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Understanding Bread Consumption and Waste Patterns in Algeria and Tunisia: Insights into Consumer Practices and Challenges

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ABSTRACT

Background: Bread consumption and the corresponding issue of food waste represent critical aspects of food security in the North African region, where bread remains a fundamental dietary staple.

Aims: This study was designed to systematically examine bread purchasing habits, consumption patterns, and associated wastage behaviors among populations in Algeria and Tunisia, with the ultimate objective of identifying key determinants and potential areas for targeted intervention strategies.

Methods: A cross-sectional study was conducted employing an online survey administered between September and December 2023. The study population comprised 636 respondents: 316 Algerian participants (62.8% female, 64.9% aged 25–60 years, 76% with university education) and 320 Tunisian participants (76.3% female, 76.2% aged 25–60 years, 90% with university education).

Results: Survey results indicated that municipal bakeries were the predominant source of bread for Algerian respondents (40.3%), while Tunisian respondents primarily favored modern bakeries (54.5%). Bread purchasing frequency was higher in Tunisia, with 51.3% purchasing bread daily, compared to 33.8% in Algeria. Both cohorts predominantly purchased 5–6 loaves per day, a quantity significantly influenced by household size and demographic characteristics ($p < 0.05$). Moreover, cleanliness and hygiene emerged as the most critical purchasing criteria for both Algerian (86.4%) and Tunisian (84%) respondents. Other significant priorities included taste and flavor, valued by 77.3% of Algerians and 75% of Tunisians, and bread freshness, prioritized particularly among Algerians (59.7%). Tunisian consumers, however, prioritized raw material quality (62.2%) over factors such as proximity and product diversity. Consumption patterns revealed a significant reliance on French-style baguettes (67.5% in Algeria, 60.3% in Tunisia) and highlighted cultural differences in meal consumption. Lunch was the primary occasion for bread consumption in both Algeria (62%) and in Tunisia (57.1%). Interestingly, bread wastage, while limited, was attributed to sensory deficiencies, including staleness, suboptimal taste, and poor texture. Inaccurate quantity estimation and subsidized bread prices were identified as leading causes of waste in both countries. Despite the majority of respondents reporting the storage of leftover bread, occasional discarding remained prevalent, with 6.5% of Algerian respondents and 5.8% of Tunisian respondents consistently discarding stored bread. Significant associations were identified between demographic factors and bread wastage behaviors in both countries ($p < 0.05$).

Conclusions: This study underscores the importance of enhancing bread quality, augmenting consumer awareness regarding optimal purchasing and storage practices, and aligning subsidy mechanisms with sustainable consumption practices to effectively reduce bread waste, thus contributing to national food security objectives.

Keywords: Sustainable Development Goal SDG-12.3; Bread; Consumer Behavior; Purchasing Pattern; Food Waste Reduction.

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1 INTRODUCTION

Household food waste has emerged as a prominent research focus in recent years, driven by studies highlighting its substantial contribution to overall food waste and the consequent potential for waste reduction (FAO, 2025; OECD, 2025). The discarding of edible food occurs against a backdrop of global hunger, affecting 783 million

individuals, and food insecurity, threatening one-third of the world's population (UNEP, 2024). Ensuring food security constitutes thus a paramount challenge in numerous developing regions, where the increasing population and rising affluence are exerting unprecedented pressure on food production systems (FAO, 2025; OECD, 2025). Furthermore, the wastage of foodstuffs represents a misapplication of the resources invested in their production,

including land, water, energy, and inputs. The food loss and waste account for 8-10% of global greenhouse gas (GHG) emissions, in addition to the loss of inherent economic value of the produced foodstuffs (UNEP, 2024).

Given the critical importance of reducing food waste to achieve global food security and to contribute to climate change mitigation, waste management has emerged as a pivotal concern for maximizing sustainable development and economic viability, particularly in low- and middle-income nations (FAO, 2025). Globally, approximately 19% of the edible portions of food intended for human consumption are lost or wasted within the retail, foodservice, and household sectors, equating to an estimated 1.05 billion tonnes annually. A further 13% of the world's food is lost within the food supply chain, from post-harvest stages to pre-retail environment (FAO, 2025). In fact, households are the primary source of global food waste, accounting for 631 million tonnes (60%) of the total wasted in 2022, while the catering sector generated 290 million tonnes and the retail sector 131 million tonnes (UNEP, 2024). In fact, households waste at least one billion meals daily, with an average per capita waste of 79 kg of food per year (UNEP, 2024). Households in the Middle East and North Africa (MENA) region exhibit a higher per capita food waste rate of approximately 91 kg per year, compared to European Union (EU) households, which generate 72 kg per person, accounting for 54% of the total waste (Eurostat, 2024; UNEP, 2024). The most frequently wasted food items are mostly those that characterized by high consumption and low economic value, such as bread (Allipour-Birgani *et al.*, 2023). In response to this global challenge, the United Nations has established Sustainable Development Goal (SDG) 12.3, aiming for a 50% reduction of per capita food waste at the consumer level by 2030, with a focus on both private households and the food service sector.

Bread holds the position of the most consumed staple food worldwide, underlining its fundamental importance in human nutrition. Global bread production was estimated at 265 million metric tons in 2022, with a projected average annual market growth rate (CAGR 2025-2030) of 6.25% (Statista, 2025). A diverse range of bread varieties, types and flavors exists worldwide. Bread consumption patterns vary across the different continents, with particularly high levels observed in Europe and the MENA region, exceeding 100 kg per person annually. The consumption of bread and its various forms is influenced by a range of factors, including age, education, income, gender, dietary practices, and the presence of underlying health conditions (Demirtaş *et al.*, 2018). Regrettably, bread consistently ranks among the highest food waste on a global scale, exhibiting significant susceptibility to staling and spoilage due to its nutritional composition (Ben Rejeb *et al.*, 2022). A meta-analysis of

observational studies by Allipour-Birgani *et al.* (2023) estimated the pooled proportion of wheat bread waste to be 18% (95% CI: 14–24; $I^2 = 99.94\%$). In North Africa, bread waste has been identified as a significant contributor to the overall food waste in Morocco (Abouabdillah *et al.*, 2015; Capone *et al.*, 2016), in Algeria (Arous *et al.*, 2017; Capone *et al.*, 2016), and Tunisia (Capone *et al.*, 2016; Sassi *et al.*, 2016; Jribi *et al.*, 2020). Notably, Jribi *et al.* (2021) reported that 32% of Tunisian survey respondents admitted to discarding a significant quantity of bread. To effectively design and implement regulations and intervention programs aimed at food waste prevention, a comprehensive understanding of the underlying causes of high household bread waste is essential. In North African countries, bread production is often supported by government subsidy systems (Bouchafaa, 2018; Capone *et al.*, 2016), while in Tunisia only approximately 20% of bread is produced from locally sourced wheat (Thabet *et al.*, 2024). The significant reliance on wheat imports in North African nations renders their bread production particularly vulnerable to a multitude of factors, including climate change, environmental conditions, economic fluctuations, socio-political dynamics, and geopolitical events. The ongoing geopolitical instability resulting from the conflict in Ukraine has disrupted global wheat supply chains, leading to price volatility and spikes in the international market. In this context, while subsidies aim to combat food insecurity, bread wastage paradoxically undermines this objective. The waste of subsidized bread diminishes the availability of resources for ensuring food security for those in genuine need and diverts resources from other essential sectors such as healthcare, education, and infrastructure. Low subsidized prices can inadvertently incentivize overconsumption and subsequent waste (Khader *et al.*, 2019; Obeidat *et al.*, 2015), although Bouchafaa (2018) argues that this is not the sole determinant of bread wastage. Existing literature on food waste has highlighted various behavioral, sociodemographic and attitudinal factors, influencing household food disposal practices (Ananda *et al.*, 2021; Boulet *et al.*, 2021; Jribi *et al.*, 2020; Jribi *et al.*, 2021; Mattar *et al.*, 2018; Moroşan *et al.*, 2024; van der Werf *et al.*, 2019; van Geffen *et al.*, 2020). However, research specifically examining the drivers of consumer behavior and sociodemographic characteristics in relation to bread waste remains limited (Ananda *et al.*, 2024; Svanes *et al.*, 2018), with studies focused on the North African context being particularly under-represented (El Bilali, 2018). While household and retail waste are significant contributors in both high-income countries and North Africa, the unique context of government subsidies, cultural (e.g., gatherings) and religious (e.g., Ramadan) practices, economic vulnerabilities, and climate-related challenges renders food wastage in North Africa a distinct issue, necessitating further research on

household bread waste in this specific region (Capone et al., 2016).

Bread occupies a distinctive and central position within North African consumer diets, representing the most widely consumed food. North African countries offer a rich variety of traditional and modern breads, including *tabouna*, *mlawi*, *kesra*, baguette, *wholemeal* bread, and *khobz eddar*, each playing a vital role in the region's culinary heritage and culture. In North Africa, bread is typically sold in either municipal or modern bakeries. Municipal bakeries primarily offer subsidized, basic bread (often a French-style baguette or a similar staple), whereas modern bakeries offer a variety of products including traditional subsidized bread alongside artisan breads, pastries, and other baked goods such as croissants, baguettes, cakes, and sweets (Capone et al., 2016). Their products are typically priced higher. These products often operate with more advanced equipment and offering a more comfortable shopping environment. French-style baguettes are the predominant bread type consumed in Algeria (Bouchafaa, 2018), with an estimated daily consumption of 48.6 million units representing a very high per capita intake (Fedala et al., 2015). In Tunisia, the average family consumes approximately 42 kg of bread annually, with a per capita consumption of 74 kg per year (INC, 2025). Morocco also exhibits high bread consumption, reaching 350 kg per inhabitant per year in 2020 (Elbiyad et al., 2024). This level of consumption reflects the cultural and everyday significance of bread in North Africa. Meanwhile, North African countries are directly affected by the issue of bread wastage. According to the Algerian Ministry of Internal Trade and National Market Regulation (2018), approximately 10 million baguettes are wasted daily, amounting to an estimated annual loss of \$340 million. Moreover, official data indicates that an average of 2.7 million breads remain unconsumed on a daily basis, further emphasizing the extent of wastage. Similarly, in Tunisia, the INC (2025) estimates annual bread waste at around 113,000 tonnes, representing approximately 16% of household bread expenditure and 5% of total household food expenditure. Morocco also experiences significant wastage, with 30 million units wasted daily, accounting for 25% of the daily production in 2020 (Elbiyad et al., 2024). Consequently, reducing bread waste is an urgent imperative to ensure food security and to build more sustainable food systems. In this context, it is worth understanding the complex interplay of sociodemographic and behavioral factors for developing effective strategies to reduce bread waste and mitigate its far-reaching environmental, social and economic consequences.

