**Adoption of Sustainable Tableware: Demographic Insights and Consumer Perception Toward Agrowaste- Based Alternatives**

 **Abstract**

Plastic pollution is a pressing global issue, exacerbated by the widespread use of single-use plastics and unsustainable consumption patterns. Although awareness of environmental impacts has increased, plastic production continues to rise, leading to significant ecological damage. In response, biodegradable alternatives derived from agricultural waste, such as groundnut and walnut shells, are gaining traction. This study investigates consumer awareness, perception, willingness to pay, and barriers associated with the adoption of biodegradable tableware made from agrowaste. Using a structured survey and statistical analysis (chi-square test), the research reveals that income and education levels significantly influence purchasing behavior. The results of the chi-square test revealed that the null hypothesis was rejected for both income and education. Based on the chi-square values, it was concluded that the perception level and willingness to pay extra for biodegradable tableware are influenced by respondents’ income (χ² = 38.905). Similarly, the perception level of the respondents was also found to be significantly influenced by their educational status (χ² = 139.876). Among the various barriers identified, affordability and availability of the products emerged as the major barrier to adoption, particularly among lower-income groups. The findings highlight the need to address key challenges such as cost, awareness, and product durability, while also promoting sustainability and circular economy practices.

**Keywords:** Agrowaste, Biodegradable tableware, Consumer perception, Eco-friendly products, Circular economy

1. **Introduction**

The global reliance on plastic, particularly single-use plastic products, has led to one of the most critical environmental challenges of our time. As of 2018, annual plastic production reached approximately 380 million tons, contributing to an estimated cumulative production of 6.3 billion tons since the 1950s. Alarmingly, only 9% of this plastic is recycled, with the rest accumulating in landfills or polluting terrestrial and marine ecosystems. Studies show that 90% of seabirds have ingested plastic debris, and by 2050, it is projected that the volume of plastic in oceans may exceed that of fish.

Despite increased efforts to reduce plastic usage and promote recycling, plastic production continues to grow rising by 4% in 2013 alone **(World watch Institute, 2015).** The persistent use of non-biodegradable plastics presents long-term risks to natural resources, biodiversity, and future generations.

Disposable plastic cutlery, in particular, contributes significantly to this crisis. The global demand has reached approximately 640 billion pieces annually **(Reddy, 2016**), with the market valued at $2.62 billion in 2017 and projected to reach $3 billion by 2025 **(Rashid, 2019**). Amid these concerns, biodegradable products made from agricultural residues such as groundnut and walnut shells offer a sustainable alternative. These materials not only reduce dependency on petroleum-based plastics but also provide a value-added use for agricultural waste.

Recently, consumers have become increasingly aware of the impact that high levels of plastic waste, especially single-use plastic waste, has on the environment. A social movement encouraging consumer to be mindful of their plastic consumption has led to higher demand for products that have attributes such as being biodegradable, being byproducts of existing production, and not containing plastic (**Mishra et al. 2017).**

This study seeks to assess consumer awareness, perception, willingness to pay and perceived barriers to adopting biodegradable tableware made from agrowaste, offering insights into how such innovations can support sustainable consumption and a circular economy.

1. **Review of literature**

The transition from petroleum-based plastics to biodegradable alternatives has garnered increasing academic and industrial interest in recent years. This literature review outlines key findings related to consumer awareness, perception, behavior and willingness to adopt biodegradable products, particularly those derived from agricultural waste.

**Mehta et al. (2021**) found that consumers in Belfast demonstrated limited awareness of bio- based plastics and exhibited a low willingness to pay a premium for such products. The study emphasized the necessity of product standardization and transparent labelling to build consumer trust and promote widespread acceptance.

In a global study across 42 countries, **Filho et al. (2022**) observed generally positive attitudes toward bioplastics, particularly for packaging and kitchenware. Nonetheless, the authors noted that high perceived costs, limited government incentives, and perceived inconvenience were major adoption barriers. Their findings highlight the need for structural and policy-level support to complement consumer willingness.

