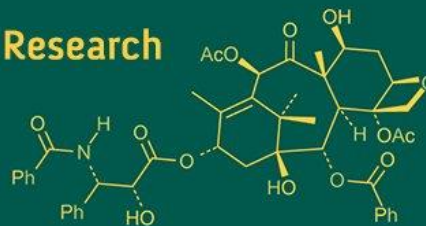


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A tri-dimensional assessment of copper and earthen cookware: Nutritional impact, environmental sustainability, and cultural significance

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Abstract

Traditional cookware has long played a pivotal role in shaping dietary practices, nutritional outcomes, and cultural identity across communities. In recent years, rising concerns about modern cookware materials and a renewed interest in sustainable living have prompted a reassessment of age-old culinary tools. The present study explores the nutritional, health, and environmental relevance of traditional cooking vessels, specifically copper and earthen pots, based on responses from 50 participants. The objective was to examine their use to perceive the nutritional benefits of using copper and earthen pots, awareness about possible elemental leaching from copper and earthen cookware, environmental views related to the use, cultural practices and beliefs associated with their usage. Findings reveal that copper vessels are traditionally linked to improved digestion, enhanced immunity, and overall physiological well-being, while earthen pots are valued for their natural mineral content, alkalinity, and ability to enhance both the flavor and nutritional quality of food. Participants also recognized that both types of cookware align with eco-friendly practices, being biodegradable, resource-efficient, and energy-conserving, thereby promoting an environmentally conscious cooking culture. The reuse and longevity of these vessels highlight their contribution to sustainability and the preservation of cultural heritage. However, respondents also expressed awareness of potential risks such as elemental leaching from copper, underscoring the need for informed and cautious use to maximize benefits safely. Overall, the study indicates that traditional cookware represents a harmonious blend of ancestral culinary wisdom and modern principles of nutrition and sustainability. Functional qualities such as durability, heat retention, and ease of handling further justify their continued relevance in contemporary kitchens. The findings suggest that heritage cookware extends beyond cultural symbolism, serving as a practical model for health-conscious, environmentally responsible, and nutritionally enriching food preparation in today's households.

Keywords: Copper cookware, earthen pots, nutritional benefits, health impacts, environmental sustainability, cultural heritage, traditional culinary practices

Introduction

Copper, earthenware, aluminium, and stainless steel utensils traditional cookware has been used for many centuries and continues to thrive owing to its ability to follow parameters and evenly distribute heat, retain flavor, and enrich the nutritional profile of cooked food. However, modern scientific research and advancement have increasingly focused on the same toxicological safety and health implications associated with the leaching of metals from these utensils under varying cooking conditions and temperatures.

According to Banavi *et al.* (2020) [2] in Environmental Science and Pollution Research, tin-lined copper cookware exhibited a significant amount of leaching of metals such as copper, manganese, iron, and zinc as metal when exposed to acidic food simulants and longer cooking times. The researchers concluded that qualities such as food pH, cooking duration, and temperature are the main variables influencing copper release, suggesting that prolonged exposure or use with acidic foods can pose a potential risk of metal accumulation in the human body. Çiftçi and Henden's (2016) [3] findings in Science of the Total Environment analyzed the following things: glazed and non-glazed earthenware pots commonly used in households of Turkish people. The following observations were made: non-glazed pots leached considerably higher levels and concentrations of inorganic metal, i.e., arsenic.

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Their research emphasized that glazes act as protective barriers, though improper glazing or cracks can still result in toxic, harmful trace element contamination.

Koo *et al.* (2020) ^[10] in Food and Chemical Toxicology demonstrated that the repeated washing, oiling, and reuse of metallic utensils significantly affected the release of heavy metals such as arsenic, cadmium, chromium, nickel, and lead. Factors such as acidic foods, longer cooking durations, inadequate cooking, and higher temperatures intensified metal migration, particularly in the older cookware, and pose a hazard. Likewise, the study of Sultan *et al.* in Toxics examined the metal aluminium and also copper utensils and reported that lead and made an observation that nickel contamination was strongly influenced by the cookware's age and the acidity of the food being cooked. The study highlighted that recycled and unregulated metal utensils pose a major public health concern in the following low- and middle-income countries, where manufacturing standards are often lacking and poor. According to Ecocly creations, 2022 earthenware cookware retains heat and moisture, enhancing flavour and nutrient content, improve digestion and nutrients absorption.

