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**Original Article**

Use Patterns and Behavioral Determinants of Synthetic Food Colorant Use in Urban Pakistani Households: A Qualitative Study

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ABSTRACT

South Asian families have been using synthetic food coloring in their daily and festive meals to make them visually appealing, despite its documented link with allergic, gastrointestinal, and neurobehavioral outcomes. There is limited qualitative literature available in Pakistan about the drivers of the practice at the household level. **Objectives:** To investigate the reported use practices and perceived factors influencing the consumption of synthetic food colorants among urban, peri-urban, and rural-adjacent Pakistani households. **Methods:** The study employed a qualitative exploratory-descriptive design, and 30 home cooks were purposively sampled from urban (city centers with population density >1,000 persons/km²), peri-urban (areas at the urban periphery with mixed land use), and rural-adjacent (villages within 10 km of urban centers) areas of Lahore, Karachi, and Islamabad. Semi-structured interviews and field notes were taken and analyzed using Braun and Clarke's reflexive thematic analysis. **Results:** Four themes were found i.e. (1) the Aesthetic Imperative, where vivid color is associated with food quality and social acceptability, (2) the Intuitive measure, a natural, unmeasured, intergenerationally transmitted dosing practice; (3) the Natural Barrier, involving cost, time, and sensory barriers of natural alternatives; and (4) Cognitive Dissonance and Risk Minimization, a simultaneous awareness and rationalized dismissal of health risks. **Conclusions:** Continued reliance on synthetic food dyes in households is not a lack of knowledge in urban Pakistan, but it is a culturally embedded and socially reinforced practice, and needs context-sensitive nutrition education, cost-friendly natural alternatives, and intensive regulatory enforcement.

INTRODUCTION

The primary sense that is used to evaluate food is its color; this determines what one expects the food to taste like, whether it is fresh or of good quality before trying it. Colors that fall outside the culturally learned preferences are seen as less desirable or spoiled, whereas warm colors like red, orange, and yellow consistently make palatability judgements and appetites rise [1]. Consequently, the use of synthetic colorants has become essential to food industries and home kitchens because of their bright color, stability, and low cost when compared to natural colors [2]. The safety of synthetic colorants is still disputed, however.

In a 2024 update on European Food Safety Authority (EFSA) and Joint FAO/WHO (JEC) evaluations, most azo and non-azo dyes were found to be within acceptable daily intake levels for typical intake, though several were identified as being over 10 years old and needing to be reassessed [3]. Experimental studies have reinforced these concerns: chronic exposure of mice to Allura Red AC has been found to increase susceptibility to intestinal inflammation via serotonergic pathways; and biomonitoring in the United States has revealed that children, pregnant women, and women of childbearing age are at a high risk of exposure to



several FD&C dyes approaching or surpassing benchmark levels [4, 5]. The behavioral literature is also very busy with a foundational meta-analysis associating synthetic colorants with measurable increases in hyperactivity among children [6] and more recent reviews associating artificial dyes with attention and behavioral problems in children with and without diagnosed neurodevelopmental disorders [7-9]. In Pakistan, these global issues dovetail with a lax regulatory framework. Branded and non-branded food items were found to contain synthetic dyes in considerable proportion in schools, near schools, and other educational institutions in the vicinity of Karachi [10], and the presence of illegal dyes containing Sudan dyes (some at concentrations in thousands of times the permissible limits) was confirmed in food items sold in all food markets across Karachi by chromatographic analysis [11]. In India, similar regional data indicates that, although there are regulations, consumer awareness of the harmful effects of artificial colorants on health is still inconsistent, and household-based studies in Indonesia have revealed that even mothers with good knowledge of toxic metals in artificial food colorants continue to use non-food grade colorants in their own cooking, demonstrating that knowledge alone is not enough [12, 13]. Natural dyes like turmeric are still relatively underutilized due to limited color output, instability, and price relative to synthetic dyes, and are underutilized in consumer studies conducted in the South Asian region as well [14, 15]. It is important to note that this study assessed self-reported use practices rather than quantified dietary exposure; laboratory quantification or validated dietary exposure assessment would be required to estimate actual exposure levels.

Even though there is considerable toxicological and cross-sectional evidence of the use of synthetic colorants in the household of the urban Pakistanis, there is almost no qualitative evidence that could explain why despite all this awareness of the risks, the use of synthetic colorants persists in the households of urban Pakistanis, or how the cultural norms, intergenerational cooking practices, and economic constraints combine to maintain the practice at the level of everyday decisions making. This gap is significant as dietary exposure assessments relying only on laboratory analyses or quantitative surveys do not reflect the real-life rationale, social pressures, and dose exposures associated with the household level. Therefore, this study aims to qualitatively explore self-reported use patterns and behavioral determinants of synthetic food colorants among urban Pakistani households to understand the sociocultural reasons for colorant use, patterns of reported colorant use by households, and how households balance colorant use with health awareness.

