ESI Preprints **Not Peer-reviewed**

Between Health Ally and Export Commodity: An Analysis of Consumers' Perceptions of Tea and Its Health Benefits in Bujumbura City

Alice Ndayirukiye
CRSNE-Research Center in Natural Sciences and Environment,
Faculty of Sciences, Université du Burundi, Bujumbura, Burundi
Menus Nkurunziza
CRMP-Research Center in Mathematics and Physics,
Faculty of Science, Université du Burundi, Bujumbura, Burundi
Emmanuel Singoye
CREDSR-Research and study Center on Development in Societies in Reconstruction, Faculty of Arts and Social Sciences,
Université du Burundi, Bujumbura, Burundi
Jeremie Ngezahayo
Pierre Claver Mpawenayo
CRSNE-Research Center in Natural Sciences and Environment,
Faculty of Sciences, Université du Burundi, Bujumbura, Burundi
Diomede Ndayitwayeko
Doctoral school, Department of Public Health, Faculty of Medicine,
Université du Burundi, Bujumbura, Burundi
Ferdinand Ndikuryayo
CURPAS-University Centre for Research and Applied Pedagogy in Science,
Institute of Applied Pedagogy, Burundi
Anaclet Nsabimana
School of Science-College of Science and Technology Kigali,
Department of Chemistry, Kigali, University of Rwanda, Butare, Rwanda
Godefroid Gahungu
CRSNE-Research Center in Natural Sciences and Environment,
Faculty of Sciences, Université du Burundi, Bujumbura, Burundi

Approved: 07 September 2026
Posted: 09 September 2026

Cite As:
Ndayirukiye, A., Nkurunziza, M., Singoye, E., Ngezahayo, J., Mpawenayo, P.C., Ndayitwayeko, D., Ndikuryayo, F., Nsabimana, A., & Gahungu, G. (2026). *Between Health Ally and Export Commodity: An Analysis of Consumers' Perceptions of Tea and Its Health Benefits in Bujumbura City*. ESI Preprints. https://doi.org/10.19044/esipreprint.9.2026.p106

Abstract

Tea (*Camellia sinensis*) serves as Burundi's second-largest foreign exchange earner, supporting over 60,000 smallholder tea farmers. Despite the high quality of local high-altitude harvests, a significant disconnect persists between the beverage's intrinsic functional value and domestic consumption practices. This study evaluated consumer perceptions, functional knowledge, and preparation habits in Bujumbura to identify key public health literacy gaps. A quantitative cross-sectional survey (n = 300) was conducted across Ntahangwa, Mugere, and Mukaza districts using simple systematic random sampling via mobile-administered structured questionnaires.

Results reveal a striking health-behavior paradox: while 54.4% of respondents report drinking tea for health reasons, over 90% regularly add refined sugar, and 28.0% incorporate bovine milk. These culinary additions introduce high glycemic loads and introduce milk proteins that clinically attenuate flavonoid bioavailability and acute vascular efficacy. Awareness of specific prophylactic properties was minimal: only 1.0% recognized tea's role in glycemic regulation, 0.3% were aware of cancer-preventive benefits, and 7.3% associated intake with sleep quality. Notably, despite 71.0% of participants attaining secondary or higher education, 97.0% could not identify any specific bioactive compounds.

Suboptimal preparation methods and low functional literacy severely diminish the health-promoting potential of Burundian tea. Targeted public health interventions, nutritional education focusing on reduced additives, and optimized brewing practices are urgently required to leverage local tea as an accessible tool in mitigating regional non-communicable diseases.

Keywords: Burundi tea, Consumer perception, Health benefits, nutritional awareness, Bujumbura

Introduction

Tea (Camellia sinensis), originating from Southeast Asia, has established itself as the most widely consumed beverage globally after water (Cabrera et al., 2006; Khan & Mukhtar, 2013). Its consumption has transcended mere hydration to become a cultural ritual and, increasingly, a dietary intervention. Modern phytochemistry has extensively characterized the tea leaf, identifying it as a rich reservoir of bioactive secondary metabolites (Dufresne & Farnworth, 2001; Abiri et al., 2023; Kumar et al., 2025). These include alkaloids (caffeine, theophylline and theobromine), amino acids (L-theanine), and, most notably, polyphenolic compounds such as flavonoids (Harbowy et al., 1997). In green tea, flavan-3-ols or catechins,

particularly epigallocatechin-3-gallate (EGCG), predominate, while in black tea, enzymatic oxidation converts these into complex theaflavins and thearubigins during processing (Tanaka & Kouno, 2003). It was reported that theaflavins in black tea and catechins in green tea are equally effective antioxidants (Leung et al., 2001).

From this perspective, Burundian black tea is a health ally comparable to the more famous green tea. Epidemiological and clinical studies have consistently linked the regular intake of these compounds to prophylactic effects against chronic pathologies, including cardiovascular diseases (Gardner et al., 2007; Stangl et al., 2006), type 2 diabetes, and certain carcinomas, (Khan & Mukhtar, 2013; Yang & Wang, 2016; Guo et al., 2023) primarily due to their potent capacity to scavenge reactive oxygen species (Kris-Etherton & Keen, 2002; Radeva-Ilieva et al., 2025; Czarniecka-Skubina et al., 2022; Stoeva et al., 2025).