The objective of this study was to examine the bread consumption habits and its wastage in North African households, with a particular focus on Algeria and Tunisia. The study aimed to: (1) identify the behaviors, attitudes and preferences associated with bread consumption; and (2)

ascertain the levels and determinants of bread waste generated at the household level. To achieve these aims, the sociodemographic characteristics of participants and their purchasing and consumption practices with regard to bread were investigated. Finally, the extent and reasons of waste were analyzed, and a series of recommendations for its reduction were proposed.

2 SUBJECTS AND METHODS

The present research employed an exploratory survey methodology conducted in Algeria and Tunisia, utilizing a structured questionnaire. This instrument was adapted for the North African context based on previous studies performed in the MENA region (Capone et al., 2016; Demirtaş et al., 2018; Jribi et al., 2020; Jribi et al., 2021).

The data collection instrument employed for the survey on bread consumption and waste was a self-administered online questionnaire. Developed using Google Forms and formulated in French, the prevalent academic language in both Algeria and Tunisia, the questionnaire comprised 32 items, organized into three distinct sections. The initial section addressed bread purchasing practices and consumption patterns. The second section concerned the extent and behaviors towards bread wastage. The final section addressed information regarding participants' gender, age, educational attainment, occupation, and household size. Either 3-point or 5-point Likert scales were used to measure respondents' attitudes, opinions, or level of impact or agreement with a statement.

Data collection occurred between September and December 2023, using a convenience sample. The questionnaire was disseminated online through various institutional communication channels, including official websites, email correspondence, and social media platforms, such as Facebook/META. High internet penetration rate (72.9% in Algeria and 79.6% in Tunisia in 2024) justified this mode of dissemination (Data Reportal, 2025a, Data Reportal 2025b).

A total of 636 completed questionnaires were received: 316 from Algerian respondents, and 320 from Tunisia (Table 1). Participation in the survey was voluntary, and all responses were anonymized to ensure confidentiality. Valid questionnaires were selected if they were fully completed and submitted by participants, as reflected a response rate of respectively 4.5 % for the Tunisian panel and 4.9% for the Algerian panel.

Data analysis was performed using descriptive statistics (percentages) and Chi-square tests, conducted with SPSS version 25 software and Microsoft Excel. The analytical objective was to ascertain the strength of the associations between the variables in question and the demographic

characteristics of the respondents. Statistical significance was determined using a threshold of $p < 0.05$.

3 RESULTS

3.1 Characteristics of the Study Participants

Table 1 presents the general sociodemographic characteristics of Algerian and Tunisian survey respondents.

Table 1. Sociodemographic Characteristics of Algerian and Tunisian Survey Respondents (N=636)

	Algeria (n=316)	Tunisia (n=320)
Category	Respondents (%)	
Gender		
Women	62.8	76.3
Men	37.2	23.7
Age (years old)		
18 – 24	22.1	14.7
24 – 40	44.9	53.8
41 – 60	25.4	22.4
≥ 61	7.6	9.1
Marital status		
Single	52	52
Married	48	48
Education		
Primary/High schools	4.3	1.9
Professional training	12.9	7.7
University	82.8	90.4
Number of persons in the household		
1	7.3	12.8
2	11.6	17.9
3	16.5	23.1
4	21.8	23.7
5	22.4	15.4
≥ 6	20.4	7.1

As indicated in Table 1, both respondent groups were predominantly composed of women, with a slightly higher percentage in the Tunisian sample (62.8% of Algerian and 76.3% of Tunisian respondents). The majority of respondents in both countries were aged between 25 and 60 years (64.9% of Algerian and 76.2% of Tunisian) representing a broad working-age demographic. Both samples were largely composed of highly educated individuals, with a greater proportion of university graduates in the Tunisian group (76% of Algerian and 90.4% of Tunisian); 52% of the total sample identified as single. However, differences in household size and employment status between the two groups were observed. Algerian respondents (63%) predominantly resided in larger households comprising five or more members, while Tunisian respondents were more likely to belong to smaller households with fewer than five members (77.5%). Furthermore, a difference in professional activity was evident, with a higher percentage of Tunisian respondents (66.7%)

being employed compared to their Algerian counterparts (32.5%). Consequently, these variations in sample composition may exert an influence on survey responses related to economic or consumption patterns.

The present study employed a convenience sampling method, with participants selected on a voluntary basis, which inherently limits the generalizability of findings; consequently, the sample cannot be considered fully representative of the entire adult population in Algeria and in Tunisia due to its non-probabilistic nature. Nevertheless, the sample demonstrates representativeness within the specific demographic groups studied (Jribi *et al.*, 2020) and exhibits profiles in terms of gender, education, and professional activity that are largely consistent with similar studies conducted in Tunisia (Jribi *et al.*, 2020; Sassi *et al.*, 2016) and Algeria (Arous *et al.*, 2017); furthermore, to mitigate the limitations of non-random sampling and enhance representativeness, survey weights were applied in all Chi-square analyses (Neff *et al.*, 2015).

3.2 Bread Purchasing Habits of Consumers in Tunisia and Algeria: Influence of Sociodemographic Characteristics

Respondents were initially asked about their customary practices and behaviors when purchasing bread in Algeria (Table 2) and Tunisia (Table 3).

In Algeria, as depicted in Table 2, municipal bakeries (offering subsidized bread), constituted the primary point of purchase, with 40.3% of respondents. This was followed by neighborhood grocery stores (26.6%) and modern bakeries (26%). A minority (1.3%) of respondents reported purchasing bread at shopping malls, while 5.8% reported home baking. Statistical analysis revealed a significant influence of education and household size on the place of purchase ($p < 0.05$).

In Tunisia (Table 3), the survey data revealed that the majority of respondents (54.5%) acquired bread from modern bakeries, followed by municipal bakeries (19.2%), neighborhood grocery stores (12.8%), and shopping malls (9.6%). Approximately 3.8% of Tunisian respondents baking bread at home. Household size was found to exert a significant influence on the place of purchase ($p < 0.05$). Regarding the frequency of bread acquisition (Table 2), Algerian respondents reported purchasing bread either daily (33.8%) or 4 to 6 days per week (35.7%), with these patterns significantly associated with educational attainment and household size ($p < 0.05$). In terms of the quantity purchased, 43.5% of Algerian respondents typically acquired 5–6 loaves per day, 27.9% purchased 3–4 loaves, and 16.3% purchased 1–2 loaves daily. Statistical analysis revealed significant associations between the quantity of bread purchased and

Table 2. Self-reported Bread Purchasing Behaviors of Algerian Survey Respondents Across Demographic Groups (* $p < 0.05$ within demographic group)

% Algerian Respondents		Gender		Age			Marital Status		Education		Number of persons in the household							
Total	Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5	≥ 6	
Purchase frequency																		
Everyday	33.8	39.5	28.8	25	23.6	22.2	30	41	4.5	71.45	11.1	39.3	0	62.5	47.1	31.1	28.9	37.1
4-6 days/w	35.7	26.3	44.9	20.5	34.5	48.9	50	26.9	44.6	28.55	55.6	31.6	63.2	0	11.8	34.5	44.4	35.1
2-3 days/w	24	27.6	2.1	25	32.7	26.7	20	24.4	24.3	0	18.5	23.9	30	25	35.3	24.1	24.4	27.8
Once a week	3.2	1.3	3.2	0	1.8	0	0	3.8	2.7	0	7.4	2.6	0	10	5.9	6.9	0	0
Rarely	2.6	3.9	1.3	6.8	1.8	0	0	3.8	1.4	0	3.7	2.6	2.6	2.5	0	3.4	2.2	0
Never	0.7	1.3	0	2.3	1.8	2.2	0	0	1.4	0	4	0	4.2	0	0	0	0	0
Chi² p value	0.082	0.337		0.053			0.026*		0.010*									
Buns Number																		
1 – 2	17.3	27.8	7.2	25.0	17.9	12.5	0.0	20.5	14.3	16.0	7.7	18.5	60.0	50.0	11.1	13.8	18.4	12.5
3 – 4	26.5	35.4	18.1	37.5	33.9	12.5	0.0	37.3	15.6	12.0	23.1	29.8	0.0	0.0	66.7	44.8	16.3	25.0
5 – 6	43.8	34.2	53.0	31.3	35.7	60.4	70.0	30.1	57.1	56.0	46.2	41.1	40.0	50.0	16.7	41.4	57.1	31.3
7 – 8	9.9	1.3	18.1	4.2	10.7	14.6	10.0	9.6	10.4	12.0	23.1	8.1	0.0	0.0	5.6	0.0	8.2	12.5
9 and more	2.5	1.3	3.6	2.1	1.8	0.0	20.0	2.4	2.6	4.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	18.8
Chi² p value	0.001*	0.001*		0.011*			0.31		0.001*									
Place of purchase																		
Modern Bakeries	26	32.9	3.8	29.5	23.6	31.1	0	26.9	27.7	19.85	33.3	29.4	0	37.5	29.4	24.1	22.1	30.9
Municipal Bakeries	40.3	36.3	0	43.5	43.6	31.1	50	46.2	35.1	52.65	33.3	39	66.7	37.5	47.1	44.8	40	35.7
Neighborhood grocery store	26.6	19.7	33.3	13.6	23.6	37.8	50	17.9	33.8	23.8	33.3	23.9	0	0	23.5	27.6	35.6	25
Shopping mall	1.3	2.6	43.6	2.3	1.8	0	1.3	2.6	0	0	0	1.7	33.3	0	0	0	0	2.8
Homemade	5.8	7.9	19.2	11.4	7.3	0	0	6.4	5.4	3.7	0	6	0	25	0	3.4	2.2	5.6
Chi² p value	0.061	0.094		0.138			0.0462*		0.003*									
Bread price																		
Correct	53.2	63.2	43.6	72.7	54.5	35.6	40	67.9	36.5	38.1	33.3	59	33.3	75	76.5	48.3	46.7	52.8
Cheap	42.9	34.2	42.9	22.7	41.8	60	60	28.2	59.5	61.9	66.7	35.9	33.3	12.5	23.5	48.3	48.9	47.2
Expensive	3.9	2.6	3.9	4.5	3.6	4.4	0	3.8	4	0	0	5.1	33.3	12.5	0	3.4	4.4	0
Chi² p value	0.049*	0.024*		0.002*			0.101		0.124									