Findings of Mathee and Street (2020) ^[12] emphasized the health including occupational and community health hazards of artisanal metal cookware manufacturing, highlighting increased exposure to lead, cadmium, and tin among workers and consumers in low-resource settings. While the leaching of metals presents a clear risk, the antimicrobial properties of copper have gained renewed attention for their potential health benefits. Grass, Rensing, and Solioz (2011) ^[8] in Applied and Environmental Microbiology demonstrated that surfaces of copper cookware exhibit the rapid "contact killing" activity against major disease-causing pathogens, including the bacteria *Escherichia coli* and *Staphylococcus aureus*, through the following ways of oxidative stress and membrane damage. Expanding this application, study of Montero *et al.* (2019) ^[13] in Antimicrobial Resistance and Infection Control indicate that copper-containing surfaces and coatings in hospital settings reduced to some extent bacterial contamination by more than (99.9%), indicating their usefulness in prevention of infection and control strategies. Similarly, Salah *et al.* (2021) ^[14] reported that copper nanoparticles could inhibit the growth of microbes and the formation of biofilm, further supporting the function of copper's potential in public health and water sanitation applications.

The U.S. Environmental Protection Agency (EPA, 2008) formally recognized copper cookware as the first metallic antimicrobial agent, validating centuries of traditional wisdom that considered copper metal cookware as beneficial for safe storage of basic needs of food and water. Earthenware, though studied less for function, including its antimicrobial properties, continues to be valued in old and contemporary societies for its properties of thermoregulation and ecological advantages. Coutinho (2021) ^[4] highlighted earthenware's properties of biodegradability, energy efficiency, and cultural significance and importance, promoting it as a sustainable alternative method of cooking. Microbial analyses of earthenware-stored water, such as the study conducted in Makurdi, Nigeria (2019) ^[11], revealed the significant contamination and toxicity by bacteria and fungi, including *E. coli*, *Staphylococcus aureus*, and *Pseudomonas* spp., indicating that poor hygiene, sanitation, and

maintenance can compromise the safety ability of earthen containers. Finally, studies on consumer perception and awareness underscore a lack of knowledge regarding the chemical composition, property, and health implications of traditional cookware. Asante-Kyei *et al.* (2024) ^[1] found that in Ghana, consumers had limited understanding and awareness about the potential risks of earthenware and plastic utensils, often prioritizing the feature of cultural and aesthetic factors over safety considerations. Such findings, combined with Fellows *et al.* (2024) ^[7] in Environmental Health Perspectives, who identified metal cookware as a major source of lead exposure in informal economies, emphasize the urgent need for public education, policy regulation, and safer manufacturing practices.

In summary, it collectively demonstrates and highlights that traditional cookware materials such as copper and earthenware offer qualities of both nutritional and cultural benefits but at the same time can also pose chemical and microbiological hazards when used improperly. The extent to which metal leaching is influenced by factors including the acidity of food, which is nature, temperature, time duration, composition of material, base, and age of cookware; all these factors collectively contribute to leaching. Copper, while posing a leaching risk, provides the unique advantage of antimicrobial and nutritional advantages that make it a material of continued scientific and cultural relevance. Therefore, future research should focus on developing standardized manufacturing protocols, safe-use guidelines, quality standards, and public health and awareness programs that preserve the cultural value of traditional cookware while ensuring consumer health and safety.

Methodology

This study was based on a survey designed to examine public perceptions and usage of traditional cookware, particularly copper and earthenware pots. The main objective was to explore how usage patterns, perceived nutritional and health benefits, cultural significance, and environmental considerations influence people's attitudes toward these cookware types in modern households.

The research was conducted through a semi-structured online questionnaire developed and distributed via Google Forms. The questionnaire was divided into five sections:

- Demographic Information
- Usage Patterns
- Perceived Health and Nutritional Benefits
- Awareness of Leaching or Toxicity
- Cultural and Environmental Perspectives

Data collection was carried out through online circulation among homemakers, elderly, and Professional chefs to obtain informed and varied perspectives. A total of 50 respondents were included through purposive sampling. The responses were analyzed using basic descriptive statistical methods such as frequency and percentage analysis, and results were illustrated through table and graphs.

Special attention was given to identifying how nutritional awareness, traditional practices, and environmental consciousness collectively shape modern perceptions and continued use of copper and earthenware cookware.