In the East African region, tea cultivation is not merely agricultural but a cornerstone of macroeconomic stability. Specifically, tea contributes about USD 32 million to export earnings and supports over 60,000 smallholder farmers (Bitama et al., 2020). While commercial planting began in 1952, the Agricultural Research Institute (ISABU) established the first commercial plantations at Teza in 1963. Tea cultivation in Burundi benefits from the high-altitude terroir of the Congo-Nile Ridge (regions of Teza, Rwegura, Tora, Ijenda and Buhoro). Recent studies confirm that antioxidant activity (total phenols and flavonoids) has a positive association with altitude in tea-growing regions (De et al., 2025). It may be possible that the combination of acidic soils and a cool, humid climate at altitudes exceeding 2,000 meters favors the slow growth of leaves, thereby concentrating flavor profiles and polyphenol content (Kumar et al., 2025). Consequently, Burundian tea is highly prized on international auction markets, such as Mombasa, for its superior organoleptic qualities. In early 2025 market reports, Burundian tea fetched an average price of 2.51 USD per kg, outperforming teas from Tanzania (1.30 USD) and Uganda (1.19 USD) (EATTA, 2025).

Despite this agronomic success, the domestic consumption dynamic within Burundi presents a paradox. While the Office du Thé du Burundi (OTB) and private operators have optimized supply chains for export, the local market in urban centers like Bujumbura remains characterized by traditional consumption patterns. As rapid urbanization in Bujumbura drives a nutrition transition characterized by increased intake of processed sugars and saturated fats the incidence of non-communicable diseases (NCDs) is rising. In 2019, NCDs were estimated to cause 37% of all deaths in Burundi and the age-standardized mortality rate for major NCDs (cardiovascular, cancer, diabetes) remains high at 720 per 100,000 for male (WHO, 2023). In

this landscape, tea could serve as an accessible, low-cost functional food for public health mitigation (Cabrera et al., 2006). However, the potential health benefits of tea are contingent not only on the quality of the raw material but also on preparation methods and consumer awareness.

Preliminary observations suggest that the Burundian consumer views tea primarily as a vehicle for social bonding or thermoregulation, rather than a health-promoting beverage. Furthermore, local culinary habits often involve the simultaneous addition of high quantities of sucrose and bovine milk. From a biochemical perspective, this is critical; studies have indicated that casein proteins in milk can complex with tea polyphenols, potentially reducing their bioavailability and antioxidant efficacy in vivo (Lorenz et al., 2007; Dhillon et al., 2021; Otemuyiwa et al., 2017). Therefore, a significant gap exists in the literature regarding the intersection of agro-economic availability and nutritional literacy in Burundi. To date, no study has systematically quantified the level of awareness among Bujumbura's population regarding the specific health benefits of their national product.

The objective of this study is to conduct a comprehensive analysis of consumer perceptions in the economic capital, Bujumbura. Specifically, this research aims to: (1) profile the sociodemographic characteristics of tea consumers; (2) document domestic preparation habits that may influence nutritional quality; and (3) assess the Knowledge, Attitude, and Practice (KAP) gap regarding the preventive health properties of tea. Understanding these parameters is essential for formulating public health strategies and allowing the local tea industry to pivot towards a value-added, health-centric marketing approach.

Material and Methods

Study area

The study was conducted in the municipality of Bujumbura (Figure1), the economic capital of Burundi. This area was selected for its cosmopolitan nature and demographic density. The survey covered three administrative districts of the municipality: Mugere, Mukaza, and Ntahangwa.