Table 3. Self-reported Bread Purchasing Behaviors of Tunisian Survey Respondents Across Demographic Groups (* $p < 0.05$ within demographic group)

% Tunisian respondents	Total	Gender		Age			Marital Status		Education		Number of persons in the household							
		Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary /High schools	Professional training	University	1	2	3	4	5	≥ 6
Purchase frequency																		
Everyday	51.3	48.7	59.5	65.2	41.7	71.4	35.7	52.6	51.4	66.7	50	51.1	40	42.9	52.8	48.6	66.7	71.4
4-6 days/w	21.2	22.7	16.2	21.7	26.2	11.4	14.3	20.5	22.2	33.3	33.3	19.9	10	25	22.2	27	16.7	14.3
2-3 days/w	19.9	20.2	18.9	8.7	23.8	8.6	42.9	19.2	19.4	0	16.7	20.6	35	28.6	16.7	18.9	8.3	0
Once a week	5.8	5.9	5.4	0	7.1	5.7	7.1	5.1	5.6	0	0	6.4	15	3.6	8.3	2.7	0	14.3
Rarely	0.6	0.8	0	4.3	0	0	0	1.3	0	0	0	0.7	0	0	0	0	4.2	0
Never	1.3	1.7	0	0	1.2	2.9	0	1.3	1.4	0	0	1.4	0	0	0	2.7	4.2	0
Chi² p value	0.827	0.045*			0.986			0.974			0.613							
Buns Number																		
1 – 2	7.1	5.9	10.8	13	8.3	2.9	0	12.8	1.4	0	0	7.8	0	3.6	0	0	33	8.3
3 – 4	20.5	20.2	21.6	17.4	21.4	22.9	14.3	19.2	123.6	0	16.7	21.3	5	7.1	19.4	35.1	29	28.6
5 – 6	69.2	71.4	62.2	65.2	65.5	74.3	85.7	61.5	75	100	75	68.1	90	89.3	80.6	62.2	29	42.9
7 – 8	2.6	1.7	5.4	4.3	3.6	2.9	0	5.1	0	0	0	7.8	0	0	0	2.7	8	0
9 and more	0.6	0.8	0	0	1.2	0	0	1.3	0	0	8.3	2.1	5	0	0	0	0	0
Chi² p value	0.527	0.833			<0.045*			0.834			<0.001*							
Place of purchase																		
Modern Bakeries	54.5	53.8	56.8	47.8	54.8	62.9	42.9	46.2	62.5	25	41.7	54.6	45.0	71.4	63.9	57.9	37.5	28.6
Municipal Bakeries	19.2	18.5	21.6	30.4	21.4	8.6	14.3	25.6	13.9	25	25.0	19.1	5.0	10.7	25.0	5.3	37.5	57.1
Neighborhood grocery stores	12.8	12.6	13.5	13.0	9.5	17.1	21.4	11.5	13.9	50	16.7	12.8	15.0	0.0	8.3	23.7	16.7	0.0
Shopping mall	9.6	10.9	5.4	4.3	9.5	8.6	21.4	11.5	6.9	0	0	9.9	30	14.3	2.8	10.8	0	0
Homemade	3.8	4.2	2.7	4.3	4.8	2.9	0.0	5.1	2.8	0	8.3	3.5	5.0	3.6	0.0	2.6	8.3	14.3
Chi² p value	0.867	0.569			0.429			0.865			<0.001*							
Bread price																		
Correct	70.5	72.3	64.9	69.6	73.8	65.7	64.3	66.7	16.7	33.3	66.7	71.6	70	64.3	77.8	64.9	70.8	85.7
Cheap	17.9	13.4	32.4	13	14.3	25.7	28.6	20.5	73.6	33.3	0	19.1	15	14.3	16.7	27	16.7	14.3
Expensive	11.5	14.3	2.7	17.4	11.9	8.6	7.1	12.8	9.7	33.3	33.3	9.2	15	21.4	5.6	8.1	12.5	0
Chi² p value	0.010*	0.608			0.684			0.038*			0.686							

Algerian respondents' gender, age, marital status, and household size ($p < 0.05$).

In Tunisia (Table 3), frequent bread purchasing was also observed, with 51.3% of respondents acquiring bread daily, 21.2% purchasing it 4-6 days per week, and 19.9% purchasing 2-3 days per week. This frequency was significantly influenced by age ($p < 0.05$). Regarding quantity, 69.2% of Tunisian respondents reported purchasing 5-6 loaves daily, while 20.5% purchase 3-4 loaves. This was significantly associated with marital status and household size ($p < 0.05$).

Regarding the perceived price of a standard baguette (Tables 2 and 3), the majority of respondents considered it reasonable, with 53.2% of Algerian and 70.5% of Tunisian respondents expressing this view. In addition, 42.9% of Algerian respondents and, to a lesser extent, 17.9% of Tunisian respondents perceived it as inexpensive. Among Algerian respondents (Table 2), this perception significantly varied based on gender, age, and marital status ($p < 0.05$), while for Tunisian respondents (Table 3), it was influenced by gender and educational level ($p < 0.05$).

Subsequently, respondents were asked about the criteria influencing their bread purchasing decisions. Results are presented in Table 4 for Algeria and Table 5 for Tunisia.

These results (Tables 4 and 5) highlighted a strong emphasis on "cleanliness and hygiene" in both respondent groups, with 86.4% of Algerian respondents and 84% of Tunisian respondents identifying it as a critical factor ("strongly agreed"). This was followed by bread "taste and flavor", prioritized by 77.3% of Algerian and 75% of Tunisian respondents, significantly influenced by household size and gender in the Algerian sample ($p < 0.05$). Additionally, 59.7% of Algerian and 42.9% of Tunisian consumers rated "warmth and freshness" as a very important factor ("strongly agreed") in bread purchases, with household size significantly influencing this preference in the Algerian sample ($p < 0.05$). No significant demographics associations were observed for cleanliness and hygiene, taste and flavor, or warmth and freshness in the Tunisian group. "Raw material quality" was moderately recognized in the Algerian sample (64.3% "slightly agreed"), with significant associations ($p < 0.05$) with age, marital status, and household size. In contrast, Tunisian respondents strongly valued "raw material quality" (62.2% "strongly agreed"), though no significant demographic associations were found ($p > 0.05$). "Store proximity" was considered important by 54.5% of Tunisian respondents ("strongly agreed") but was not a key factor for Algerian panelists. "Price" showed a relatively even distribution across levels of importance in both groups, indicating a lower overall impact on purchasing decisions. Factors such as "bread diversity" and "packaging" were deemed less influential, with fewer than 30% of respondents rating them as very important.

"Bread diversity" was significantly influenced by age and household size in the Algerian sample ($p < 0.05$). No significant demographic associations were observed for price, proximity, or packaging criteria in either panel.

3.3 Bread consumption and wastage in Tunisia and Algeria: influence of sociodemographic features

Qualitative ratings were requested regarding the average amount of bread usually consumed in order to identify whether or not a wastage occurs. The results are presented in Table 6 for Algeria and Table 7 for Tunisia.

The survey findings revealed a high prevalence of bread consumption among respondents, with 98.7% of Algerians and 94.2% of Tunisians regularly consuming bread, predominantly of French-style baguettes (67.5% of Algerian and 60.3% of Tunisian respondents). Interestingly, Tunisian respondents exhibited greater diversity in bread type consumption, with 19.2% consuming whole-grain bread, 3.2% selecting specialty breads (e.g., sandwich bread, brioche, etc.), and 3.2% opting for dietary breads (e.g., low-salt, gluten-free, etc.). Among Algerian respondents, 16% consumed semolina bread, and 9.3% preferred traditional bread, while a smaller proportion reported consuming specialty breads (1.9%) or dietary breads (0.6%). Conversely, only 5.8% of Tunisian respondents reported consuming traditional bread and 3.8% semolina bread. The choice of bread type was significantly ($p < 0.05$) associated with demographics in both groups: gender, age, marital status, and education in the Tunisian panel and education in the Algerian panel.

Regarding the quantity of bread consumed (Tables 6 and 7), 51.6% of Algerian and 54.5% of Tunisian respondents reported consuming 75–99% of their purchased bread. An additional 29.9% of Algerians and 19.9% of Tunisians consumed 50–74%. Only 7.1% of Algerians and 17.9% of Tunisians stated that they consume all the bread they purchased, while a small proportion (0.7% in both panels) admitted to purchasing bread without consuming it. In the Algerian sample, self-reported levels of bread consumption were significantly associated with education and household size ($p < 0.05$), whereas no significant demographic associations were observed in the Tunisian sample.

Consumer satisfaction with bread quality also appeared to influence consumption and thus waste reduction. As shown in Table 6, among the Algerian panel, 59.7% rated the bread as "Good," 37.01% as "Medium," and 3.2% as "Bad." In Tunisia (Table 7), bread quality was predominantly rated as "Medium" (55.1%), followed by "Good" (24.9%) and "Bad" (20%). Bread quality assessments were significantly influenced by age, gender, and household size in the Algerian sample, and by age in the Tunisian sample ($p < 0.05$).