METHODS

This qualitative exploratory-descriptive study was conducted from November 2025 to March 2026 at the Department of Human Nutrition and Dietetics, University of Management and Technology, and included home cooks in urban, peri-urban, and rural-adjacent areas of Lahore, Karachi, and Islamabad, Pakistan in a qualitative exploratory-descriptive approach as part of a broader study on the exposure of synthetic food colorants to households. Participants were purposively identified through the research team's personal and community contacts in selected urban and peri-urban neighborhoods of Lahore, Islamabad, and Karachi, with initial informants approached in person, at their homes, by trained female research assistants; the sample was subsequently expanded through snowball referrals from these participants to reach hard-to-reach joint-family households. The professional caterers/commercial food handlers and the respondents who failed to cook food at their home were excluded. Likewise, respondents who were not able to communicate in Urdu or English were excluded. A purposive sampling method was employed with the addition of snowball sampling to access the hard-to-reach joint family households i.e. extended or joint-family households that are difficult to access or recruit for research because of factors such as remote location, limited accessibility, social or cultural barriers, lack of formal registration, or reluctance to participate, to ensure a maximally diverse sample of informants that ranged in age, education, monthly income, family structure and place of residence. Data collection was continued until thematic saturation, which was assessed iteratively throughout the data collection process. Saturation was deemed achieved when three consecutive interviews yielded no new codes or sub-themes during the ongoing analysis [16]. This was reached at interview 27, with the final three interviews (n=3) confirming that no additional themes emerged. Thus, a total sample of 30 participants was completed to ensure saturation was robustly demonstrated. In-depth semi-structured interviews were conducted in Urdu, on an audio tape with consent, and where possible, observation notes were taken during the visits to the kitchen. The interview guide addressed issues of perception of food color, sources and amounts of colorant used, knowledge about health risks, and perceived barriers to using natural alternatives. Interviews were transcribed exactly as they were heard, translated by the research team into English, and analyzed following the six phases of reflexive thematic analysis [17], including familiarization with data, inductive line-by-line coding, theme development, and review

against the whole coded dataset. A sub-sample of transcripts (n=8, 27%) was coded independently by two researchers to increase analytic rigor. The coding process followed an inductive line-by-line approach, where initial codes were generated from the data without pre-existing coding frameworks.

The research team maintained reflexive journals throughout the analysis to document personal assumptions, positionality, and potential biases. Regular team meetings were held to discuss coding decisions and emerging interpretations. Discrepancies between coders were clarified and resolved through discussion and consensus, with any unresolved disagreements referred to a third researcher for adjudication. Themes were developed iteratively, with candidate themes reviewed against the entire coded dataset and refined through team discussion to ensure they accurately represented participant experiences.

RESULTS

A total of 30 participants were interviewed, and most of them are female (26/30) who were mostly housewives, teachers, private and government sector workers, a driver, a shopkeeper, and a tailor. Their ages were between 24 and 65 years, and their experience in cooking was from 2-52 years. Household composition was similarly nearly equally balanced between nuclear and joint families, as the monthly income of the household ranged from PKR 10,000 to PKR 100,000, showing a wide socioeconomic gap between the urban, peri-urban, and rural adjacent areas. The study shows the full sociodemographic characteristics (Table 1).

Table 1: Sociodemographic Characteristics of Study Participants (n=30)

Characteristics	Category	n (%)
Gender	Female	26 (86.7%)
	Male	4 (13.3%)
Age (years)	24-40	16 (53.3%)
	41-65	14 (46.7%)
Education	Illiterate	5 (16.7%)
	Primary	5 (16.7%)
	Secondary	5 (16.7%)
	Intermediate	5 (16.7%)
	Graduate	7 (23.3%)
	Postgraduate	3 (10.0%)
Occupation	Housewife	21 (70.0%)
	Teacher	2 (6.7%)
	Private Job	2 (6.7%)
	Government Job	1 (3.3%)
	Businessman	1 (3.3%)
	Driver	1 (3.3%)