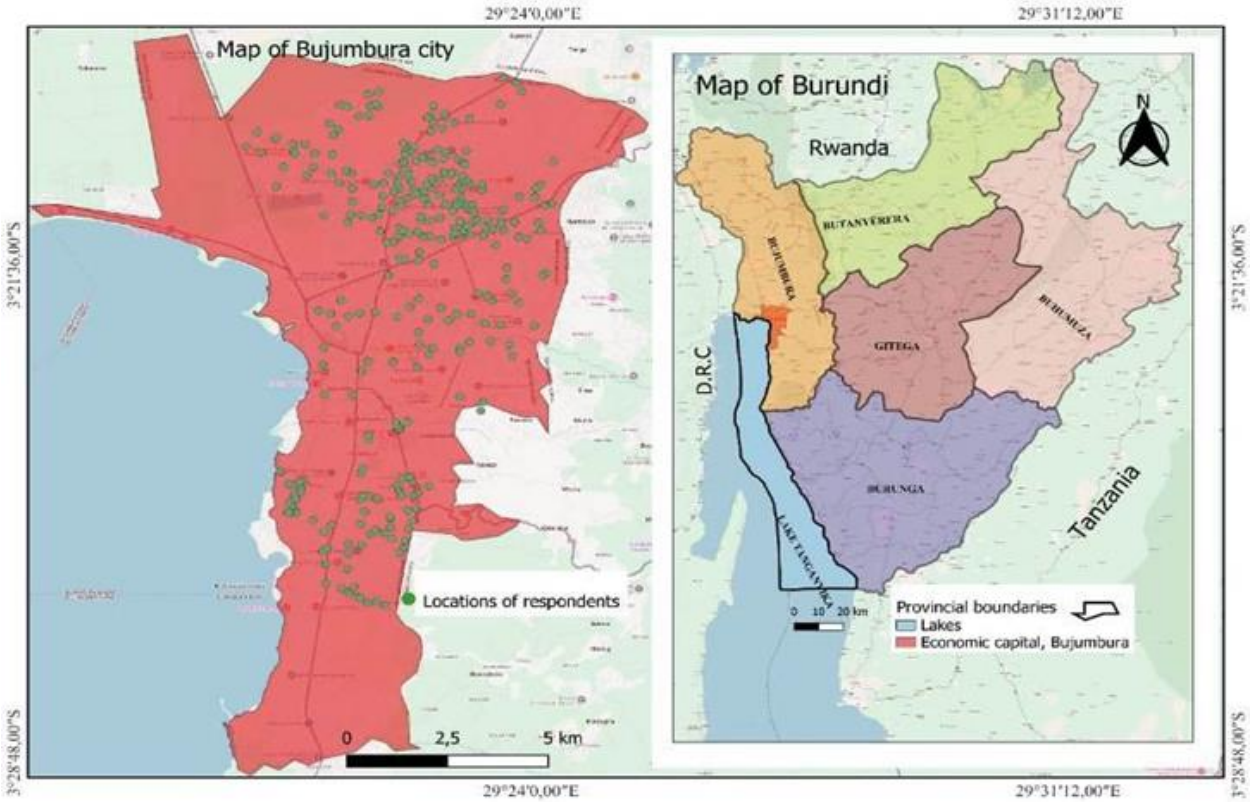

Figure 1: Location of the study area (Bujumbura municipality) on the national map of Burundi

Sample size determination

The target population consists of tea-consuming residents aged 18 (legal age of majority) and over. The study population was determined based on the 2024 general population census of Burundi, which records a total of 5,858,803 inhabitants aged 18 or older across urban (1,568,575) and rural (4,290,228) areas. To ensure the study focused on the most active consumer segment, the proportion of the urban population (p) was established using Equation 1:

$$p = \frac{A}{B}\ 100 \quad (1)$$

where p is the estimated proportion of the population residing in urban areas**,** ***A*** the total urban population aged 18 or older (1,568,575) and ***B*** is the total national population aged 18 or older (5,858,803).

Following the determination of p, the required sample size was calculated using the Cochran formula (Cochran, 1977) of equation 2:

$$n = \frac{z^2 \ p(1-p)}{2}$$

(2)

where n is the sample size, z = 1.96 (95 % confidence level), $\boldsymbol{p}$ is the proportion in Eq. 1 and = 0.05 (the margin of error). This yielded a rounded final sample size of n = 300 participants to ensure a statistically significant representation of the target population.

According to the general population census, the adult urban population of Bujumbura (k = 737,189) is distributed across three main municipalities: Ntahangwa (463,294), Mugere (187,835), and Mukaza (86,060). The sample size (x) for each administrative entity was allocated proportionally based on
Equation 3:

$$x = \frac{y \ 300}{k}$$

(3)

Where x is the sample size for each area, y is the population of the municipality, and k is the total urban population of Bujumbura. Consequently, the allocated participant sample sizes were 187 for Ntahangwa, 78 for Mugere, and 35 for Mukaza.

Data collection and analysis

After determining the sample size for each commune, households were selected starting from designated geographical seed points within each zone. The commune sample size was allocated proportionally across the constituent neighborhoods based on their estimated population density. Sampling was carried out during November 2025 using a structured questionnaire.

A simple systematic random sampling methodology was implemented using the KoboCollect application to ensure representative coverage across dense urban communes.

The primary data collection was carried out through structured questionnaire (see supplementary file). Questionnaire was deployed on mobile devices, allowing for real-time data entry, GPS tagging of survey sites, and immediate synchronization with a centralized database. This digital approach eased the efficient management of the 300 survey responses collected across the urban communes. To ensure optimal representativeness within each district, starting points were identified at regular intervals, acting as seeds. The first household was selected using a random seed, and from this point, a predefined direction was followed by the surveyors. The sampling interval was calculated for each area based on the estimated total number of households and the target sample size. Finally, stratification based

on sociodemographic characteristics was implemented. Following the collection phase, the data were exported via excel and subjected to SPSS Software for further statistical analysis and visual representations.

To assess the perceived functional value of tea, the study used a structured thematic framework. Respondent perceptions were categorized into eleven distinct variables of interest, which served as the basis for the qualitative analysis: (i) dietary habit (social/cultural), (ii) general health improvement, (iii) digestive health support, (iv) sleep quality enhancement, (v) cardiovascular disease reduction, (vi) immune system fortification , (vii) disease prevention, (viii) suitability for all ages, (ix) cognitive function improvement, (x) blood sugar (glycemic) regulation and (xi) cancer prevention/risk reduction.

To facilitate the analysis, these responses were categorized into three primary thematic clusters:

- knowledge of specific benefits encompassing digestive support, sleep enhancement, cardiovascular protection, immune fortification, glycemic regulation, and cancer risk reduction;
- general health perception including generic health improvement and suitability across all age demographics;
- consumption habits focusing on the frequency and patterns of intake.