Table 4. Self-reported Bread Purchase Decision Criteria Among Algerian Survey Respondents, Rated on an Agreement Scale by Demographics (* $p < 0.05$ within demographic group)

% Algerian respondents Agreement scale		Gender		Age			Marital Status		Education		Number of persons in the household						
Total	Women	Men	18-24	24-40	41-60	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5	≥ 6	
Cleaning and hygiene																	
Not at all	1.3	2.6	0	4.5	0	0	2.6	0	0	0	1.7	33.3	0	0	0	2.8	
Not really	3.9	3.9	3.9	6.8	3.6	2.2	6.4	1.4	14.3	7.4	3.4	0	25	5.9	0	4.4	
Slightly agreed	8.4	11.8	5.1	15.9	7.3	4.4	12.8	4.1	14.3	7.4	9.4	0	37.5	0	10.3	5.6	
Strongly agreed	86.4	81.6	91	72.7	89.1	93.3	78.2	94.6	100	85.2	85.5	66.7	37.5	94.1	89.7	88.9	
Chi² p value	0.212	0.170					0.154		0.957			0.001*					
Raw material quality																	
Not at all	10.4	11.8	9	15.9	9.1	8.9	11.5	9.5	0	7.4	12	33.3	12.5	11.8	13.8	11.1	
Not really	25.3	30.3	20.5	38.6	23.6	13.3	34.6	14.9	0	29.6	24.8	0	62.5	47.1	24.1	20	
Slightly agreed	64.3	57.9	70.5	45.5	67.3	77.8	53.8	75.7	71.45	63	63.2	66.7	25	41.2	62.1	77.8	
Strongly agreed	0	0	0	0	0	0	0	0	28.55	0	0	0	0	0	0	0	
Chi² p value	0.259	0.049*					0.048*		0.284			0.057*					
Taste and flavor																	
Not at all	0.6	0	1.3	0	1.8	0	0	1.4	0	3.7	0	0	0	5.9	0	0	
Not really	1.9	0	3.8	2.3	0	4.4	1.3	2.7	0	3.7	1.7	0	0	5.9	3.4	0	
Slightly agreed	20.1	28.9	11.5	29.5	21.8	13.3	0	29.5	10.8	18.5	21.4	66.7	37.5	29.4	20.7	20	
Strongly agreed	77.3	71.1	83.3	68.2	76.4	82.2	100	69.2	85.1	74.1	76.9	33.3	62.5	58.8	75.9	80	
Chi² p value	0.015*	0.284					0.130		0.688			0.261					
Warmth and freshness																	
Not at all	0.6	0	1.3	2.3	0	0	1.3	0	0	0	0.9	0	12.5	0	0	0	
Not really	7.8	11.8	3.8	11.4	10.9	0	11.5	4.1	16.65	3.7	8.5	0	12.5	0	10.3	2.8	
Slightly agreed	31.8	34.2	29.5	31.8	36.4	28.9	20	34.6	27	33.3	32.5	33.3	0	35.3	48.3	36.1	
Strongly agreed	59.7	53.9	65.4	54.5	52.7	71.1	70	52.6	68.9	63	58.1	66.7	75	64.7	41.4	61.1	
Chi² p value	0.155	0.335					0.108		0.741			0.018*					

Table 4. Continued

% Algerian respondents Agreement scale		Gender		Age			Marital Status		Education		Number of persons in the household							
Total	Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5	≥ 6	
Price																		
Not at all	2.6	1.3	3.8	2.3	3.6	2.2	0	2.6	2.7	0	3.7	2.6	0	0	5.9	0	2.2	5.6
Not really	29.9	28.9	30.8	22.7	40	26.7	20	32.1	28.4	30.95	18.5	32.5	33.3	12.5	23.5	44.8	26.7	30.6
Slightly agreed	35.1	42.1	28.2	34.1	36.4	31.1	50	38.5	29.7	7.15	48.1	34.2	33.3	25	47.1	34.5	40	22.2
Strongly agreed	32.5	27.6	37.2	40.9	20	40	30	26.9	39.2	61.9	29.6	30.8	33.3	62.5	23.5	20.7	31.1	41.7
Chi² p value	0.241			0.444			0.368			0.0462*			0.659					
Diversity																		
Not at all	3.9	2.6	5.1	2.3	7.3	2.2	0	5.1	2.7	16.65	7.4	2.6	0	37.5	5.9	0	2.2	2.8
Not really	31.8	31.6	32.1	31.8	38.2	24.4	30	37.2	27	30.95	22.2	34.2	0	12.5	41.2	31	35.6	30.6
Slightly agreed	34.4	46.1	23.1	43.2	30.9	31.1	30	37.2	31.1	23.8	37	35	100	25	41.2	31	42.2	13.9
Strongly agreed	29.9	19.7	39.7	22.7	23.6	42.2	40	20.5	39.2	28.55	33.3	28.2	0	25	11.8	37.9	20	52.8
Chi² p value	0.009*			0.385			0.254			0.158			0.001*					
Proximity																		
Not at all	4.5	3.9	5.1	4.5	9.1	0	0	7.7	1.4	0	11.1	3.4	0	25	5.9	3.4	2.2	2.8
Not really	25.3	25	25.6	22.7	32.7	20	20	25.6	25.7	30.95	22.2	25.6	66.7	37.5	23.5	24.1	20	33.3
Slightly agreed	39.6	44.7	34.6	47.7	32.7	37.8	50	42.3	35.1	14.3	44.4	40.2	0	12.5	58.8	37.9	46.7	25
Strongly agreed	30.5	26.3	34.6	25	25.5	42.2	30	24.4	37.8	54.8	22.2	30.8	33.3	25	11.8	34.5	31.1	38.9
Chi² p value	0.575			0.240			0.163			0.599			0.136					
Packaging																		
Not at all	5.2	6.6	3.8	9.1	5.5	2.2	0	7.7	2.7	0	0	6.8	33.3	0	5.9	3.4	2.2	8.3
Not really	35.1	31.6	38.5	43.2	41.8	24.4	10	42.3	28.4	47.65	29.6	35.9	0	50	52.9	27.6	40	30.6
Slightly agreed	39	43.4	34.6	34.1	36.4	46.7	40	37.2	40.5	14.3	40.7	40.2	33.3	37.5	35.3	44.8	42.2	33.3
Strongly agreed	20.8	18.4	23.1	13.6	16.4	26.7	50	12.8	28.4	38.1	29.6	17.1	33.3	12.5	5.9	24.1	15.6	27.8
Chi² p value	0.524			0.095			0.118			0.456			0.542					

Table 5. Self-reported Bread Purchase Decision Criteria by Demographics in the Tunisian Panel. Rated on an Agreement Scale (* $p < 0.05$ within demographic group)

% Tunisian respondents Agreement scale	Gender			Age			Marital Status		Education		Number of persons in the household							
	Total	Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5	≥ 6
Cleaning and hygiene																		
Not at all	1.9	1.7	2.7	0	0	5.7	7.1	2.6	1.4	0	0	2.1	5	0	2.8	2.7	0	0
Not really	2.6	2.5	2.7	0	2.4	2.9	7.1	1.3	4.2	0	0	2.8	0	3.6	2.8	5.4	0	0
Slightly agreed	11.5	9.2	18.9	21.7	10.7	11.4	0	16.7	6.9	0	33.3	9.9	15	21.4	5.6	5.4	8.3	28.6
Strongly agreed	84	86.6	75.7	86.9	86.9	80	85.7	79.5	87.5	100	66.7	85.1	80	75	88.9	86.5	91.7	71.4
Chi² p value	0.416	0.192			0.42			0.331			0.766							
Raw material quality																		
Not at all	1.3	1.7	0	4.3	1.2	0	0	1.3	1.4	0	0	1.4	0	0	0	2.7	4.2	0
Not really	9	8.4	10.8	4.3	14.3	2.9	0	9	9.7	0	8.3	9.2	5	10.7	22.2	0	4.2	14.3
Slightly agreed	27.6	26.1	32.4	52.2	25	20	21.4	34.6	20.8	0	33.3	27.7	15	39.3	19.4	27	33.3	42.9
Strongly agreed	62.2	63.9	56.8	39.1	59.5	77.1	78.4	55.1	68.1	100	33.3	61.7	80	50	58.3	70.3	33.3	42.9
Chi² p value	0.694	0.032*			0.548			0.901			0.214							
Taste and flavor																		
Not at all	1.9	0.8	5.4	4.3	0	2.9	7.1	1.3	2.8	0	0	2.1	0	0	2.8	2.7	4.2	0
Not really	3.8	3.4	5.4	4.3	4.8	2.9	0	5.1	2.8	0	0	4.3	5	3.6	5.6	2.7	0	14.3
Slightly agreed	19.2	18.5	21.6	21.7	17.9	17.1	28.6	16.7	20.8	0	25	19.1	15	21.4	13.9	16.2	20.8	42.9
Strongly agreed	75	77.3	67.6	69.6	77.4	77.1	64.3	76.9	73.6	100	75	74.5	80	75	77.8	78.4	75	42.9
Chi2 p value	0.276	0.684			0.876			0.92			0.847							
Warmth and freshness																		
Not at all	3.2	2.5	5.4	0	3.6	5.7	0	1.3	5.6	0	0	3.5	0	3.6	2.8	5.4	4.2	0
Not really	19.2	16.8	27	17.4	17.9	17.1	35.7	15.4	22.2	33.3	16.7	19.1	25	21.4	13.9	27	12.5	0
Slightly agreed	34.6	37	27	39.1	34.5	31.4	35.7	41	30.6	33.3	25	35.5	35	35.7	36.1	27	45.8	28.6
Strongly agreed	42.9	43.7	40.5	43.5	44	45.7	28.6	42.3	41.7	33.3	58.3	41.8	40	39.3	47.2	40.5	37.5	71.4
Chi² p value	0.371	0.826			0.234			0.92			0.952							

Table 6. Self-Reported Bread Consumption and Wastage Behaviors Among Algerian Survey Respondents, Categorized by Demographics (* $p < 0.05$ within demographic group)