**Hoffman et al. (2019),** through an online survey conducted in Australia, identified a generally positive perception of biodegradable plastics among respondents, despite their limited knowledge about the subject. A significant 68% of participants expressed a strong preference for a shift toward biodegradable materials. The study also highlighted the vital role of government and local authorities in raising awareness and promoting sustainable alternatives through better waste management systems**.**

**Klein et al. (2019)** emphasized that consumer attitudes, personal values aligned with sustainability, past experiences with bioplastic products, and interest in product-related information are key influences on the purchasing behavior of German consumers. They recommend targeted marketing and communication strategies to further boost the adoption of bioplastics.

**Leal et al. (2021)** found widespread concern about plastic-related environmental issues and general interest in bioplastics. However, the adoption of bioplastics was hindered by limited product availability and a significant lack of accessible information. The study reported that fewer than 10% of European consumers regularly use bioplastics, while 93% felt uninformed, especially in countries like Portugal, Spain, and the UK.

**Notaro et al. (2022)** showed that consumers valued environmental benefits—such as reduced carbon footprint and renewable sourcing—more than the technical or mechanical properties of bioplastic products. Moreover, higher education levels and female gender were positively correlated with willingness to adopt biobased alternatives. This underscores the influence of socio-demographic and psychographic variables on adoption behavior.

**Weinrich and Herbes (2023)** emphasized that intrinsic values and environmental attitudes were stronger predictors of consumer behavior toward bioplastics than income or age. Additionally, the study identified four major product characteristics influencing purchase behavior: material origin, product certification, clarity of sustainability claims, and biodegradability.

**Ruf et al. (2022)** highlighted widespread misconceptions and knowledge gaps among consumers regarding the actual environmental benefits of bioplastics. Many consumers conflated “biodegradable” with “compostable,” or assumed that all biobased products break down in natural environments—misunderstandings that could deter informed purchase decisions. Furthermore, branding and eco-labelling were often inconsistent or ambiguous, leading to consumer confusion and skepticism.

**Herrmann et al. (2022)** focused on consumer trust, identifying that vague or exaggerated environmental claims led to perceptions of “greenwashing,” which significantly reduced willingness to pay. Their study underscores the importance of verified certifications and transparent communication strategies in shaping consumer trust and market acceptance.

**Anamika et al. (2022)** examined the utilization of agro-waste, such as rice husk, groundnut shell, and sugarcane bagasse, in producing biodegradable cutlery. Their results showed promising mechanical and thermal properties, indicating that these materials could be viable substitutes for petroleum-based plastics. However, they noted that market penetration remains limited due to a lack of awareness and consumer education.

While several studies have explored consumer perceptions of bioplastics and biodegradable packaging materials, limited empirical research exists specifically on consumer attitudes toward agrowaste-based biodegradable tableware.

There is also a scarcity of research exploring the intersection between environmental values, product knowledge, and perceived barriers—such as cost, safety, and hygiene when it comes to novel materials like groundnut or walnut shell-based tableware. Moreover, consumer willingness to pay, especially in relation to visible product features (color, texture, labels) and socio-psychological drivers (norms, identity, and environmental concern), has not been thoroughly examined.

This study aims to bridge these gaps by investigating the perception, willingness to pay, and barriers associated with biodegradable tableware made from agrowaste-based bionanocomposites, providing valuable insights for product developers, marketers, and policymakers.

1. **Objectives:**

This study aims to:

* Explore demographic profile and the extent to which consumers are willing to pay more for environmentally friendly products.
* Assess socio-economic profile of consumers and consumer perception towards biodegradable tableware made from agrowaste.
* Identify key barriers that affect consumer purchase behavior, including affordability, awareness, and product performance.