Data analysis focused primarily on descriptive statistics, frequencies, and exploratory cross-tabulations to profile consumption patterns and knowledge gaps across sociodemographic groups. Consistent with the primary exploratory scope of this study, statistical determinant modeling (such as regression or association testing) was not performed and is reserved for a dedicated forthcoming study.

Sub-sample segmentation and analytical denominators

To maintain clear reporting across tables, dataset sub-groups were categorized based on survey skip-pattern logic:

- full primary sample (n = 300): all surveyed adult tea consumers used for general sociodemographics.
- habitual consumption sub-sample (n = 131): respondents who consume tea strictly out of dietary, social, or thermoregulatory habits without health-seeking intent.
- health-motivated sub-sample (n = 164): respondents who explicitly report consuming tea for health benefits.
- bioactive compound literacy sub-sample (n = 9): respondents who demonstrating unprompted recall of specific bioactive molecules.

Ethical Statement

This study was conducted in accordance with the declaration of Helsinki. The study consisted of a voluntary, anonymous survey of adults concerning their tea consumption habits and perceived health benefits. No personal identifying information was collected. Sociodemographic data were recorded using broad categories (age range, gender, marital status, educational level and location data were not stored. Informed consent was obtained from all participants via an introductory page describing the study purpose, the anonymous nature of data collection, and the right to withdraw at any time. No participants under 18 years were included.

Results

Socio-demographic profile of survey participants

The socio-demographic analysis of the 300 surveyed tea consumers is summarized in **Table 1**. The sample exhibits a nearly balanced gender distribution, with males accounting for 53% (n=159) and females being 47% (n=141). Geographically, 62% (n=187) of respondents were from the Ntahangwa district, followed by Mugere (26%, n=78) and Mukaza (12%, n=35). The population is notably youthful, with individuals under 35 years accounting for over 66% of respondents (18-25 years: 23.7%, n=71; 26-35 years: 42.7%, n=128; 36-50 years: 26%, n=78). Only 7.7% (n=23) were aged above 50. Education levels are high: 42.3% (n=127) completed secondary education and 28.7% (n=86) reached university levels, while only 24.7% (n=74) have a primary level and 4.33% (n=13) had no formal education.

Table 1: Sociodemographic characteristics of surveyed consumers (n=300)

Variables	Categories	Number (n)	Percentage (%)
Gender	Male	159	53
	Female	141	47
Age group	18 - 25 years	71	23.7
	26 – 35 years	128	42.7
	36 – 50 years	78	26
	> 50 years	23	7.7
Education level	Informal	13	4.33
	Primary	74	24.7
	Secondary	127	42.3
	University	86	28.7
Administrative entity	Mugere	78	26
	Mukaza	35	12
	Ntahangwa	187	62

Tea preparation and consumption patterns

Preparation methods are summarized in **Table 2** and **Figure 2**. The most prevalent practice is the addition of sugar, found in more than 90% of the responses. Tea with sugar alone accounts for 41.7% of responses. Natural

additives are also common, with lemongrass appearing in 13% of preparations and a combination of ginger, lemon, and honey in 4.3%. Approximately 35.4% of respondents boil their tea, while 28% incorporate milk. Only 6.7% of the sample consumes tea without sugar.

Table 2: Prevalence (%) of tea preparation modes among respondents.

Preparation mode	Percentage (%)*
Simple preparation	
Tea with sugar	41.7
Tea without sugar	6.7
Preparations with natural additives	
Tea with lemongrass and sugar	10.0
Tea with honey	6.3
Tea with ginger	4.0
Tea with ginger, lemon, and honey	4.3
Tea with lemon and sugar	3.3
Preparations with dairy (milk)	
Tea with milk and sugar	14.3
Tea with lemongrass, milk, and sugar	3.0
Boiled preparations (decoction)	
Tea heated to boiling with sugar	24.7
Tea heated to boiling with milk and sugar	10.7
Combined Stimulants	
Tea with coffee and honey	2.0
Tea with coffee	0.7

*The total percentage exceeds 100% due to the multiple-choice nature of the survey question

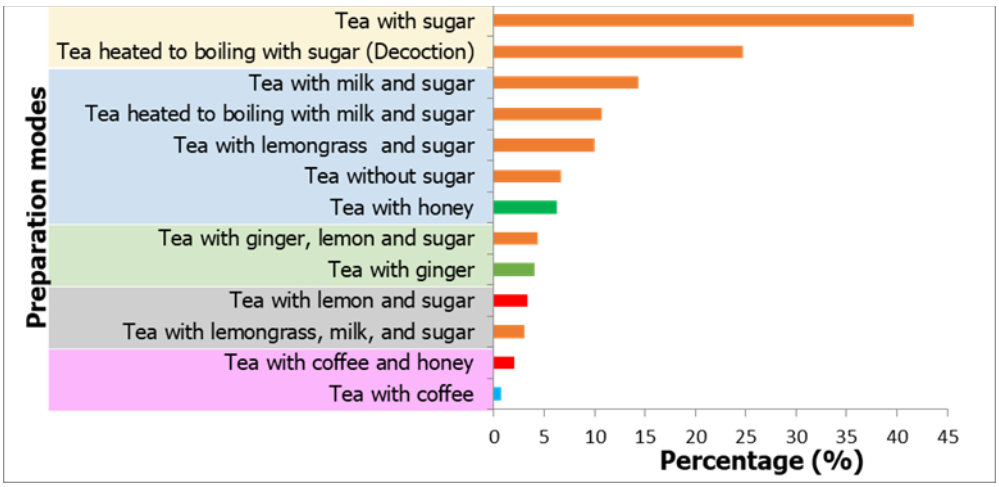

Figure 2: Prevalence of tea preparation modes: simple preparation (yellow) preparations with natural additives (blue), preparations with dairy (milk) (green), boiled preparations or decoction (gray), combined stimulants (pink)

In terms of frequency, Table 3 presents exploratory descriptive patterns in consumer habits across sociodemographic segments. Observed descriptive differences indicate higher reported consumption among

divorced or widowed respondents (81.8%), university graduates (55.1%), and civil servants (56.8%), compared to farmers (25.0%).

