup>4</sup>. Plastic toothbrushes are constructed of polypropylene material, which contribute to plastic pollution. An estimated one billion toothbrushes are used and discarded annually in the United States alone<sup>5</sup>.

Plastic toothbrushes are widely used, however, they cannot be recycled because the composite plastic they are made of is tough to degrade and frequently becomes jammed in recycling equipment<sup>6</sup>. The waste composite plastics increase surface area and mobility when they age and become particle matter, which makes them easy to absorb into the food chain and fatally harms all living things<sup>7</sup>. In response to the increased awareness of this issue, eco-friendly toothbrushes have been introduced. One type which is gaining popularity is bamboo toothbrushes. A dentist in Brisbane created the first bamboo toothbrush, which has a handle composed of real cellulose fibre<sup>8</sup>. Bamboo is one of the fastest-growing plants due to its high growth rate, which permits harvest cycles every three to five years without negatively impacting the environment<sup>9</sup>.

Furthermore, because it doesn't require fertilisers or pesticides to be grown, bamboo is regarded as a low-impact crop. Because of this, growing bamboo reduces soil erosion and water pollution, making it a more environmentally friendly option than growing conventional crops<sup>10</sup>. Scientists have postulated that plastic buildup in the body may be hazardous, so there are the alternative called bamboo as it is a form of grass, so it is natural and will not build up in your body the way plastic can and it releases no harmful chemicals into the environment<sup>11</sup>. Long-term benefits of bamboo include helping the environment and being both durable and costeffective<sup>12</sup>. However, there have been few studies on bamboo toothbrushes in the limited literature.

Healthcare professionals worldwide are increasingly aware of the significant contribution of global healthcare to carbon dioxide emissions. Therefore, improving carbon footprint has become a shared environmental objective among them. In the United Kingdom, the National Health Service views it as a triumph when healthcare professionals integrate sustainability principles into treatment protocols<sup>2</sup>. Plastic waste presents notable environmental and health hazards, stemming from the pollutants released during

incineration and its persistence in waterways and marine ecosystems. In efforts to mitigate these issues, eco-friendly oral hygiene products (Eco-OHPs) like bamboo toothbrushes, Neem-based toothpaste, Charcoal-based toothpaste and environmentally friendly dental floss are being advocated as alternatives to traditional plastic toothbrushes. Assessing the current landscape of Eco-OHPs is imperative for both environmental preservation and oral health maintenance. Considering the importance of environmental sustainability, the current study opted to utilize bamboo toothbrushes to evaluate user satisfaction and awareness of sustainable oral hygiene products.

This study aimed to investigate the current level of awareness and purchasing status of eco-OHPs among adults who are aware about eco-friendly products.

## **II) MATERIAL AND METHOD:**

### **Study design:**

The study surveyed adults aged from 18 to 55 years. A structured google questionnaire including 13 questions were designed and distributed to general population of Bhopal, Madhya Pradesh covering oral hygiene product usage, awareness of Eco-OHPs, and use of sustainable oral hygiene products.

### **Selection criteria:**

The population from various areas of Bhopal, Madhya Pradesh were included in the study, whereas those who were not willing to participate in the study and had incompletely filled forms were excluded.

### **Ethical Clearance:**

Approval from the Institutional Ethics Committee (IEC NO.EC244212) was obtained before conducting the study.

### **Data Collection:**

The study consisted of 13 multiple-choice questions regarding the awareness and implementation of eco-friendly oral hygiene products. The questions with different options were created using Google Forms. Google Forms was shared with the participants, and they were asked to fill out the form.

### **Statistical analysis:**

A total of 326 responses were gathered. And recorded in a Microsoft Excel sheet and analyzed using SPSS Software version 28. A p-value of 0.05 was considered significant.

## **III) RESULTS:**

The data were analyzed using a professional statistical analysis program (SPSS version 28, USA) & the results were found.