Monthly Income	Shopkeeper	1 (3.3%)
	Tailor	1 (3.3%)
	10,000-35,000	10 (33.3%)
	36,000-60,000	12 (40.0%)
Family Type	61,000-100,000	8 (26.7%)
	Nuclear	14 (46.7%)
Cooking Experience	Joint	16 (53.3%)
	2-10 years	9 (30.0%)
	11-25 years	11 (36.7%)
Residential Area	26-52 years	10 (33.3%)
	Urban	15 (50.0%)
	Peri-urban	9 (30.0%)
City	Rural adjacent	6 (20.0%)
	Lahore	11 (36.7%)
	Karachi	10 (33.3%)
	Islamabad	9 (30.0%)

Thematic analysis of interview transcripts and observational field notes resulted in four major themes that help to elucidate the behavioral, cultural, and perceptual aspects of synthetic food color use within urban Pakistani households: (1) The Aesthetic Imperative, (2) The Intuitive Measure, (3) The Natural Barrier, and (4) Cognitive Dissonance and Risk Minimization.

Theme 1: The Aesthetic Imperative. In particular, participants had a strong conviction that the sense of attractiveness is closely linked with perceived quality, authenticity, and acceptability of food, including its color. To many home cooks, "right" simply meant the color of the dish itself rather than something to decorate it with. If biryani doesn't have red color, it just doesn't feel like biryani. A family member of a 45-year-old homemaker in Lahore says, "What is this food? It has no color." If a guest comes, then the fear is that the color is less. When people visit, I feel shamed if the color is not as dark.) If there is no color, a young mother (Karachi) says, 'it's made well,' and guests look and say, 'it's made well', but do not eat enthusiastically. This aesthetic drive came into prominence with festival and celebratory cuisine, where color was interpreted as the expression of the cook's sincerity and benevolence. Interestingly, this expectation did not wane in the course of education; a graduate participant described how although he was aware that colorants were chemical additives, he continued to be told by his in-laws and his family that he must use them.

Theme 2: The Intuitive Measure. In the interviews, participants explained how they measured the amount of colorant not with a measurement but through an "andaza," or an intuitive estimation that is passed down from generation to generation and gained from experience. This practice was considered and accepted as evidence of culinary skill, not as a risk factor. I take it with my fingers

and add it. It's just experience. No matter how much biryani, it's that much color. About 2–3 pinches, for 4 kg of biryani. — (60-year-old grandmother, Islamabad) No participants reported ever weighing or measuring the colorant, and the concept of a "correct" dose was based on visual outcomes and not on safety advice. Errors in estimating were explained in a rather non-medical way, where one person stated that he would reduce the color of biryani by adding yogurt to it in place of clarifying how much yogurt was added.

Theme 3: Natural Barrier. Participants reported both practical and economic limitations, as well as limitations in perception, to using natural alternatives to turmeric like beetroot, turmeric, saffron, and spinach in their daily cooking. The sachet one, that is, is cheap...it costs 10 rupees. Beetroot is sold at the rate of 100–120 per kg. Beetroot does not get that shiny red color as the sachet one does. Natural solutions were also thought to affect the flavor and yield boring, less interesting colors that do not match the rest of the family or guests' preferences, which will further ensure the use of cheaper, more predictable synthetic sachets.

Theme 4: Cognitive Dissonance and Risk Minimization. One pattern in all the interviews was the ability of participants to identify potential health hazards and, at the same time, actively deny the concerns while minimizing them cognitively so that the use could proceed with minimal guilt. I've heard that they're poisonous, but it's okay if one does, right? Our grandmother has been eating it all her life; nothing happened — 35-year-old homemaker. I know it isn't good for me, but I can't stop myself. My family won't be happy if I do not add some color. Participants were not likely to obtain information on safe use from formal sources like healthcare providers or regulatory agencies, with most saying they learned from family, neighbors, or shopkeepers—a tension that demonstrates that social pressure very often took precedence over health awareness.

Together, these four themes illustrate the complex and multidimensional nature of food colorant use practices in urban, peri-urban, and rural-adjacent Pakistani households and the reported factors influencing these practices beyond ignorance, including aesthetic expectations, estimation-based dosing, barriers to natural alternatives, and cognitive strategies for balancing awareness with continued use.