% of Algerian Respondents		Gender		Age			Marital Status		Education		Number of persons in the household							
Total																		
		Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5	≥ 6
Bread Consumption																		
Yes		98.7	98.7	98.7	100	96.4	100	98.7	98.6	100	96.3	99.1	100	100	100	100	100	93.8
No		1.3	1.3	1.3	0	3.6	0	1.3	1.4	0	3.7	0.9	0.9	0	0	0	0	6.2
Chi² p value		0.745	0.302					0.986		0.675		0.477						
Type of bread																		
Classic baguette		68.5	63.3	73.5	64.6	62.5	77.1	80.0	63.9	72.7	76.9	68.5	80.0	87.5	83.3	62.1	69.4	64.9
Semolina bread		16.0	12.7	19.3	12.5	14.3	20.8	20.0	14.5	18.2	23.1	12.9	0.0	0.0	11.1	17.2	20.4	16.2
Traditional regional bread		9.3	13.9	4.8	10.4	17.9	0.0	0.0	12.0	6.5	0	12.1	20.0	12.5	5.6	17.2	6.1	8.1
Whole grain bread		3.7	6.3	1.2	6.3	3.6	2.1	0.0	4.8	2.6	0	4.8	0.0	0.0	0.0	3.4	2.0	2.7
Specialty bread		1.9	2.5	1.2	4.2	1.8	0.0	0.0	3.6	0.0	0	1.6	0.0	0.0	0.0	0.0	2.0	5.4
Dietary bread		0.6	1.3	0.0	2.1	0.0	0.0	0.0	1.2	0.0	0	0	0.0	0.0	0.0	0.0	0.0	2.7
Chi² p value		0.071	0.405					0.82		0.001*		0.552						
Bread Quality																		
Bad		3.2	3.9	2.6	6.8	3.6	0	0	5.1	1.4	0	4.3	33.3	12.5	0	3.4	4.4	0
Medium		37	53.9	20.5	68.2	30.9	15.6	30	56.4	16.2	14.8	43.6	66.7	25	58.8	31	28.9	36.1
Good		59.7	42.1	76.9	25	65.5	84.4	70	38.5	82.4	85.2	52.1	0	62.5	41.2	65.5	66.7	63.9
Chi² p value		0.001*	0.001*					0.001*		0.495		0.042*						
% of bread consumed																		
1-24%		1.2	1.3	1.2	2.1	1.8	0.0	0.0	2.4	0.0	0.0	1.6	0.0	0.0	0.0	3.4	0.0	2.7
25-49%		4.9	7.6	2.4	10.4	3.6	0.0	10.0	7.2	2.6	7.7	5.6	0.0	0.0	11.1	3.4	2.0	5.4
50-74%		28.4	29.1	27.7	12.5	35.7	37.5	20.0	22.9	35.1	15.4	28.2	20.0	0.0	16.7	20.7	34.7	35.1
75-99%		56.2	49.4	62.7	62.5	42.9	62.5	70.0	54.2	57.1	46.2	57.3	60.0	37.5	61.1	62.1	57.1	54.1
100%		8.6	11.4	6.0	10.4	16.1	0.0	0.0	13.3	3.9	23.1	7.3	20.0	50.0	11.1	10.3	6.1	2.7
Buy without consuming		0.6	1.3	0.0	2.1	0.0	0.0	0.0	1.3	7.7	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0
Chi² p value		0.447	0.028*					0.626		0.003*		0.020*						

Table 6. Continued

% of Algerian Respondents		Gender		Age		Marital Status		Education		Number of persons in the household									
		Total	Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5	≥ 6
Bread not consumed at the end of the meal																			
I consume it all		3.9	3.9	3.8	6.8	3.6	0	10	5.1	2.7	0	3.7	4.3	0	12.5	11.8	3.4	2.2	2.8
I keep it		88.3	86.8	89.7	90.9	87.3	86.7	90	88.5	87.8	100	85.2	88	100	75	76.5	82.8	88.9	94.4
I throw it away		7.8	9.2	6.4	2.3	9.1	13.3	0	6.4	9.5	0	11.1	7.7	0	12.5	11.8	13.8	8.9	2.8
Chi ² p value		0.809			0.229				0.862		0.939			0.527					
Bread wastage after storage																			
Never		13	14.5	11.5	22.7	10.9	8.9	0	17.9	8.1	0	7.4	15.4	33.3	50	11.8	6.9	8.9	18.8
Rarely		14.9	25	5.1	27.3	16.4	4.4	0	23.1	6.8	33.3	3.7	17.9	66.7	12.5	5.9	10.3	24.4	6.3
Sometimes		63	50	75.6	36.4	63.6	82.2	90	47.4	78.4	59.5	81.5	58.1	0	12.5	47.1	75.9	62.2	68.8
Often		2.6	2.6	2.6	2.3	3.6	2.2	0	3.8	1.4	0	3.7	2.6	0	0	5.9	3.4	4.4	0
Always		6.5	7.9	5.1	11.4	5.5	2.2	10	7.7	5.4	23.8	3.7	6	0	25	29.4	3.4	0	63
Chi ² p value		0.005*			0.008*				0.023*		0.251			<0.001*					

Table 7. Self-Reported Bread Consumption and Wastage Behaviors by Demographics in the Tunisian Panel (* $p < 0.05$ within demographic group)

% of Tunisian Respondents		Gender		Age			Marital Status		Education			Number of persons in the household					
Total		Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5
Bread Consumption																	
Yes	94.2	93.3	97.3	95.7	97.6	88.6	85.7	94.9	94.4	100.0	100.0	93.6	90.0	100.0	94.4	92.1	100.0
No	5.8	6.7	21.6	4.3	2.4	11.4	14.3	5.1	5.6	0.0	0.0	6.4	10.0	0.0	5.6	7.9	8.3
<i>Chi² p value</i>				0.122				0.503		0.602			0.433				
Type of bread																	
Classic baguette	60.3	59.7	64.9	87.0	65.5	42.9	35.7	76.9	47.2	57.1	58.3	61.7	35.0	53.6	58.3	65.8	85.7
Bread (Large)	3.2	2.5	5.4	4.3	4.8	0.0	0.0	3.8	2.8	0.0	0.0	3.5	10.0	0.0	2.8	2.6	14.3
Semolina bread	3.8	5.0	0.0	0.0	3.6	8.6	0.0	1.3	5.6	0.0	8.3	3.5	5.0	7.1	2.8	2.6	0.0
Traditional regional bread	5.8	6.7	2.7	0.0	9.5	2.9	0.0	3.8	8.3	14.3	8.3	5.7	10.0	7.1	8.3	2.6	4.2
Whole grain bread	19.9	21.0	16.2	4.3	11.9	37.1	50.0	10.3	29.2	14.3	25.0	19.1	35.0	32.1	16.7	15.8	12.5
Specialty bread	3.2	1.7	8.1	4.3	3.6	2.9	0.0	2.6	4.2	0.0	0.0	3.5	5.0	0.0	2.8	5.3	4.2
Dietary bread	3.2	3.4	2.7	0.0	1.2	5.7	14.3	1.3	2.8	14.3	0.0	2.8	0.0	0.0	8.3	5.3	0.0
<i>Chi² p value</i>				<0.001*				<0.001*		<0.001*			0.751				
Bread Quality																	
Bad	62.5	21.8	24.3	30.4	15.5	37.1	14.3	25.6	19.4	0	16.7	23.4	25	14.3	22.2	24.3	57.1
Medium	55.1	58	45.9	60.9	61.9	40	42.9	60.3	50	100	50	54.6	60	46.4	61.1	51.4	42.9
Good	62.5	20.2	29.7	8.7	22.6	22.9	42.9	14.1	30.6	0	33.3	22	15	39.3	16.7	24.3	0
<i>Chi² p value</i>		0.374		0.036*				0.176		0.495			0.211				
Amount of bread consumed																	
1-24%	3.2	3.4	2.7	4.3	3.6	2.9	0.0	2.6	4.2	0	8.3	2.8	0.0	3.6	5.6	2.6	4.2
25-49%	3.8	5.0	0.0	8.7	4.8	0.0	0.0	2.6	5.6	0	8.3	3.5	0.0	7.1	5.6	0.0	28.6
50-74%	19.9	18.5	24.3	13.0	23.8	17.1	14.3	19.2	20.8	0	16.7	20.6	25.0	25.0	13.9	15.8	16.7
75-99%	53.8	55.5	48.6	43.5	54.8	62.9	42.9	51.3	56.9	66.7	41.7	54.6	45.0	39.3	61.1	63.2	28.6
100%	17.9	16.8	21.6	30.4	11.9	17.1	35.7	24.4	9.7	33.3	25.0	17.0	30.0	25.0	8.3	18.4	16.7
Buy without consuming	1.3	0.8	2.7	0.0	1.2	0.0	7.1	0.0	2.8	0	0.0	1.4	0.0	0.0	5.6	0.0	0.0
<i>Chi² p value</i>		0.281		0.078				0.597		0.949			0.188				

Table 7. Continued

% of Tunisian Respondents	Gender		Age		Marital Status		Education		Number of persons in the household									
	Total	Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5	≥ 6
Bread not consumed at the end of the meal																		
I consume it all	15.4	11.8	11.8	21.7	6	20	50	17.9	8.3	33.3	8.3	15.6	40	17.9	13.9	13.5	4.2	0
I keep it	66.7	70.6	70.6	69.6	69	68.6	42.9	62.8	73.6	66.7	83.3	65.2	40	67.9	69.4	67.6	70.8	85.7
I throw it away	17.9	17.6	18.9	8.7	25	11.4	7.1	19.2	18.1	0	8.3	19.1	20	14.3	16.7	18.9	25	14.3
<i>Chi² p value</i>	0.065	<0.001		0.003			0.157		0.586									
Bread wastage after storage																		
Never	19.9	20.2	18.9	34.8	14.3	25.7	14.3	21.8	16.7	33.3	8.3	20.6	15	21.4	16.7	27	20.8	14.3
Rarely	38.5	36.1	45.9	30.4	31	45.7	78.6	33.3	43.1	66.7	50	36.9	45	35.7	33.3	43.2	37.5	28.6
Sometimes	28.2	29.4	24.3	30.4	34.5	20	7.1	32.1	25	0	25	29.1	15	32.1	33.3	24.3	25	42.9
Often	7.7	7.6	8.1	0	11.9	5.7	0	9	6.9	0	16.7	7.1	20	10.7	8.3	0	4.2	14.3
Always	5.8	6.7	2.7	4.3	8.3	2.9	0	3.8	8.3	0	0	6.4	5	0	8.3	5.4	12.5	0
<i>Chi² p value</i>	0.774	0.019*		0.703			0.683		0.73									