Results and Discussion

Table 1: Demographic Profile of Respondents(N=50)

Variables	Categories	Frequency (f)	Percentage (%)
1. Gender	i. Female	27	54.0
	ii. Male	23	46.0
2. Age Group (years)	i. 18-25	12	24.0
	ii. 26-30	11	22.0
	iii. 30-35	19	38.0
	iv. 35 and above	8	16.0
3. Occupation	i. Homemakers	25	50.0
	ii. Professional chefs	12	24.0
	iii. Elderly	13	25.0
4. Residence	i. Urban	20	40.0
	ii. Semi-urban	14	28.0
	iii. Rural	16	32.0

The study comprised 50 participants 54 per cent female, 46 per cent male, with 50 per cent being homemakers, 24 per cent being professional chefs, and 25 per cent being elderly. Of these, 40 per cent were from metropolitan areas, 32 per

cent from rural areas and 28 per cent were from semi-urban ones. According to research, women continue to be the majority of cooks worldwide, however men are becoming more involved in Indian urban kitchens.

Table 2: Usage Patterns, Health Perceptions, Barriers, Practical Challenges and Cultural-Environmental Views of Respondents Toward Traditional Cookware (N = 50)

Sl. No.	Statement	Responses	Frequency (f)	Percentage (%)
1	Do you currently use traditional cookware at home?	i. Yes	30	60.0
		ii. No	20	40.0
2	Which type of traditional cookware do you use most often?	i. Earthen pots	20	40.0
		ii. Copper pots	15	30.0
		iii. Both	10	20.0
		iv. Cast Iron	7.5	15
		v. Brass utensils	7.5	15
		vi. None	3	6.0
3	How often do you cook with traditional cookware?	i. Daily	19	38.0
		ii. Weekly	13	26.0
		iii. Occasionally	10	20.0
		iv. Rarely	8	16.0
4	What types of food do you commonly prepare in them?	i. Gravy dishes	10	20.0
		ii. Rice items	15	30.0
		iii. Water storage	14	28.0
		iv. Milk/tea	11	22.0
		v. Others (open-ended)	-	-
5	Who in your family mostly uses traditional cookware	i. Self	5	10.0
		ii. Parents	25	50.0
		iii. Elders	10	20.0
		iv. Others	10	20.0
6	What is your main reasons for using traditional cookware	i. Taste	16	32.0
		ii. Nutrition	15	30.0
		iii. Culture	12	24.0
		iv. Cost	4	8.0
		v. Environment	19	38.0
7	Do you believe food cooked in traditional cookware taste better	i. Yes	35	70.0
		ii. No	15	30.0
8	Are you aware of toxicity or leaching risks from copper cookware?	i. Yes	30	60.0
		ii. No		40.0
9	Do you know how to correctly maintain copper cookware (e.g., tin-coating/kalai)?	i. Yes	20	40.0
		ii. No	25	50.0
		iii. Not sure	5	10.0
10	What prevents you from using traditional cookware more frequently?	i. High cost	5	10.0
		ii. Difficult maintenance	10	20.0
		iii. Not easily available	5	10.0
		iv. Fragile / breaks easily	4.2	8.4
		v. Requires more cooking time	8.6	17.2
		vi. Lack of awareness	8.6	17.2
		vii. No barriers	8.6	17.2

11	What motivates you to use modern cookware instead?	i. Convenience	20	40.0
		ii. Durability	8.3	16.6
		iii. Time efficiency	8.6	17.2
		iv. Lightweight	9	18.0
		v. Safety	10	20.0
		vi. perception	5	10.0
		vii. Aesthetics	9.1	18.2