**Hypothesis**

* **H01:** There is no significant relationship between respondents’ monthly income and willingness to pay higher prices for the agrowaste based biodegradable tableware.
* **H02:** there is no impact of literacy rate on consumers perception towards the agrowaste based biodegradable tableware.
1. **Research Methodology**

This study adopted a quantitative research approach to explore consumer perceptions, willingness to pay, and barriers to adopting agrowaste-based biodegradable tableware. A structured questionnaire was developed and administered to a diverse sample of consumers to gather insights into their awareness, perception, and purchase intention.

**4.1 Research design**

The research was designed as a cross-sectional survey. The questionnaire comprised both closed- and open-ended questions organized into five key sections: demographic profile, environmental concern, perception of biodegradable products, willingness to pay, and perceived barriers. Responses were collected using a 5-point Likert scale to capture the degree of agreement or disagreement with various statements.

**4.2 sampling and data collection**

A purposive sampling technique was employed to ensure that participants from diverse age groups, income brackets, and educational backgrounds were included. The survey was distributed both online (via Google Forms) and in-person at markets, retail stores, and educational institutions to reach a broader demographic.

A total of 250 valid responses were collected over a period of 3-4 months. Sample size reflects a practical balance between data reliability and feasibility in terms of time, resource availability, and response rate management during the data collection period. Participation was voluntary, and respondents were assured of anonymity and confidentiality to encourage honest and unbiased feedback.

The present investigation was undertaken to explore consumer perceptions regarding agrowaste-based biodegradable products. In alignment with the study objectives—assessing consumer perception toward agrowaste-based biodegradable products the investigation was carried out in Bazpur block of Udham Singh Nagar district, located in the state of Uttarakhand. This area was selected due to its diverse consumer base and accessibility for primary data collection related to sustainable product usage.

**4.3 Data analysis**

The data collected was cleaned and coded for statistical analysis using SPSS. Descriptive statistics such as frequencies, percentages, and mean scores were calculated to summarize consumer awareness and perception. To examine the relationship between demographic variables (such as income and education) and consumer perception, the Chi-square test of independence was applied. This helped identify significant associations between variables such as willingness to pay and educational background or income levels.

**4.4 Reliability and Validity**

To ensure the reliability of the instrument, a pilot study was conducted with **30** respondents prior to the main survey. Based on their feedback, minor revisions were made to enhance clarity and relevance. The internal consistency of the Likert-scale items was measured using **Cronbach’s alpha**, which yielded a value of **0.82**, indicating good reliability.

1. **Results and discussion**

The demographic profile of the respondents provides a comprehensive overview of the sample population based on age, gender, education level, and occupation. This information is crucial for understanding the factors that might influence consumer perceptions and willingness to pay for agrowaste-based biodegradable tableware.

**Table 1 Demographic profile of respondents**

|  |  |  |  |
| --- | --- | --- | --- |
| **Attributes** | **Description** | **Frequency** | **percentage** |
| **Age** | 21-3031-4041-5051-60 | 24523212 | 2043.326.910 |
| **Gender** | MaleFemale | 4272 | 4060 |
| **Educational qualification** | IlliteratePrimary level High school Intermediate GraduationPost graduation | 4213041186 | 3.417.52534.1155 |
| **Occupation** | BusinessPrivate jobGovernment jobAgriculture and allied activitiesHousewife | 1814163042 | 1511.713.32535 |

The majority of respondents (43.3%) were aged between 31–40 years, indicating a strong representation of individuals likely to influence sustainable purchasing decisions. 60% of the female respondents, reflecting potentially greater household decision-making and concern for eco-friendly products. Educationally, 34.1% had completed intermediate-level education and 25% finished high school, suggesting a moderate awareness of environmental issues. Housewives (35%) and those engaged in agriculture (25%) formed the largest occupational groups, underlining the relevance of biodegradable tableware among consumers managing households and those familiar with agrowaste materials.