**table 1: responses of study participants**

QUESTIONS	RESPONSES	NUMBER	PERCENTAGE	TOTAL
Gender	Male	157	48.2%	326
	Female	169	51.8%	
	Others	0	0 %	
Age	Under 18	6	1.8%	326
	18-24	138	42.3%	
	25-34	164	50.3%	

	35-44	15	4.6%	
	45-54	3	0.9%	
	55 and above	0	0%	
Are you familiar with the concept of sustainable (natural products ex:bamboo toothpick) dental hygiene products?	Yes	103	31.6%	326
	No	223	68.4%	
How did you initially learn about sustainable dental hygiene products?	Social media	217	66.6%	326
	Television or radio advertisements	8	2.5%	
	Word of mouth (family, friends,colleagues)	51	15.6	
	Dentist or dental professional	27	8.3	
	Not heard	22	6.7	
	Ayurveda professional	0	0	
Have you ever purchased or used sustainable dental hygiene products?	Yes	63	19.3 %	326
	No	263	80.7%	
If yes, which sustainable dental hygiene products have you purchased or used? (Select all that apply)	Bamboo toothbrush	48	14.7%	326
	Biodegradable dental floss	6	1.8%	
	Natural toothpaste	38	11.7%	
	Toothpaste pellets/tablets	5	1.5%	
	Refillable mouthwash	6	1.8%	
	Eco-friendly packaging	14	4.3%	
	Not used	234	71.8%	
	Others	7	2.1	
If yes, which sustainable dental hygiene products have you purchased or used? (Select all that apply)	Lack of awareness	288	88.3%	326
	Price	176	54%	
	Limited availability	216	66.3%	
	Uncertain effectiveness	13	4%	
	Others	5	1.5%	
How important is sustainability to you when it comes to dental hygiene products?	Very important	37	11.3%	326
	Somewhat important	188	57.7%	
	Not important	101	31%	
What would motivate you to switch to sustainable dental hygiene products? (Select all that apply)	Lower price compared to traditional products	36	11%	326
	Clear environmental benefits	178	54.6%	
	Recommendation from a dentist or dental professional	121	37.1%	
	Easy availability	97	29.8%	
	Positive impact on oral health	138	42.3%	
	Others	74	22.7%	
	Neem-based toothpaste	170	52.1%	

Are you aware of any specific sustainable oral hygiene products available in India? (If Applicable, select all )	Charcoal based toothpaste	105	32.2%	
	Miswak toothbrush	51	15.6%	
	Refillable toothpaste tablets/powders	10	3.1%	
	Eco-friendly dental floss(e.g: cornstarch-based)	13	4%	
	Not aware of any specific products	143	43.9%	
	Others	2	0.6%	
If you have used any of the specific sustainable oral hygiene products mentioned above, please rate your experience compared to traditional products:	Much better	166	50.9%	
	Slightly better	45	13.8%	
	About the same	100	30.7%	
	Slightly worse	3	0.9%	
	Much worse	0	0	
	N/A (haven't used any specific sustainable products)	166	50.9%	
Are you willing to pay a premium for sustainable oral hygiene products compared to traditional products?	Yes, I am willing to pay more	49	15%	326
	No, I prefer affordable options	205	62.9%	
	It depends on the price difference	72	22.1%	
How likely are you to recommend sustainable dental hygiene products to others?	Very likely	36	11%	326
	Somewhat likely	273	83.7%	
	Not likely	17	5.2%	

Among the respondents, 31.6% were aware of Eco-OHPs, and 19.3% had experience purchasing Eco-OHPs. The mode of information mostly was through social media (Internet) was about 66.6%. The most common reason for not purchasing was the lack of awareness (88.3%), limited availability (66.30%) (Fig:1). The experience in purchasing Eco-OHPs was affected by whether the respondents recognized the positive impact on oral health, availability, clear environmental benefits, price as compared to traditional products. The respondents who purchased ECO-OHPs were maximum of Bamboo toothbrush to average purchase of Natural toothpaste. And 73.35 % people not even used(Fig 3). The respondents of the people were average for sustainability of how important the dental hygiene products are as somewhat important (Fig:6).