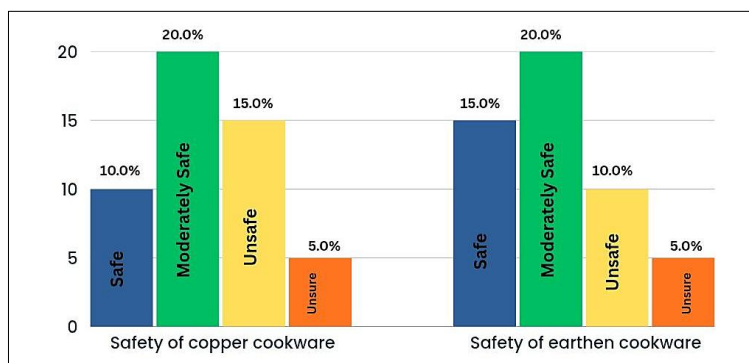


Fig 1: Health perception and cultural environmental views

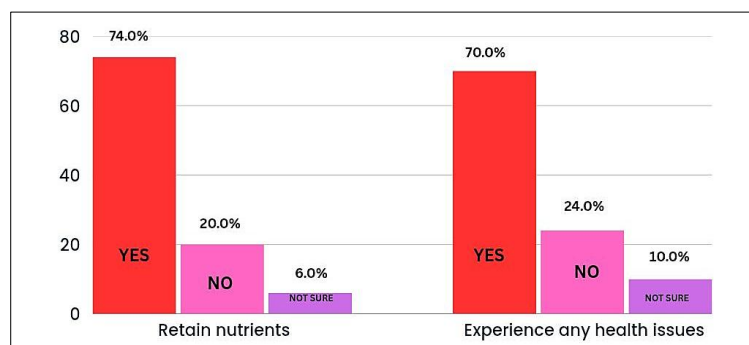


Fig 2: health perception and cultural environmental views

In the survey it is found that 30 per cent use copper pots, 44 per cent of people utilized earthen pots, with 38 per cent using them most frequently. Additionally, 30 per cent reported better nutrition and 70 per cent believed that traditional cookware benefited digestion. Only 60 per cent of respondents were aware of the dangers of metal leaching, despite these advantages. These results are consistent with those of Khan & Banerjee (2020) ^[16], who noted that “earthen utensil, almost preserve all the micronutrients

present in the food” (Khan & Banerjee), and Banavi *et al.* (2020) ^[15], who discovered that “the migration of the studied metals,” may lead to acute and chronic diseases” when using copper pots lined with tin. Therefore, even though this sample has high usage and favorable opinions of traditional cookware, the moderate awareness of safety issues suggests that specific education and design changes are needed to promote safe and sustainable use.

Table 3: Perceived Nutritional & Health Benefits (Likert Scale) (N = 50), (1 = Strongly Disagree, 5 = Strongly Agree)

Section	Statement	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Perceived nutritional and health benefits	i. Food cooked in traditional cookware tastes better.	20.0	40.0	15.0	20.0	5.0
	ii. Earthen pots enhance the nutritional value of food.	24.5	35.0	10.0	20.0	14.5
	iii. Copper utensils improve digestion or immunity	25.0	35.0	10.0	20.0	5.0
	iv. Using earthen pots balances the acidity of food.	20.0	25.0	19.0	20.0	16.0
	v. Traditional cookware contributes positively to overall health.	25.0	35.0	10.0	20.0	5.0
	vi. Copper utensils may leach metals if not properly maintained.	35.0	19.0	20.0	16.0	10.0
	vii. Earthenware may contain contaminants if poorly manufactured.	20.0	40.0	15.0	20.0	5.0

The findings of the survey conducted show that most participants strongly agreed or agreed that traditional cookware improves taste, enhances nutrition, and supports overall health. Many also believed that earthen pots balance acidity and that copper utensils may offer digestive benefits, though some responses were mixed for copper. At the same

time, participants showed awareness of risks, with several agreeing that copper can leach metals and earthenware may contain contaminants if poorly made. Only a small portion disagreed or strongly disagreed, indicating overall positive perceptions toward traditional cookware with some caution about safety.

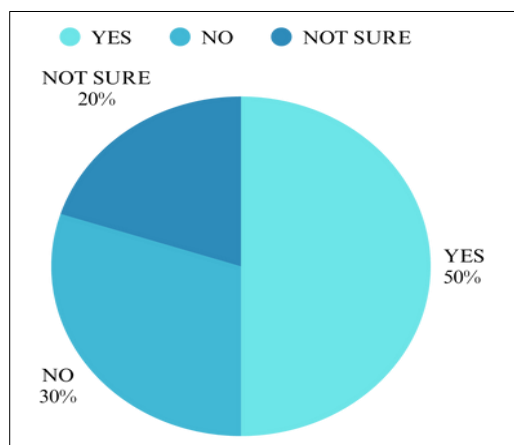


Fig 3: Are earthen pots environmentally friendly?