Table 3: Distribution of respondents according to their tea consumption habits and socio-economic characteristics (n=131)

		Consumption habits	
Socio-economic characteristic	**n**	**No[b]**	**Yes[a]**
Gender			
Female	55	28 (50.9%)	27 (49.1%)
Male	76	39 (51.3%)	37 (48.7%)
Marital status			
Single	62	31 (62.0%)	19 (38.0%)
Divorced/Widowed/Separated	11	2 (18.2%)	**9 (81.8%)**
Married	91	34 (48.6%)	36 (51.4%)
Education			
None	4	2 (50.0%)	2 (50.0%)
Primary	19	10 (52.6%)	9 (47.4%)
Secondary	59	33 (55.9%)	26 (44.1%)
University	49	22 (44.9%)	27 **(55.1%)**
Occupation			
Farmers	4	3 (75.0%)	1 **(25.0%)**
Artisans	25	12 (48.0%)	13 (52.0%)
Other activities	9	5 (55.6%)	4 (44.4%)
Commerce	25	14 (56.0%)	11 (44.0%)
Civil servants	37	16 (43.2%)	**21 (56.8%)**
Jobless	31	17 (54.8%)	14 (45.2%)

[a]Percentage of respondents who say they consume tea only as a dietary habit. [b] Percentage of non-respondents

Perceptions and bioactive literacy

The survey assessed the alignment between consumer belief and nutritional science. As summarized in **Table 4**, the primary driver for consumption is dietary habit (30.6%), followed by a generic good for health perception (16.6%). Recognition of specific clinical benefits is negligible: only 1.0% of respondents identified tea's role in blood sugar regulation, and a mere 0.3% were aware of its cancer-preventive properties.

Table 4: Perceived health benefits of tea consumption among respondents (n=300)

Perceived benefit	Frequency (n)	Percentage (%)*
Dietary habit (social/cultural)	93	30.6
General health improvement (generic)	50	16.6
Digestive health support	39	13.0
Sleep quality enhancement	22	7.3
Cardiovascular disease reduction	21	7.0
Immune system fortification	18	6.0
Disease prevention (non-specific)	15	5.0
Suitability for all ages (including children)	10	3.3
Cognitive function improvement	8	2.7
Blood sugar (glycemic) regulation	3	1.0
Cancer prevention/risk reduction	1	0.3

*Percentages reflect the primary benefit cited by respondents

To examine how perceptions vary across demographic segments, Table 5 summarizes the distribution of knowledge and health perceptions. Descriptively, participants with primary education reported a higher proportion of specific knowledge (57.1%) than university graduates (39.3%), while women were descriptively more inclined to perceive tea as beneficial compared to men (37.9% vs. 29.6%).

Table 5: Distribution of respondents according to their general knowledge of tea benefits and perceptions of its health value by socio-demographic characteristics (n=164)

		Knowledge of benefits		Good for health perception	
Characteristics	**n**	**No[a]**	**Yes[b]**	**No[a]**	**Yes[b]**
Gender					
Female	66	39 (59.1%)	27 (40.9%)	41 (62.1%)	25 (37.9%)
Male	98	56 (57.1%)	42 (42.9%)	69 (70.4%)	29 (29.6%)
Status					
Single	62	34 (54.8%)	28 (45.2%)	44 (71.0%)	18 (29.0%)
Divorced/Widowed	11	6 (54.5%)	5 (45.5%)	7 (63.6%)	4 (36.4%)
Married	91	55 (60.4%)	36 (39.6%)	59 (64.8%)	32 (35.2%)
Education					
None	5	3 (60.0%)	2 (40.0%)	4 (80.0%)	1 (20.0%)
Primary	7	3 (42.9%)	4 (57.1%)	5 (71.4%)	2 (28.6%)
Secondary	70	43 (61.4%)	27 (38.6%)	44 (62.9%)	26 (37.1%)
University	82	46 (60.7%)	32 (39.3%)	57 (70.5%)	25 (29.5%)
Occupation					
Farmers	5	0 (0.0%)	5 (100.0%)	5 (100.0%)	0 (0.0%)
Artisans	31	22 (71.0%)	9 (29.0%)	18 (58.1%)	13 (41.9%)
Other activities	9	5 (55.6%)	4 (44.4%)	7 (77.8%)	2 (22.2%)
Commerce	33	17 (51.5%)	16 (48.5%)	26 (78.8%)	7 (21.2%)
Civil servants	44	26 (59.1%)	18 (40.9%)	31 (70.5%)	13 (29.5%)
Without activity	42	25 (59.5%)	17 (41.0%)	25 (59.0%)	17 (41.0%)

[a] Percentage of respondents who report certain benefits of tea. [b] Percentage of non-respondents

Nutritional biochemistry literacy

The depth of the knowledge gap is quantified in **Table 6**. Out of the entire sample, only a minimal subset of nine individuals (n=9) could identify specific bioactive compounds in tea. A high percentage (97%) of participants were unable to name molecules such as polyphenols, catechins, or L-theanine, indicating that even among the educated elite, tea consumption remains a habit of “social mimicry” rather than informed pharmacological choice

Table 6: Level of knowledge regarding specific bioactive compounds in tea by socio-demographic characteristics (n=9).