Table 8. Importance of Criteria Influencing Bread Waste Decisions Among Algerian Survey Respondents, Categorized by Demographics (* $p < 0.05$ within demographic group)

Importance Scale		Gender		Age			Marital Status		Education		Number of persons in the household								
		Total	Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5	≥ 6
Staling																			
VU	19.5	30.3	9	45.5	14.5	4.4	4.4	34.6	4.1	23.8	3.7	23.1	33.3	25	41.2	6.9	20	16.7	
U	16.9	21.1	12.8	34.1	9.1	11.1	11.1	20.5	13.5	16.65	7.4	19.7	0	37.5	23.5	20.7	11.1	11.1	
N	4.5	2.6	6.4	0	10.9	2.2	2.2	5.1	4.1	0	7.4	4.3	0	25	5.9	3.4	2.2	2.8	
I	37	27.6	46.2	13.6	34.5	57.8	57.8	20.5	52.7	45.2	63	29.9	33.3	0	23.5	37.9	48.9	36.1	
VI	22.1	18.4	25.6	6.8	30.9	24.4	24.4	19.2	25.7	14.3	18.5	23.1	33.3	12.5	5.9	31	17.8	33.3	
<i>Chi² p value</i>		0.003*		0.001*				0.001*		0.132		0.099							
Bad taste																			
VU	12.3	19.7	5.1	25	12.7	2.2	0	21.8	2.7	23.8	3.7	13.7	33.3	25	11.8	6.9	13.3	13.9	
U	21.4	23.7	19.2	36.4	12.7	17.8	20	24.4	18.9	23.8	7.4	24.8	0	25	41.2	20.7	15.6	13.9	
N	5.2	6.6	3.8	2.3	12.7	0	0	7.7	2.7	0	7.4	5.1	33.3	25	11.8	0	4.4	2.8	
I	39	26.3	51.3	13.6	36.4	60	80	21.8	55.4	45.2	66.7	31.6	33.3	0	23.5	41.4	46.7	41.7	
VI	22.1	23.7	20.5	22.7	25.5	20	0	24.4	20.3	7.15	14.8	24.8	0	25	11.8	31	20	27.8	
<i>Chi² p value</i>		0.008*		0.001*				0.001*		0.166		0.076							
Poor quality																			
VU	14.9	22.4	7.7	29.5	14.5	4.4	0	25.6	4.1	40.5	3.7	16.2	33.3	37.5	11.8	6.9	17.8	13.9	
U	18.8	23.7	14.1	29.5	12.7	15.6	20	21.8	16.2	7.15	3.7	23.1	0	12.5	23.5	20.7	15.6	13.9	
N	5.8	5.3	6.4	6.8	10.9	0	0	7.7	4.1	0	11.1	5.1	33.3	25	17.6	0	2.2	5.6	
I	40.9	26.3	55.1	15.9	38.2	60	80	24.4	56.8	45.2	66.7	34.2	33.3	12.5	29.4	48.3	44.4	38.9	
VI	19.5	22.4	16.7	18.2	23.6	20	0	20.5	18.9	7.15	14.8	21.4	0	12.5	17.6	24.1	20	27.8	
<i>Chi² p value</i>		0.003*		0.001*				0.001*		0.036*		0.069							
VU: Very Unimportant, U: Unimportant, N: Neither, I: Important, VI: Very Important																			

VU: Very Unimportant, U: Unimportant, Ni: Neither, I: Important, VI: Very Important

Table 8. Continued

Importance Scale		% of Algerian respondents		Gender		Age			Marital Status		Education		Number of persons in the household						
		Total	Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5	≥ 6
Poor texture																			
VU		14.3	18.4	10.3	29.5	12.7	4.4	0	23.1	5.4	23.8	7.4	15.4	33.3	25	23.5	3.4	15.6	13.9
U		22.1	28.9	15.4	36.4	16.4	15.6	20	28.2	16.2	23.8	7.4	25.6	0	37.5	23.5	24.1	22.2	13.9
N		4.5	3.9	5.1	2.3	9.1	2.2	0	5.1	4.1	0	7.4	4.3	33.3	25	5.9	0	0	5.6
I		45.4	32.9	57.7	20.5	45.5	62.2	80	30.8	59.5	45.2	74.1	38.5	33.3	0	35.3	51.7	48.9	50
VI		13.6	15.8	11.5	11.4	16.4	15.6	0	12.8	14.9	23.8	3.7	16.2	0	12.5	11.8	20.7	13.3	16.7
Chi ² p value		0.028*		0.001*		0.001*		0.009*		0.202		0.098							
Habits																			
VU		29.2	42.1	16.7	16.7	52.3	25.5	10	43.6	14.9	7.15	3.7	36.8	33.3	37.5	23.5	17.2	35.6	30.6
U		14.3	18.4	10.3	10.3	25	12.7	0	16.7	12.2	23.8	11.1	14.5	33.3	25	35.3	13.8	8.9	11.1
N		42.9	26.3	59	59	18.2	49.1	80	34.6	50	45.2	77.8	34.2	33.3	37.5	29.4	41.4	37.8	58.3
I		9.7	9.2	10.3	10.3	0	9.1	10	1.3	18.9	23.8	7.4	9.4	0	0	0	17.2	15.6	0
VI		3.9	3.9	3.8	3.8	4.5	3.6	0	3.8	4.1	0	0	5.1	0	0	11.8	10.3	2.2	0
Chi ² p value		0.001*		0.001*		0.001*		0.001*		0.016*		0.093							

VU: Very Unimportant, U: Unimportant, N: Neither, I: Important, VI: Very Important

VU: Very Unimportant, U: Unimportant, N: Neither, I: Important, VI: Very Important

Table 9. Self-reported Key Criteria Influencing Bread Wastage Decisions by Demographic groups in the Tunisian Panel, Rated on an Importance Scale (* $p < 0.05$ within demographic group)

Importance Scale	% of Tunisian respondents		Gender		Age			Marital Status		Education		Number of persons in the household					
	Total	Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5
Staling																	
VU	19.2	30.3	9	45.5	14.5	4.4	42.9	34.6	4.1	23.8	3.7	23.1	33.3	25	41.2	6.9	16.7
U	26.3	21.1	12.8	34.1	9.1	11.1	35.7	20.5	13.5	16.65	7.4	19.7	0	37.5	23.5	20.7	11.1
N	9.3	2.6	6.4	0	10.9	2.2	21.4	5.1	4.1	0	7.4	4.3	0	25	5.9	3.4	2.8
I	16.7	27.6	46.2	13.6	34.5	57.8	0	20.5	52.7	45.2	63	29.9	33.3	0	23.5	37.9	36.1
VI	28.2	18.4	25.6	6.8	30.9	24.4	0	19.2	25.7	14.3	18.5	23.1	33.3	12.5	5.9	31	33.3
<i>Chi² p value</i>		0.003*		0.001*				0.001*		0.132							0.099
Bad taste																	
VU	16.7	19.7	5.1	25	12.7	2.2	28.6	21.8	2.7	23.8	3.7	13.7	33.3	25	11.8	6.9	13.3
U	32.1	23.7	19.2	36.4	12.7	17.8	35.7	24.4	18.9	23.8	7.4	24.8	0	25	41.2	20.7	15.6
N	14.1	6.6	3.8	2.3	12.7	0	14.3	7.7	2.7	0	7.4	5.1	33.3	25	11.8	0	4.4
I	14.7	26.3	51.3	13.6	36.4	60	0	21.8	55.4	45.2	66.7	31.6	33.3	0	23.5	41.4	46.7
VI	22.4	23.7	20.5	22.7	25.5	20	21.4	24.4	20.3	7.15	14.8	24.8	0	25	11.8	31	27.8
<i>Chi² p value</i>		0.008*		0.001*				0.001*		0.166							0.076
Poor quality																	
VU	19.2	22.4	7.7	29.5	14.5	4.4	0	25.6	4.1	40.5	3.7	16.2	33.3	37.5	11.8	6.9	13.9
U	26.9	23.7	14.1	29.5	12.7	15.6	20	21.8	16.2	7.15	3.7	23.1	0	12.5	23.5	20.7	15.6
N	14.1	5.3	6.4	6.8	10.9	0	0	7.7	4.1	0	11.1	5.1	33.3	25	17.6	0	2.2
I	18.6	26.3	55.1	15.9	38.2	60	80	24.4	56.8	45.2	66.7	34.2	33.3	12.5	29.4	48.3	38.9
VI	21.2	22.4	16.7	18.2	23.6	20	0	20.5	18.9	7.15	14.8	21.4	0	12.5	17.6	24.1	27.8
<i>Chi² p value</i>		0.003*		0.001*				0.001*		0.036*							0.069

VU: Very Unimportant, U: Unimportant, N: Neither, I: Important, VI: Very Important

Table 9. Continued

Importance Scale	% of Tunisian respondents		Gender		Age			Marital Status			Education		Number of persons in the household					
	Total	Women	Men	18-24	24-40	41-60	≥ 61	Single	Married	Primary/High schools	Professional training	University	1	2	3	4	5	≥ 6
Poor texture																		
VU	17.9	18.4	10.3	29.5	12.7	4.4	0	23.1	5.4	23.8	7.4	15.4	33.3	25	23.5	3.4	15.6	13.9
U	28.2	28.9	15.4	36.4	16.4	15.6	20	28.2	16.2	23.8	7.4	25.6	0	37.5	23.5	24.1	22.2	13.9
N	16.7	3.9	5.1	2.3	9.1	2.2	0	5.1	4.1	0	7.4	4.3	33.3	25	5.9	0	0	5.6
I	19.2	32.9	57.7	20.5	45.5	62.2	80	30.8	59.5	45.2	74.1	38.5	33.3	0	35.3	51.7	48.9	50
VI	17.9	15.8	11.5	11.4	16.4	15.6	0	12.8	14.9	23.8	3.7	16.2	0	12.5	11.8	20.7	13.3	16.7
Chi ² p value	0.028*		0.001*			0.009*			0.202			0.098						
Habits																		
VU	48.7	42.1	16.7	16.7	52.3	25.5	10	43.6	14.9	7.15	3.7	36.8	33.3	37.5	23.5	17.2	35.6	30.6
U	19.9	18.4	10.3	10.3	25	12.7	0	16.7	12.2	23.8	11.1	14.5	33.3	25	35.3	13.8	8.9	11.1
N	26.3	26.3	59	59	18.2	49.1	80	34.6	50	45.2	77.8	34.2	33.3	37.5	29.4	41.4	37.8	58.3
I	1.9	9.2	10.3	10.3	0	9.1	10	1.3	18.9	23.8	7.4	9.4	0	0	0	17.2	15.6	0
VI	3.2	3.9	3.8	3.8	4.5	3.6	0	3.8	4.1	0	0	5.1	0	0	11.8	10.3	2.2	0
Chi ² p value	0.001*		0.001*			0.001*			0.016*			0.093						
VU : Very Unimportant. U : Unimportant. N: Neither. I: Important. VI: Very Important																		

VU : Very Unimportant. U : Unimportant. N: Neither. I: Important. VI: Very Important

These outcomes highlighted the interplay between bread quality, demographic factors, and consumption habits, suggesting that improvements in bread quality particularly in Tunisia may encourage higher consumption rates and help minimize waste.