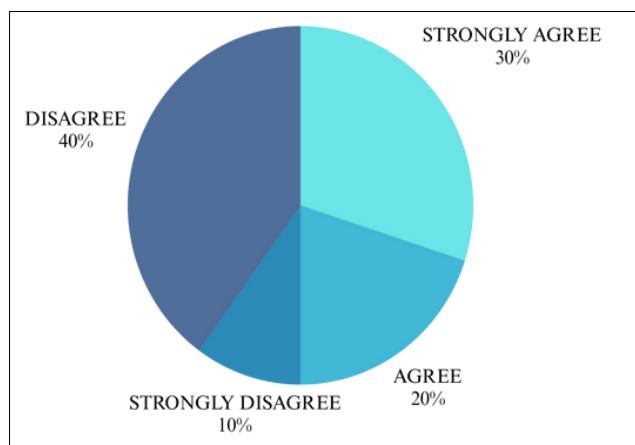


Fig 4: Does traditional cookware help preserve cultural heritage?

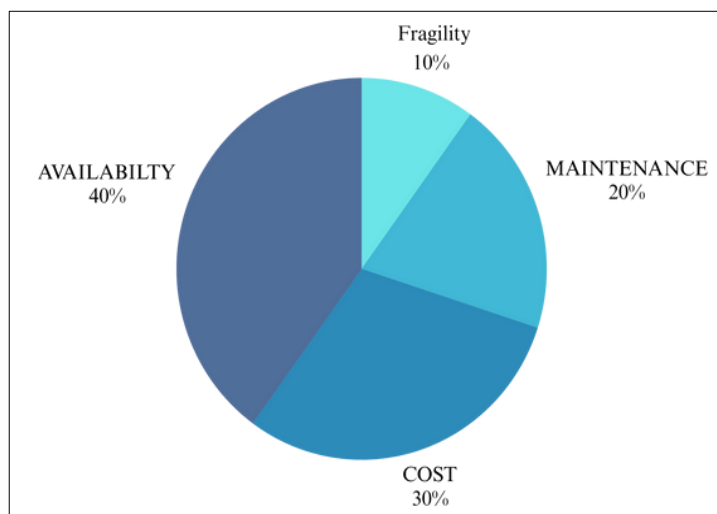


Fig 5: What is the main challenge in using traditional cookware?

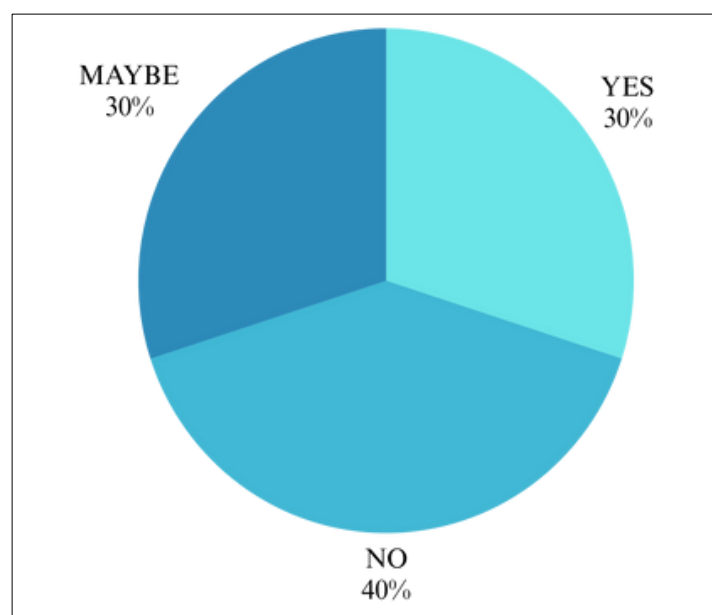


Fig 6: Would you pay more for eco-friendly cookware?

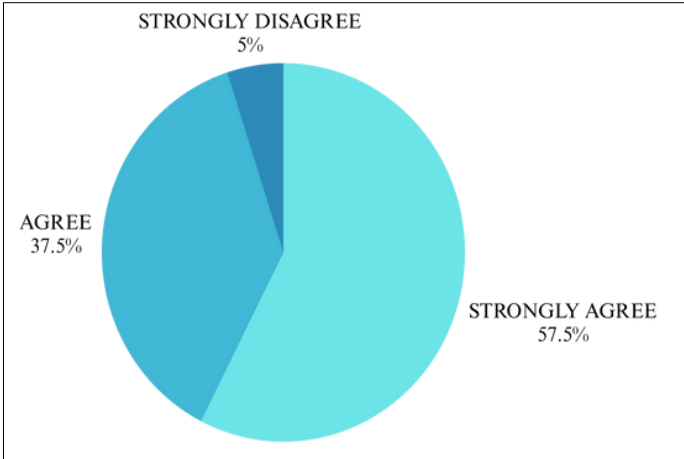


Fig 7: Can promoting traditional cookware reduce plastic usage?