		Polyphenols		Caffeine		Theophylline		L-Theanine)	
Characteristics	**n=9**	**No [b]**	**Yes [a]**	**No [b]**	**Yes [a]**	**No [b]**	**Yes [a]**	**No [b]**	**Yes [a]**
Gender									
Female	1	1 (100.0%)	0 (0.0%)	0 (0.0%)	1(100.0%)	1(100.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)
Male	8	7 (87.5%)	1 (12.5%)	0 (0.0%)	8 (100.0%)	8 (100.0%)	0 (0.0%)	7 (87.5%)	1 (12.5%)
Status									
Divorced/Widowed	1	1 (100.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)
Married	8	7 (87.5%)	1 (12.5%)	0 (0.0%)	8 (100.0%)	8 (100.0%)	0 (0.0%)	7 (87.5%)	1 (12.5%)
Education									
None	1	1 (100.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)
University	8	7 (87.5%)	1 (12.5%)	0 (0.0%)	8 (100.0%)	8 (100.0%)	0 (0.0%)	7 (87.5%)	1 (12.5%)
Occupation									
Artisan	1	1 (100.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)
Commerce	1	1 (100.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)
Civil servant	4	3 (75.0%)	1 (25.0%)	0 (0.0%)	4 (100.0%)	4 (100.0%)	0 (0.0%)	4 (100.0%)	0 (0.0%)
Jobless	3	3 (100.0%)	0 (0.0%)	0 (0.0%)	3 (100.0%)	3 (100.0%)	0 (0.0%)	2 (66.7%)	1 (33.3%)

[a] Percentage of respondents who are familiar with certain bioactive substances in tea. b Percentage of non-respondents.

Discussion

The paradox of additives

The high combined prevalence of additive usage with over 90% of respondents adding refined sugar and 28% incorporating milk (Table 2) presents an important nutritional dynamic. From a metabolic standpoint, the addition of high quantities of sucrose introduces a glycemic load that may counter or mask the potential insulin-sensitizing actions attributed to tea polyphenols. As noted by Flavel et al. rapid glycemic surges from refined sugars can exacerbate underlying insulin resistance (Flavel et al., 2023). Furthermore, clinical trials evaluating endothelial function have demonstrated that milk proteins (specifically caseins) can interact with tea flavan-3-ols, partially blunting or diminishing their acute vascular and antioxidant benefits in human subjects (Arts et al., 2002; Lorenz et al., 2007; Chen et al., 2024). Similarly, prolonged high-temperature decoction (boiling) may accelerate the thermal degradation of delicate catechin structures like EGCG. Consequently, common domestic preparation habits in Bujumbura may substantially diminish the functional health potential expected from premium high-altitude tea.

The communication failure in public health

The near-total ignorance of tea's role in cancer prevention (0.3%) and glycemic regulation (1%) in Table 4 represents a communication failure in Burundian health education. This finding is consistent with the literature suggesting that the population was unaware of its chemo preventive (anti-cancer) properties (Radeva-Ilieva et al., 2025; Czarniecka-Skubina et al., 2022).

In global public health models, higher education is typically a predictor of better nutritional choices (Pampel et al., 2010; Nikora & McFarlane, 2010). However, in the context of Burundi, formal schooling appears to remain siloed from practical health applications.In accordance with Worsley's (2002) observations, tea consumption habits are influenced by social norms and empirical legacies rather than an understanding of the product's prophylactic properties (Worsley, 2002).

While tea is internationally studied for its ability to reduce oxidative stress and prevent deoxyribonucleic acid (DNA) damage, it is extensively studied for its capacity primarily through the action of its polyphenolic compounds (Mao et al., 2017; Truong & Jeong, 2021). Local consumers view it through a lens of subjective sensory experience. This is exemplified by the 7.3% of respondents, who drink tea for sleep; they likely experience the entourage effect where L-theanine promotes relaxation despite the presence of caffeine, yet they lack the pharmacological understanding of this interaction (Owen et al., 2008). A core finding of this research is the striking divergence between formal academic attainment and functional health literacy. While the socio-demographic profile of the sample (n=300) indicates a relatively high level of formal schooling, with 71% of respondents having reached secondary or university education, this does not correlate with an understanding of the nutritional biochemistry of tea. This education-literacy gap is quantified by the fact that 97.0% of participants were unable to identify a single bioactive compound responsible for the beverage's therapeutic effects. According to the study conducted by Kumar and his co- authors, the pharmacological actions of tea constituents remain unknown and warrant further investigation (Kumar et al., 2025).