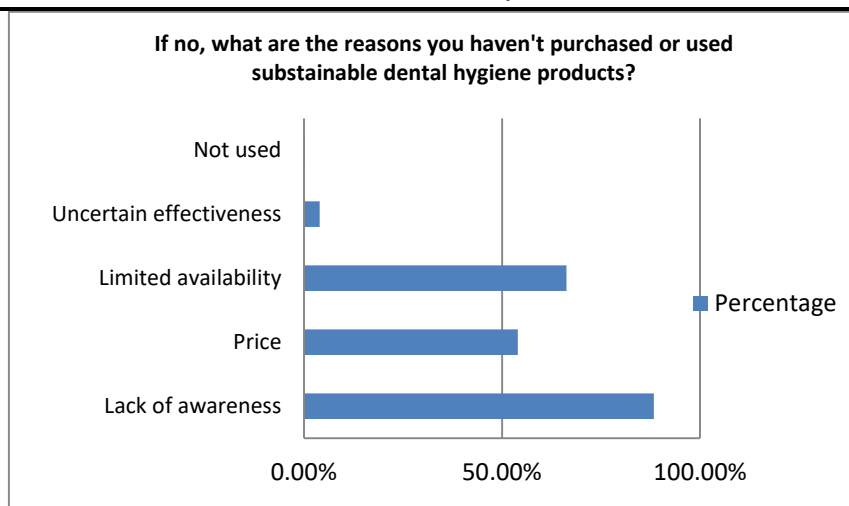


fig:1

The factors which motivate the people to switch to sustainable dental hygiene products were clear environmental benefits (54.6%), positive impact on oral health (42.3%), recommendation from dentist (37.1%), price compared to traditional products (11%) (Fig:4). Specific sustainable oral hygiene products were used such as Neem based toothpaste (52.1%) maximum, Charcoal based toothpaste (32.2%) average, Miswak toothbrush (15.6%) (Fig:7).

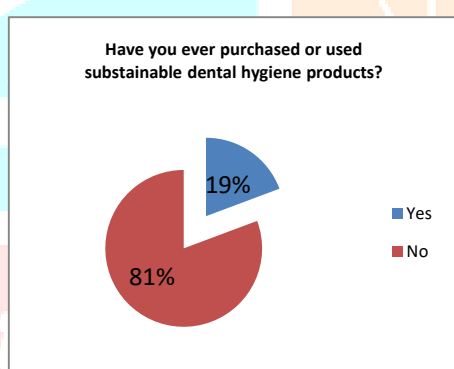


fig:2

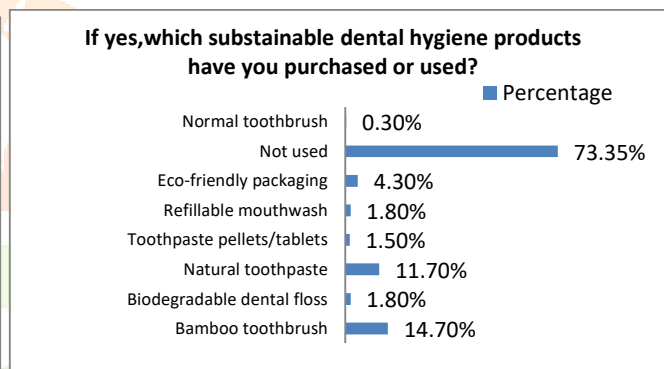


fig:3

The responses of the rate of experience as compared to traditional products was much better. 15% of people were willing to pay a premium for sustainable OHPs (Fig:5). People likely to recommend sustainable dental hygiene products to others were about 11%.