**5.1 Understanding towards biodegradable tableware**

 The study revealed that a significant proportion of respondents demonstrated sound understanding of biodegradable tableware and its environmental benefits. Most participants were aware that such products decompose naturally and contribute to reducing pollution and plastic waste. They also appreciated that biodegradable tableware is often derived from renewable sources such as agricultural residues. This understanding fosters positive attitudes toward sustainable consumption.

However, despite this awareness, respondents expressed concerns about certain performance attributes. Many doubted the durability and robustness of biodegradable alternatives compared to plastic products. The perceived fragility of such items especially in wet or hot food applications was a deterrent for some. Furthermore, the most commonly cited barrier to adoption was the relatively higher cost of biodegradable products, suggesting that affordability remains a critical challenge.

**Fig. 1 Understanding towards biodegradable tableware**

**5.2 Willingness to pay for sustainable alternatives**

When it came to willingness to pay, the responses showed a mix of support and hesitation. A majority (43.3%) were willing to pay 5–10% more for agrowaste-based products, and nearly 30% were open to paying 11–20% more. Only a small segment (12.5%) expressed willingness to pay above 20%, whereas 15% stated they would not pay any extra. These results indicate a general inclination toward eco-friendly alternatives, though bounded by economic constraints.

**Table 2 willingness to pay for sustainable alternatives**

|  |  |  |
| --- | --- | --- |
| **Willingness to Pay Extra** | **Number of Respondents** | **Percentage (%)** |
| **No extra payment** | 18 | 15.0 |
| **5–10% extra** | 52 | 43.3 |
| **11–20% extra** | 35 | 29.2 |
| **Above 20% extra** | 15 | 12.5 |
| **Total** | **120** | **100** |

This highlights a price-sensitive market, where even environmentally concerned consumers are hesitant to pay significantly more for sustainable alternatives. Educational campaigns and government incentives may be required to enhance consumers perceived value of such products.

 **5.3 Perceptions Toward Agrowaste-Based Biodegradable Tableware**

A broad range of perceptions regarding eco-friendly tableware emerged from the analysis. About 70% of respondents agreed that using biodegradable alternatives contributes to reducing household plastic waste. Reusability was also recognized as a positive feature by 77.5% of participants. However, perceptions were less favourable when it came to the social recognition of using such products only 24.1% felt that choosing eco-friendly tableware enhanced their social image, while 49.1% disagreed.

When asked about their contribution to environmental improvement, 53.3% agreed that using biodegradable tableware supports environmental protection efforts, though 35.8% disagreed. Regarding availability, a majority (49.1%) felt that biodegradable products were not widely available in the market, indicating poor accessibility and distribution. The study revealed a generally positive perception among consumers toward agrowaste-based biodegradable tableware, particularly regarding its environmental benefits and potential to reduce plastic waste. A significant proportion of respondents associated such products with sustainability, eco-friendliness, and responsible consumption. This aligns with prior research indicating that environmental concern is a key driver of consumer preference for biodegradable and compostable products (**Aman et al., 2012).**

Trust in eco-labels was another mixed outcome. While 37.5% of respondents trusted eco- labeled products, a larger group (52.5%) remained only partially convinced. Additionally, when questioned whether they would still choose biodegradable products if priced higher,

66.6% said they would not—underscoring the influence of price on sustainable consumption decisions.

Concerns about durability persisted, with only 45% agreeing that biodegradable products were sufficiently durable, and nearly half (50%) disagreeing or unsure. Furthermore, only 25% of respondents felt that these products met all desired attributes of tableware (durability, appearance, safety, and usability), while 49.1% disagreed.

**5.4 Constraints in the Adoption of biodegradable tableware**

Several key constraints were identified that hinder the adoption of agrowaste-based biodegradable tableware. Chief among them was a lack of information and awareness regarding the proper use, disposal, and benefits of such products. Many respondents cited inadequate product strength and insufficient durability as major limitations.