Sociological contradictions

The observed descriptive gap between formal education levels and functional literacy (Table 5) suggests that higher academic attainment may not automatically translate into practical health knowledge. In this sample, university-educated respondents did not exhibit greater bioactive literacy than those with primary schooling. Similarly, observed descriptive trends among tea farmers highlight low personal consumption rates (25.0%), aligning with previous reports, that tea is often perceived strictly as an export crop rather than a domestic health asset (Bitama & Burny, 2020).

Given the rising incidence of non-communicable diseases (NCDs) in East Africa, Burundian tea represents an underutilized public health resource. To maximize its health dividends, public health initiatives must move beyond general promotion. Educational interventions should focus on functional literacy: teaching consumers to optimize brewing temperatures and avoid inhibitory additives like sugar and milk. Transforming tea from a

social habit into a strategic dietary intervention could significantly aid in national NCD prevention efforts.

Conclusion

This study provides a comprehensive assessment of tea consumption patterns in Bujumbura revealing a profound disconnect between cultural habits and nutritional science. This study highlights a significant divergence between the high consumption of tea in urban areas in Burundi and the exploitation of its therapeutic potential. While Camellia sinensis is a fundamental cultural element for a population that is mostly young and educated, its role as a functional food is currently undermined by a deep paradox between knowledge of phytochemistry and a lack of understanding of tea. Although 71% of respondents have a level of secondary or higher education, 97% of them are unaware of the bioactive polyphenolic matrix that determines the beneficial health effects of this drink. This lack of domain-specific knowledge creates a gap between knowledge and practice, since traditional preparation methods directly compromise the molecular integrity of the leaf.

More specifically, observational and chemical data suggest that the potential therapeutic efficacy of Burundian tea is frequently blunted by thermal degradation during prolonged decoction, potential polyphenol-protein complexation from milk addition, and the metabolic offset of high sucrose intake.

Therefore, from the public health standpoint, Burundi tea represents a biochemically underutilized resource for the prevention of non-communicable diseases (NCDs). The near-total lack of knowledge about the role of tea in blood glucose regulation (1.0%) and in reducing cancer risk (0.3%) highlights a significant gap in current health communication strategies. To move from traditional consumption to data-driven consumption, a multisectoral approach is needed. Public health authorities must go beyond simply promoting well-being and focus on understanding functional preparation methods, favoring boiling with infusion to preserve the concentration of antioxidants, and recommending the addition of ascorbic acid to improve the stability of catechins. At the same time, Burundi's tea industry must evolve from exports focused on raw materials to adding value based on health benefits. The strategic implementation of "smart packaging" which quantifies antioxidant concentration and provides standardized infusion recommendations is essential to ensure the medicinal integrity of the product at the time of consumption. In addition, developing lines of functional products incorporating dried ginger or lemongrass could leverage local flavors to reduce consumers' dependence on additives that are harmful to health. By synchronizing efforts across the education, public health, and

industry sectors, Burundi can transform an everyday staple into a powerful tool for preventing chronic diseases and improving the nation's economic value.

Authors' contributions

- Alice Ndayirukiye: Conceptualization, data acquisition, visualization, formal analysis, writing original draft, review and editing;
- Emmanuel Singoye: Software and Guidance on data analysis;
- Menus Nkurunziza: Methodology, Guidance on data analysis and synthesis;
- Jérémie Ngezahayo: Validation and Reviewing of manuscript;
- Pierre Claver Mpawenayo: Validation and Reviewing of manuscript;
- Diomède Ndayitwayeko: Validation and Reviewing of manuscript;
- Ferdinand Ndikuryayo: Conceptualization, formal analysis, review and editing;
- Anaclet Nsabimana: Validation and Reviewing of manuscript;
- Godefroid Gahungu: Conceptualization, supervision, formal analysis, writing original draft, review and editing.

Conflict of Interest: The authors reported no conflict of interest.

Data Availability: All data are included in the content of the paper.

Funding Statement: One of the authors, MSc. Alice Ndayirukiye, acknowledges the financial support from the University of Burundi.

Declaration for Human Participants: This study was approved by University of Burundi's Ethics Review Board (Comité d'Éthique de la Recherche à l'Université du Burundi – CER-UB) prior to the commencement of research. Voluntary consent to participate in the survey was sought from participants. Trained investigators obtained informed consent from participants before conducting the recording the responses to the questionnaire. Participants gave voluntary consent to participate in the survey.

References:

1. Abiri, B., Amini, S., Hejazi, M., Hosseinpanah, F., Zarghi, A., Abbaspour, F., & Valizadeh, M. (2023). Tea's anti-obesity properties, cardiometabolic health-promoting potentials, bioactive compounds, and adverse effects : A review focusing on white and green teas. *Food Science & Nutrition*, *11*(10), 5818-5836. https://doi.org/10.1002/fsn3.3595