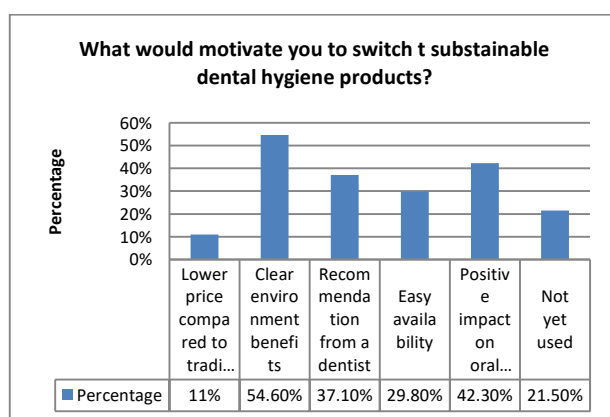


fig:4

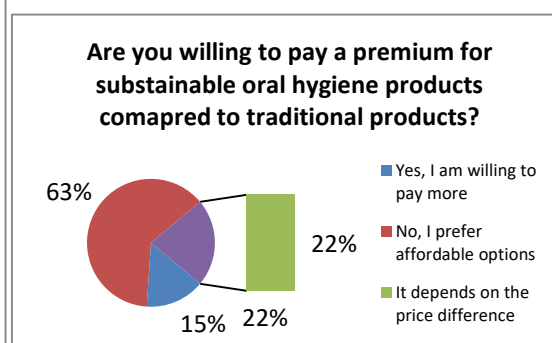


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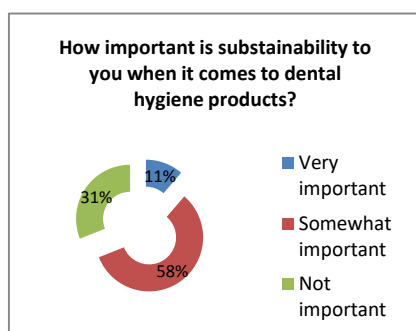


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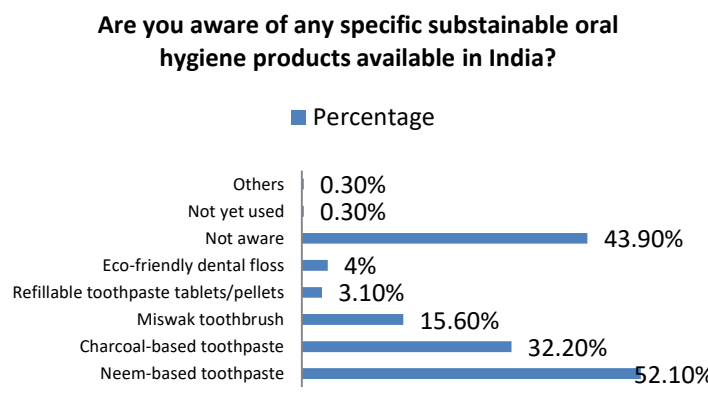


fig:7

#### IV) DISCUSSION:

This study aimed to examine the current status of Eco-OHPs, such as related awareness and purchase experience, targeting adults who are interested in ecofriendly products, and to identify which aspects related to Eco-OHPs affect future purchase intentions.

According to results of the 2019 public awareness survey<sup>7</sup>, 31.6% of the respondents were known with the concept of eco-friendly products, and 19.3% responded that they had a purchase experience.<sup>1</sup> However, according to a public awareness survey<sup>14</sup> 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 study<sup>14</sup>, “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 products<sup>14-16</sup>) 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 a result of this study investigating the factors that affect the future purchase intention of Eco-OHP, was investigated as the perception of the possibility of contributing to environmental preservation (most influential factor, followed by “recognition of differences with G-OHPs,” “awareness of the selling company,” and “perception of safety”<sup>1</sup>. Han’s study 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.<sup>13</sup>

#### V) LIMITATIONS:

The survey tool in this study was made by modifying several questionnaires used in previous studies; therefore, the direct validity verification was overlooked. Moreover, since EcoOHPs 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.

## **VI) CONCLUSION:**

Based on the findings, the objective of the research was to enhance the utilization of Eco-friendly oral hygiene products (Eco-OHPs). To achieve this goal, interventions such as advocating for environmentally friendly attributes, raising awareness regarding sustainable usage of oral health products, and broadening opportunities for product exposure are imperative. Despite the study's outcomes, it underscores the necessity for implementing sustainable oral care behaviors, considering both environmental ramifications and beneficial effects on oral health. Therefore, it presents an urgent appeal to prioritize eco-conscious selections within the healthcare domain. Thus, in order to preserve a healthy environment, it is important to develop awareness campaigns, incorporate oral hygiene habits and practice it on a daily basis.

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