Consumers also reported confusion due to inconsistent labelling and lack of clear guidance on how to distinguish genuinely sustainable products from conventional options. Additionally, limited access to biodegradable products in local markets and doubts regarding their cost-effectiveness contributed to resistance in purchasing.

Despite these constraints, many consumers expressed a willingness to support environmentally practices, provide product quality and performance were comparable to plastic alternatives. Factors such as personal health consciousness, environmental responsibility, and previous experience with green products played a crucial role in shaping their attitudes. However, lower product quality particularly durability and moisture resistance remained a critical deterrent. Insufficient marketing strategies, absence of branding, and inadequate point-of-sale communication contribute to the invisibility of these products (**Biswas & Roy, 2015).** Consumers often report difficulty in identifying environmentally friendly products due to the lack of eco-labels and trustworthy information **(Delmas & Grant, 2014).**

**Figure 2 constraints in buying or using biodegradable tableware**

**5.5 Testing of hypothesis:**

Chi square values were computed for the independent variables (income and education) with the respondent’s perception towards associated eco-friendliness nature of the biodegradable tableware and their willingness to pay extra for biodegradable tableware. As shown in the Table 3.

**Table 3. Chi square values**

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **Variables** | **Calculated chi square value** | **Remarks** |
| 1. | Income | 38.905 | H1- Accepted |
| 2. | Education | 139.876 | H1- Accepted |

The results of chi-square test revealed that null hypothesis is rejected for both income and education. On the basis of chi-square values, it was concluded that perception level and willingness to pay extra for biodegradable tableware of the respondents is influenced by the income (38.905). Similarly, perception level of the respondents was also proved to be influenced by their educational status (139.876).

1. **Conclusion**

The study highlights the urgent need to shift from single-use plastics to sustainable alternatives due to the environmental impact of plastic pollution. Biodegradable tableware made from agrowaste like groundnut and walnut shells is identified as a promising eco- friendly option. Findings indicate strong consumer recognition of its environmental benefits, including waste reduction and sustainability. However, low awareness of product availability and limited trust in quality (due to lack of eco-labels or certifications) present challenges. Importantly, the findings of this study provide valuable insights that can inform the development of agrowaste-based products more closely aligned with consumer expectations, particularly with respect to quality standards, affordability, and the incorporation of recognized certifications. Furthermore, the results can guide the formulation of more targeted and effective environmental communication strategies aimed at enhancing public trust, increasing awareness, and encouraging long-term sustainable consumer behavior. In this way, the study contributes not only to academic understanding but also to the practical advancement of sustainability efforts across product development, marketing, and policy implementation.

1. **Recommendations**

• **Awareness Campaigns**: Launch targeted awareness campaigns through community programs, schools, and social media to educate consumers on the environmental benefits and proper usage of biodegradable tableware.

• **Subsidies and Incentives**: Government and institutions should offer subsidies to manufacturers and incentives to consumers to make agrowaste-based biodegradable products more affordable and accessible.

• **Quality Certification**: Establish clear labelling and certification systems to build consumer trust and differentiate genuine eco-friendly products from misleading ones.

• **Product Innovation**: Focus on improving the strength, durability, and moisture resistance of biodegradable tableware to match consumer expectations and expand usability in various conditions.

• **Retail Expansion**: Increase the availability of biodegradable products in rural and semi-urban markets through partnerships with local vendors and cooperatives.

* **Policy Support**: Enact supportive policies including bans on single-use plastics, and mandate the inclusion of biodegradable alternatives in public procurement and institutional settings.
* **Research and Development**: Promote R&D in universities and industry for refining the use of agrowaste materials and developing new composite blends with improved properties.

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1.

2.

3.