Regarding the meal during which the most bread is consumed (Figure 1), the findings indicated that lunch was the primary occasion for bread consumption, as reported by 79.1% of Algerian respondents and 57.1% of Tunisian respondents.

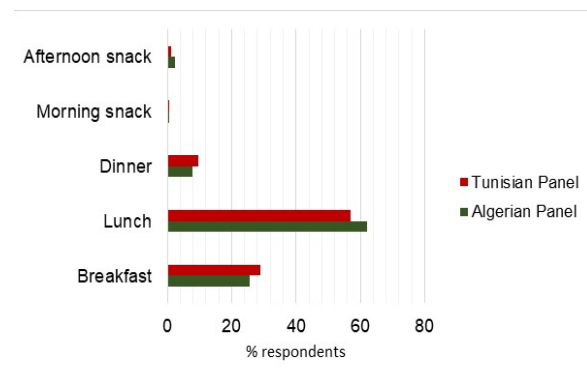


Figure 1. Distribution of Bread Consumption Times Among Algerian and Tunisian Panelists

For the Algerian panel, this was followed by dinner (45.9%) and, to a lesser extent, breakfast (26.6%). In contrast, the Tunisian panel reported breakfast as the second most common meal for bread consumption (28.8%), with dinner accounting for a smaller proportion (12.2%). Statistical analysis indicated a significant relation ($p < 0.05$) between the meal type and Algerian respondents' gender, age, and household size (data not shown). These results pointed out cultural and regional differences in bread consumption patterns across meals.

In order to evaluate the extent of bread wastage, respondents were surveyed about the fate of the uneaten bread at the end of the meal. Results are presented in Table 6 for Algeria and in Table 7 for Tunisia.

About 88.3% of Algerian respondents reported keeping leftover bread at the end of a meal, while 7.8% admitted to throwing it away, and only 3.9% stated they consumed it entirely. No significant associations were observed with demographic factors. Conversely, among Tunisian respondents, 15.4% consumed all leftover bread, 17.9% discarded it, and the majority kept it for future use. This behavior was significantly associated with age and marital status ($p < 0.05$). These results suggested that the majority of respondents in both countries tend to store leftover bread for future purposes.

Regarding the fate of stored bread, 13% of Algerian respondents stated they never discarded it, while 6.5% admitted to always throwing it away, with most acknowledging that they discarded it occasionally (Table 6). Significant associations were identified with gender, age, marital status, and household size in the Algerian panel ($p < 0.05$). Similarly, in the Tunisian panel, 19.9% reported never discarding stored bread, while 38.5% stated they rarely discarded it, and 5.8% admitted to always discarding it (Table 7). Significant associations were found with age ($p < 0.05$).

Additionally, in the Tunisia panel, significant associations were identified between post-meal bread waste and purchase frequency (Chi square $p = 0.006$) and purchase location (Chi square $p = 0.010$). However, no significant relationship was observed with purchase quantity (data not shown). Similarly, in the Algeria panel, no significant associations were found between bread waste and shopping practices (purchase quantity, purchase frequency, purchase location) (data not shown). Furthermore, statistical analysis did not establish a significant relationship between respondents' behavior regarding post-storage bread waste and shopping practices for either panel (data not shown). Finally, no significant associations were detected between bread waste (both post-meal and post-storage) and the perception of price and quality in either the Tunisia or Algeria panels (data not shown).

These results pointed out that while most respondents attempt to minimize bread waste through storage, occasional discarding remains a common practice in both countries.

In order to determine the underlying causes of bread waste, respondents were asked about criteria influencing bread discarding decisions. Results are presented in Table 8 for Algeria and in Table 9 for Tunisia.

Among Algerian respondents (Table 8), the most significant criteria for bread wastage were sensory-based, with bad taste (61.1%) and poor texture (59%) being the leading factors, followed by poor overall quality (60.4%) and staling (59.1%). Significant associations were observed with gender, age and marital status ($p < 0.05$). In Tunisia (Table 9), the primary reason for discarding bread was staling, cited by 44.9% of respondents, followed by poor quality, which accounted for 39.8%. Sensory-based criteria also played a notable role in bread discarding decisions. For instance, bad taste was considered important to very important by 37.1% of respondents, while 32.1% regarded it as unimportant. Similarly, poor texture was viewed as important to very important by 37.1% of respondents, whereas 28.2% found it unimportant. Statistical analysis revealed significant associations between age and all criteria, with bad taste and poor texture also showing significant associations with both age and gender ($p < 0.05$). Our results underscore the importance of addressing sensory attributes and quality concerns to reduce bread waste in both countries. They also

reflected broader issues of production quality and consumer satisfaction in the baking industry.

To gain better insight of the causes of bread wastage, respondents were surveyed on their opinions on the main contributing factors (Figure 2).

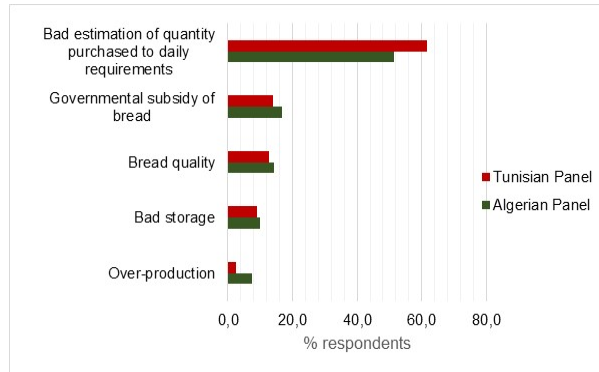


Figure 2. Respondents' Perceptions of Main Contributing Factors to Bread Waste in Algeria and Tunisia

The most frequently cited reason was the incorrect estimation of the quantity purchased relative to daily needs, reported by 51.5% of Algerian and 61.5% of Tunisian respondents. This was followed by governmental subsidies of bread, identified by 16.8% of Algerian and 14.1 % of Tunisian respondents, and concerns over bread quality, mentioned by 14.2% of Algerian and 12.8% of Tunisian respondents. Poor storage practices were cited by 9.9% of Algerian and 9% of Tunisian respondents. Over-production accounted for 7.6% of responses of the Algerian, while it was reported by only 2.6% of Tunisian respondents. These findings emphasized the key drivers of bread wastage at the consumer level.

4 DISCUSSION

Bread serves not only as a staple food but also as a significant cultural symbol in North African society. Bread wastage in North Africa reflects thus consumer behavior and cultural attitudes. Analyzing it can help design targeted interventions to reduce bread wastage and to promote more sustainable consumption practices and to achieve SDG 12.3. In this context, the present study investigated consumers' attitudes and behaviors with regard to household bread waste, in North Africa, with a particular focus on Algeria and Tunisia. By carefully examining these dimensions, drawing upon relevant scholarly work, and grounding the analysis within the specific context of Algeria and Tunisia, this research offers crucial guidance for policymakers, educators, and community stakeholders striving to minimize bread wastage in the region.

Consumption Habits and Bread Acquisition as Drivers of Waste

The genesis of bread waste often lies in the initial purchase and subsequent consumption patterns within households. Research consistently highlights the critical role of bread purchase habits in determining the extent of wastage (Demirtaş et al., 2018; Shahnoushi et al., 2013). The study's findings revealed distinct patterns in Algeria and Tunisia. In Algeria, subsidized municipal bakeries served as the primary source of bread for most respondents. This strong reliance on subsidized bread, however, was less pronounced in Tunisia, where modern bakeries played a more dominant role.

The enduring prevalence of subsidized bakeries in Algeria reflects the prevailing socio-economic landscape, where factors like the perceived high cost of living and youth unemployment drive consumers towards affordable options. While these bakeries are vital for ensuring access to a dietary staple for lower-income populations and contributing to social stability, they can also inadvertently encourage overbuying due to the low cost, as suggested by Khader et al. (2019) and Obeidat et al. (2015). In contrast, Tunisian consumers exhibited a more diversified purchasing behavior, with modern bakeries offering a wider variety of bread types and qualities, potentially explaining why price is a less significant overarching factor in their purchase decisions. Instead, factors like perceived quality and freshness appear to hold greater sway.

Across both countries, the present study identified a pattern of frequent and large bread purchases. This aligns with other research (Ananda et al., 2024; Demirtaş et al., 2018; Shahnoushi et al., 2013) linking frequent buying to increased bread wastage. Consumers who purchased bread daily might have higher expectations of "freshness," leading them to discard slightly stale but still edible bread (Hanssen et al., 2016; Østergaard et al., 2018). This tendency was amplified when large quantities are bought, making it harder to maintain the perceived "freshness" (Brancoli et al., 2019). Furthermore, frequent and large purchases can indicate a lack of adaptive consumption planning, resulting in waste when needs change (Ananda et al., 2024; Hassen et al., 2016). The impulse buying of a staple like bread, without considering actual consumption needs or meal planning, further contributes to this issue.