Of those surveyed, (25%) thought earthen pots were eco-friendly, (15%) disagreed, and (10%) were unclear. Traditional cookware protects cultural history, according to about 25% of respondents. Cost (15%), availability (20%), and maintenance (10%) were the primary obstacles. While there was little willingness to pay more for eco-friendly cookware, most people felt that encouraging traditional cookware may cut down on plastic use. These results are in line with studies that demonstrate the safety, nutrient preservation, and environmental friendliness of clay cookware (Ibrahim, Said, and Badr, 2024), while metal cookware may leak dangerous substances.

Table 4: Environmental Awareness, Sustainability, and Cultural Perception (Likert Scale) (N = 50) (1 = Strongly Disagree, 5 = Strongly Agree)

Sl. No.	Section	Statement	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree(%)	Strongly Disagree (%)
1	Environmental Awareness & Sustainability Perception	i. I believe earthen cookware is environmentally friendly.	35.0	18.0	21.0	10.0	6.0
		ii. Copper cookware is recyclable and therefore more sustainable.	20.0	25.0	25.0	15.0	15.0
		iii. I prefer cookware that is biodegradable or reduces household waste.	38.0	15.0	20.0	10.0	17.0
		iv. I am willing to pay more for environmentally sustainable cookware.	20.0	30.0	10.0	25.0	15.0
		v. Use of traditional cookware reduces dependence on chemically coated modern utensils	28.5	28.5	20.0	15.0	8.0
2	Cultural & Heritage-Linked	i. I use traditional cookware because it connects me to cultural/ancestral practices	35.5	19.5	20.0	15.0	10.0
		ii. Traditional utensils are an important part of preserving culinary heritage.	25.5	31.5	25.0	10.0	8.0
		iii. Elders in my family influence my cookware choices.	20.0	30.0	20.0	15.0	15.0
		iv. I would like to pass these traditional practices to future generations.	30.0	20.5	20.5	20.0	9.0

The results indicate strong environmental awareness among respondents, with the highest agreement (35%) for statements supporting eco-friendly and waste-reducing cookware. Many participants also agreed that traditional utensils reduce dependence on chemically coated modern alternatives. Only a smaller share showed disagreement, suggesting overall positive sustainability perceptions. Culturally, responses were similarly positive. A large portion (35.5%) strongly agreed that traditional cookware connects them to heritage and should be passed to future generations. Moderate agreement (31.5%) further supports cultural value, while disagreement levels remained low, indicating that traditional cookware is widely viewed as both culturally significant and environmentally beneficial.

Conclusion
The study reveals that copper and earthenware cookware are widely preferred due to taste, cultural significance, and perceived health benefits. The survey of 50 respondents highlights that the use of traditional cookware, particularly earthenware and copper pots, continues to hold nutritional, health, and environmental relevance in contemporary households. Findings indicate that awareness of the benefits of these traditional vessels is moderately high among participants, with a greater preference for earthenware due to its affordability, accessibility, and ability to enhance the natural flavor and quality of food. Copper pots, while recognized for their antimicrobial and digestive benefits, were less frequently used because of maintenance requirements and concerns regarding metal leaching. Participants associated earthenware with natural mineral

enrichment, balanced pH, and eco-friendliness, whereas copper cookware was appreciated for promoting better digestion, immunity, and cooking efficiency due to its excellent heat conductivity. Both types of vessels were acknowledged as sustainable options compared to modern non-stick or aluminum cookware, as they are biodegradable, energy-efficient, and long-lasting. The study also found that users valued the cultural and aesthetic appeal of traditional cookware, seeing it as a means of preserving culinary heritage while supporting environmentally responsible practices. However, a portion of respondents expressed the need for greater awareness about safe usage, particularly regarding copper maintenance and lining. Overall, the findings suggest that while traditional cookware like earthenware and copper pots is gradually being replaced by modern alternatives, it retains strong cultural significance and offers tangible nutritional and environmental benefits. Users demonstrated a growing appreciation for these vessels as sustainable, health-supportive, and heritage-based choices suitable for modern kitchens.

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