**References**

1. Aman, A. L., Harun, A., & Hussein, Z. (2012). The influence of environmental knowledge and concern on green purchase intention the role of attitude as a mediating variable. *British Journal of Arts and Social Sciences*, *7*(2), 145-167.
2. Anamika, S. A., Jatawa, S., Selvi, V. A., & Tiwari, A. (2020). Value-added products of rice husk in various disciplines. *Int. J. Res. Appl. Sci. Eng. Technol*, *10*, 594-608.
3. Biswas, A., & Roy, M. (2015). Green products: an exploratory study on the consumer behaviour in emerging economies of the East. Journal of cleaner production, 87, 463-468.
4. Delmas, M. A., & Grant, L. E. (2014). Eco-labeling strategies and price-premium: the wine industry puzzle. *Business & Society*, *53*(1), 6-44.
5. Dilkes-Hoffman, L., Pratt, S., Laycock, B., Ashworth, P., & Lant, P. (2019). Public perceptions, knowledge, and end-of-life care regarding bioplastics. Resources, Recycling and Conservation, 151, 104479.
6. Filho, W. L., Barbir, J., Abubakar, I. R., Paço, A., Stasiskiene, Z., Hornbogen, M. & Klõga, M. (2022). Consumer attitudes and concerns with bioplastics use: An international study. *PLoS One*, *17*(4), e0266918.
7. Herrmann, C., Rhein, S., & Sträter, K. F. (2022). Consumers’ sustainability-related perception of and willingness-to-pay for food packaging alternatives. *Resources, Conservation and Recycling*, *181*, 106219.
8. Käb, H., Aeschelmann, F., Dammer, L., & Carus, M. (2016). Market study on the consumption of biodegradable and compostable plastic products in Europe 2015 and 2020. *Nova-Institute: Hürth, Germany*, 6.
9. Klein, F., Emberger-Klein, A., Menrad, K., Möhring, W., & Blesin, J. M. (2019). Influencing factors for the purchase intention of consumers choosing bioplastic products in Germany. *Sustainable Production and Consumption*, *19*, 33-43.
10. Leal Filho, W., Salvia, A. L., Bonoli, A., Saari, U. A., Voronova, V., Klõga, M. & Barbir, J. (2021). An assessment of attitudes towards plastics and bioplastics in Europe. *Science of the Total Environment*, *755*, 142732.
11. Mehta, N., Cunningham, E., Roy, D., Cathcart, A., Dempster, M., Berry, E., & Smyth, B. M. (2021). Exploring perceptions of environmental professionals, plastic processors, students and consumers of bio-based plastics: Informing the development of the sector. *Sustainable Production and Consumption*, *26*, 574-587.
12. Munir, S. (2017). Edible cutlery: the future of eco-friendly utensils. *Hyderabad, India*.
13. Notaro, S., Lovera, E., & Paletto, A. (2022). Behaviours and attitudes of consumers towards bioplastics: An exploratory study in Italy. *Journal of Forest Science*, *2022*(68), 121-135.
14. Parker, L. (2018). Fast facts about plastic pollution. *National Geographic*, *20*.
15. Rashid, M. S. (2019). *Edible cutleries as sustainable substitute for plastic cutleries* (Doctoral dissertation, Brac University).
16. Reddy, D. (2016). Bakeys: You can use and eat this innovative cutlery. *Business Standard*. <https://www.business-standard.com/article/companies/bakeysyou-can-use-and-eat-> [this-innovative-cutlery-116062200024\_1.html](https://www.business-standard.com/article/companies/bakeysyou-can-use-and-eat-this-innovative-cutlery-116062200024_1.html)
17. Ruf, J., Emberger-Klein, A., & Menrad, K. (2022). Consumer response to bio-based products–A systematic review. *Sustainable Production and Consumption*, *34*, 353-370.
18. Shams, M., Alam, I., & Mahbub, M. S. (2021). Plastic pollution during COVID-19: Plastic waste directives and its long-term impact on the environment. *Environmental advances*, *5*, 100119.
19. Weinrich, R., & Herbes, C. (2023). Consumer research on bioplastics: A systematic review. *Q Open*, *3*(1), qoad013.