Interestingly, while freshness was a key consideration in the context of bread waste, the investigation revealed that cleanliness and hygiene of the purchasing location was the most influential factors in consumers' bread buying decisions in both Algeria and Tunisia, consistent with Demirtaş et al. (2018). This heightened concern for food safety, particularly post-COVID-19 (Ahsyar & Azhar, 2025; Jribi et al., 2021), underscored the importance consumers place on the perceived safety and quality of their food. Sensory characteristics like

taste and flavor also played a significant role, with gender-specific preferences observed in Algeria, where men prioritize these aspects more than women. This suggested that interventions aimed at reducing waste need to consider these primary purchase drivers, by for instance, emphasizing the link between hygiene, quality, and minimizing waste.

High Consumption and Cultural Significance in the Context of Bread Waste

The present research confirmed the high bread consumption rates in Algeria and Tunisia, underscoring its status as a dietary staple. This high consumption is rooted in a complex interplay of cultural traditions, economic realities, and historical influences. Bread is a versatile food consumed throughout the day and forms the base or accompaniment for numerous traditional dishes. In this study, household size significantly influenced consumption levels in Algeria, with larger families naturally consuming more bread (Fedala *et al.*, 2015). Cultural background also played a crucial role, with the consumption of local semolina and traditional breads reflecting regional preferences and customs (Bouchafaa, 2018). The symbolic significance of bread in North African societies, often associated with hospitality and sharing, further complicates the issue of waste.

The perceived quality of bread significantly may impact consumer satisfaction and, consequently, consumption. This study revealed differing perceptions of baguette quality between Algerian and Tunisian respondents, with socio-demographic factors like age and gender influencing these assessments (Demirtaş *et al.*, 2018; Moroşan *et al.*, 2024). Education also emerged as a significant factor shaping both consumption levels and preferences. Higher education was often associated with lifestyle changes and greater awareness of nutritional guidelines, leading to a higher consumption of whole grain bread. Conversely, those with less formal education tended to consume more traditional and semolina breads, potentially relying on sensory perceptions and cultural norms rather than nutritional information. This highlighted the need for targeted educational initiatives that consider socio-demographic influences on bread consumption to promote healthier choices and potentially reduce overall consumption of refined breads, which might be more prone to wastage.

Extent and Causes of Bread Wastage

The investigation revealed a considerable amount of bread wastage in both Algeria and Tunisia. A significant majority of respondents admitted to discarding bread after storage, even if in small quantities, highlighting storage practices as a key area for intervention. These findings were generally higher than some previous reports on food including bread wastage in Algeria (Arous *et al.*, 2017; Capone *et al.*, 2016) and in Tunisia (Sassi *et al.*, 2016) but align more closely with others (Jribi *et al.*, 2020) in Tunisia, suggesting a persistent issue.

Capone *et al.* (2016) highlighted that household bakery product waste could reach 20% in Egypt, Lebanon, Algeria, Morocco and Tunisia, particularly with subsidized bread. In contrast, in Turkey, Demirtaş *et al.* (2018) reported a level of household bread waste of 7%.

The present study also exhibited that several factors contribute to this wastage. Incorrect estimation of purchased quantity relative to actual needs was identified as a primary driver. Consumers often buy more bread than they can consume, leading to spoilage. In Tunisia, purchase frequency and location were shown significantly associated with post-meal waste. Governmental subsidies, while intended to ensure affordability, might also inadvertently encourage overbuying and less responsible consumption (Khader *et al.*, 2019; Obeidat *et al.*, 2015), although the study found no direct correlation between perceived price and waste, suggesting that the issue is more complex than just cost, confirming findings of Bouchafaa (2018).

Bread quality issues, such as staling and poor texture, were significant reported reasons for disposal, corroborating other studies (Shahnoushi *et al.*, 2013; Svanes *et al.*, 2018). Sensory-based factors were particularly influential in Algeria, while staling and poor quality were key in Tunisia, with demographic variations observed in these reasons for discarding bread. Improper storage practices further exacerbated the problem, leading to premature spoilage (Shahnoushi *et al.*, 2013; Svanes *et al.*, 2018; Østergaard *et al.*, 2018). Consequently, improving bread quality through innovations such as natural preservatives or optimized fermentation processes could extend shelf life, enhance consumers' acceptance, and thus significantly reduce waste. Innovative storage solutions have been developed, such as vacuum-sealing technology (Alpers *et al.*, 2021). Utilizing these methods can greatly enhance the shelf life of bread. Furthermore, educating consumers about proper storage techniques can empower them to make informed decisions leading to reduced waste.

Beyond consumer behavior, over-production at the bakery level was also reported to contribute to waste. Economic challenges and supply chain vulnerabilities can lead to surplus production that exceeds demand (Banasik *et al.*, 2017; Brancoli *et al.*, 2019). Logistical challenges, including aging infrastructure and poor transportation, hinder effective redistribution of surplus bread (Mostafa *et al.*, 2024; Thyberg & Tonjes, 2016). The lack of organized food preservation and redistribution practices further might compound this issue.

Strategies for Bread Waste Mitigation

Addressing bread waste in North Africa requires a multi-faceted approach focusing on values, skills, and logistics (Thyberg & Tonjes, 2016). Reforming bread subsidy policies to regulate purchase quantities and incentivize quality over quantity could be beneficial. In Egypt, Yigezu *et al.* (2021)

have observed a notable reduction in household bread waste, following the Egyptian government's 2014 policy shift, which replaced generalized flour subsidies to millers with targeted food vouchers for the neediest households. The introduction of food vouchers empowered low-income families to rationalize their bread consumption, allowing them to allocate resources to other food items. According to Yigezu *et al.* (2021), this policy adjustment was credited with decreasing bread waste and potentially improving the nutritional intake of vulnerable populations by promoting more conscious food choices. Training bakers on demand forecasting and prioritizing quality can help reduce overproduction (Fami *et al.*, 2019). Implementing regulations that facilitate the redistribution of excess edible bread to those in need aligns with the OECD's emphasis on reuse as a form of waste prevention (OECD, 2025). Digital solutions can also play a crucial role in optimizing the cereal value chain, improving demand forecasting, and minimizing surplus.

Efforts to achieve SDG 12.3 in Algeria and Tunisia involve national institutions and NGOs focused on reducing consumer-level food waste. Public awareness campaigns highlighting the economic and environmental impacts of bread waste are crucial. Demirtaş *et al.* (2018) posited the promising potential of integrating moral, ethical, and religious values within communication campaigns. Supporting this, Aleshaiwi and Harries (2021) observed in Saudi Arabia that the religious injunction against food waste ('haram' for wasting edible food, 'bayt') significantly influences consumer behavior. Despite a preference for fresh food, the religious prohibition compels individuals to employ management strategies to mitigate waste. This creates a discernible tension between the hedonic desire for freshly prepared meals and the religious imperative to utilize edible leftovers. Such findings underscore the substantial impact of religious values on food consumption patterns and waste avoidance. Leveraging traditional waste reduction practices, such as food sharing and utilizing stale bread in traditional recipes (Allipour-Birgani *et al.*, 2023; Ben Ismail *et al.*, 2022), can also offer culturally relevant solutions. Educating younger generations on these practices and to food waste reduction, and promoting alternative uses for stale bread through digital platforms (Jribi *et al.*, 2023) can be effective. Mobile applications can also assist consumers in tracking purchases, optimizing storage, and suggesting recipes for leftover bread. Consequently, a carefully constructed awareness campaign, thoughtfully interweaving religious teachings, moral considerations, practical solutions, and culturally resonant communication channels, holds the potential to leverage the intrinsic motivation to avoid the "sin of waste," thereby fostering more sustainable food practices. However, culturally sensitive and nuanced implementation remains paramount. Furthermore, valorizing stale bread into value-added products offers a promising avenue for reducing waste and creating new

economic opportunities (Ben Rejeb *et al.*, 2022; Brancoli *et al.*, 2020).

While this study provides valuable insights, its reliance on web-based surveys introduces potential sampling bias and the possibility of inaccurate reporting (Ben Hassen *et al.*, 2022; Jribi *et al.*, 2020; van Gefen *et al.*, 2020), which limits the generalizability of findings. Direct observation of food waste management practices would provide a more comprehensive understanding.

In conclusion, bread waste in North Africa is a complex issue driven by interconnected socio-economic dynamics and cultural practices. Addressing it requires nuanced strategies that consider the unique context of the region. By adopting targeted interventions that are both culturally sensitive and logistically practical, stakeholders can effectively minimize bread waste, contributing to local economic benefits, reduced food insecurity, and more sustainable food practices in the face of a growing global challenge.

5 CONCLUSIONS

The present research contributes with an insight into consumer purchase and consumption behaviors and attitudes relating to the waste of bread in Algeria and Tunisia, highlighting the significant influence of socio-demographic characteristics on these behaviors. Our findings revealed distinct patterns in purchase locations, frequency, and quantities between the two countries, with education and household size being key differentiating factors in Algeria, while household size and age played a more prominent role in Tunisia. Cleanliness and hygiene, followed by taste and flavor, emerged as the most critical factors influencing bread purchase decisions in both panels, overshadowing price and other attributes. While bread consumption was widespread, a considerable portion was not fully utilized, leading to wastage, with sensory attributes and perceived quality being major drivers for discarding bread. The incorrect estimation of purchase quantity relative to need was identified as the most significant contributing factor to bread waste in both Algeria and Tunisia, followed by the impact of governmental subsidies and concerns over bread quality. These insights underscored the need for targeted interventions that consider these socio-demographic nuances and address consumer perceptions of quality and purchasing habits to effectively mitigate bread wastage in the North African context.

Fostering an understanding of socio-demographic and cultural influences can, not only enrich the dialogue on bread consumption and wastage reduction, but also contribute to build a more sustainable and equitable food system. It requires a collective effort from individuals, businesses, and governments to change behaviors and implement effective solutions.

Further studies are needed to investigate specific storage techniques and management of uneaten bread in North African households. Additionally, it would be valuable to explore how household socio-demographic and cultural factors shape these practices.

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