DISCUSSION

The study is qualitative and provides a detailed description of the sociocultural and cognitive processes that perpetuate the reported use practices of synthetic food colorants in urban, peri-urban, and rural-adjacent Pakistani households, complementing a literature that has hitherto largely been based on laboratory analyses and quantitative surveys. The Aesthetic Imperative theme is closely related to sensory science, which has shown that color is a key component in the perceived flavors, quality, and appetite [1, 15]. What the current data contributes to this literature is the specific social meaning of this expectation in Pakistan, which was not always a personal preference of color, but rather a way to indicate hospitality, effort, and food competence that was judged by guests and in-laws, and that is not often found in laboratory-based sensory research. The theme of the intuitive measure has been found to align with, and meaningfully build on, previous Knowledge-Attitude-Practice studies in Indonesia which indicated that despite mothers' positive knowledge about the dyes' related aspects, they persisted in using non-food grade dyes in their daily cooking, and that this positive knowledge did not always reliably lead to safer practice [14]. One practical way in which this knowledge gap to practice was demonstrated was in our participants' use of finger-pinch estimation instead of any dosing device, meaning that supplying safety messages at the level of "use less colorant" would not likely lead to a measurable change in behavior unless such messages addressed the lack of any dosing infrastructure within the home kitchen. This finding is also of direct application for understanding self-reported practices, as intuition-based dosing suggests significant intra-household and inter-occasion variability in reported use of colorants, which might be substantially underestimated by standardized models of exposure. The current participants' first cost comparison, between a ten-rupee natural colorant (synthetic sachet) and a kilogram of beetroot, confirmed industry-level observations that natural colorants may be structurally disadvantaged in terms of the amount of raw material required to produce equivalent visual intensity, a factor of importance in household economics where prices are a key constraint. This is compounded by Pakistan's documented adulteration problem, whereby even the choice of "natural-looking" red spice in the home is not necessarily safe, as even the informal sector is using spice dyes that are banned and are known to cause cancer at levels well above those permitted [11]. Combined, these results indicate that the natural-colorant barrier in Pakistan is not limited to consumer preference only, but it's also due to weak upstream quality assurance. The empirical examples offered in this theme of Cognitive Dissonance and Risk Minimization demonstrate culturally

oriented examples of dissonance-reduction strategies described in the food-risk literature, where consumers who know about a hazard rationalize their continued consumption by citing familiarity, tradition, or the perception of no visible harm [18]. Grandmothers who "eat it their whole life" served as a historical-safety heuristic, similar to the historical safety heuristic found in experimental food-risk studies that found familiarity with a food reduced the perceived risk even when objective risk information was unavailable [18]. This pattern is also consistent with the wider behavioral research finding that the expectation that others will be displeased with the behavior (here, family members would be upset by the pale food) can override the individual's own perceived risks, and thus influence the actual behavior [19, 20]. Most of our participants depended on family, neighbors, or shopkeepers as their formal information sources, and this parallels the Indian literature on public awareness of the toxic metal content of artificial colorings, which reports that information from these sources is inconsistent with the regulatory standards [12, 13]. Combined, these results build on the existing toxicological and cross-sectional literature by providing insight into the fact that aesthetic norms, lack of measurement of intergenerational technique, lack of natural alternatives, and social reinforcement of rationalization play a role in sustaining continued reliance on synthetic colorants at the household level. This finding is consistent with the Indonesian literature suggesting that knowledge and practice may be only weakly correlated [14], though this qualitative study cannot establish population-level relationships. The consequences of this are obvious for understanding self-reported use practices and informing public health messaging: any public health messages on health risks of colorants without attention to the visual, economic, and social contexts that enable or reinforce their use will be ineffective in changing household use.

The results of this study are limited in their qualitative design and purposive sample that may be analytically rich without being representative of the larger population of Pakistan, and also limited by the fact that they rely on self-reported dosing practices, instead of actual laboratory measurement of the colorant intake. It is recommended that future research integrate this qualitative description with dietary exposure assessment and laboratory quantification of the amount of colorant found in traditional dishes, investigate the acceptability and cost-effectiveness of alternative natural colorants for traditional South Asian recipes, and assess culturally adapted nutrition education interventions that target social and aesthetic factors that influence the use of colorants, instead of health knowledge.

CONCLUSIONS

The use of synthetic food colorants among the 30 purposively selected households from urban, peri-urban, and rural-adjacent areas in this study appears to be influenced by factors beyond health knowledge alone; however, this qualitative exploratory study cannot establish that knowledge is not an important determinant in the broader population but is also due to a variety of aesthetic expectations, simple dosing recommendations and socially upheld rationalization of risk. Interventions to stop this behavior should be culturally appropriate, with more affordable and practical alternatives to the use of colorants which are safe and visually acceptable, as well as greater regulatory controls over the sale and labeling of colorants. For sustainable change, it will be key to make food safety messages resonate with the social and sensory perceptions of everyday household cooking.

Author's Contribution

Conceptualization: IF

Methodology: IF

Formal analysis: IF

Writing and Drafting: IF

Review and Editing: IF

The author approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

The author declare no conflict of interest.

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