2. Arts, M. J. T. J., Haenen, G. R. M. M., Wilms, L. C., Beetstra, S. A. J. N., Heijnen, C. G. M., Voss, H.-P., & Bast, A. (2002). Interactions between Flavonoids and Proteins : Effect on the Total Antioxidant Capacity. *Journal of Agricultural and Food Chemistry*, *50*(5), 1184-1187. https://doi.org/10.1021/jf010855a
3. Bitama, P., & Burny, P. (2020, septembre). *Challenges in the Tea Industry in Burundi : Upgrading and Sustainability Policies*. Agrarian Perspectives XXIX. https://orbi.uliege.be/handle/2268/251517
4. Bitama, P. C., Lebailly, P., Ndimanya, P., & Burny, P. (2020). Cash Crops and Food Security : A Case of Tea Farmers in Burundi. *Asian Social Science*, *16*(7), 81. https://doi.org/10.5539/ass.v16n7p81
5. Cabrera, C., Artacho, R., & Giménez, R. (2006). Beneficial Effects of Green Tea—A Review. *Journal of the American College of Nutrition*, *25*(2), 79-99. https://doi.org/10.1080/07315724.2006.10719518
6. Chen, N., Jiao, Z., Xie, K., Liu, J., Yao, P., Luo, Y., Zhang, T., Cheng, K., & Zhao, C. (2024). Effects of protein on green tea quality in a milk-tea model during heat treatment : Antioxidant activity, foaming properties, and unbound small-molecule metabolome. *Journal of Dairy Science*, *107*(12), 10462-10480. https://doi.org/10.3168/jds.2024-25167
7. Cochran, W. G. (1977). *Sampling techniques* (3. ed). Wiley.
8. Czarniecka-Skubina, E., Korzeniowska-Ginter, R., Pielak, M., Sałek, P., Owczarek, T., & Kozak, A. (2022). Consumer Choices and Habits Related to Tea Consumption by Poles. *Foods*, *11*(18). https://doi.org/10.3390/foods11182873
9. De, D., Ashraf, G. J., Sahu, R., & Ray, S. (2025). Impact of Altitude, Seasonal Variation, and Processing Parameters on Bioactive Compounds and Antioxidant Potential of Darjeeling Tea. *INTERNATIONAL JOURNAL OF PLANT AND ENVIRONMENT*, *11*(01), 77-92. https://doi.org/10.18811/ijpen.v11i01.09
10. Dhillon, B., Awasthi, T., Sodhi, N. S., Sogi, D. S., & Jaiswal, S. (2021). A comparative study to investigate the effects of addition of milk and sugar on total polyphenol, flavonoid, catechin and tannin contents of green and black teas consumed in India. *Journal of Food Measurement and Characterization*, *15*(5), 4652-4658. https://doi.org/10.1007/s11694-021-01036-z
11. Dufresne, C. J., & Farnworth, E. R. (2001). A review of latest research findings on the health promotion properties of tea. *The Journal of Nutritional Biochemistry*, *12*(7), 404-421. https://doi.org/10.1016/S0955-2863(01)00155-3

12. EATTA. (2025). *Mombasa Tea Auction Report January 2025 (Sale 03)**. East African Tea Trade Association. https://www.scribd.com/document/871081333/Tea-Market-Report-3-2025
13. Flavel, M., Neoh, J., & Lim, K. F. (2023). Dose-Dependency of the Glycemic Response to Polyphenol-Rich Sugarcane Extract (PRSE). *Biologics*, *3*(4), 308-320. https://doi.org/10.3390/biologics3040016
14. Gardner, E. J., Ruxton, C. H. S., & Leeds, A. R. (2007). Black tea – helpful or harmful? A review of the evidence. *European Journal of Clinical Nutrition*, *61*(1), 3-18. https://doi.org/10.1038/sj.ejcn.1602489
15. Guo, J., Li, K., Lin, Y., & Liu, Y. (2023). Protective effects and molecular mechanisms of tea polyphenols on cardiovascular diseases. *Frontiers in Nutrition*, *10*. https://doi.org/10.3389/fnut.2023.1202378
16. Harbowy, M. E., Balentine, D. A., Davies, A. P., & Cai, Y. (1997). Tea Chemistry. *Critical Reviews in Plant Sciences*, *16*(5), 415-480. https://doi.org/10.1080/07352689709701956
17. Khan, N., & Mukhtar, H. (2013). Tea and Health : Studies in Humans. *Current Pharmaceutical Design*, *19*(34), 6141-6147.
18. *KoboToolbox*. (s. d.). KoboToolbox. Consulté 2 mars 2026, à l'adresse https://www.kobotoolbox.org/
19. Kris-Etherton, P. M., & Keen, C. L. (2002). Evidence that the antioxidant flavonoids in tea and cocoa are beneficial for cardiovascular health: *Current Opinion in Lipidology*, *13*(1), 41-49. https://doi.org/10.1097/00041433-200202000-00007
20. Kumar, P., Chaudhary, S., Sood, S., Mahant, S., Pundir, S., Kalia, P., & Kumar, R. (2025). Tea beyond the cup : A comprehensive review of Camellia sinensis (L.) O. Kuntze. *Clinical Phytoscience*, *11*(1), 23. https://doi.org/10.1186/s40816-025-00413-1
21. Leung, L. K., Su, Y., Zhang, Z., Chen, Z.-Y., Huang, Y., & Chen, R. (2001). Theaflavins in Black Tea and Catechins in Green Tea Are Equally Effective Antioxidants. *The Journal of Nutrition*, *131*(9), 2248-2251. https://doi.org/10.1093/jn/131.9.2248
22. Lorenz, M., Jochmann, N., von Krosigk, A., Martus, P., Baumann, G., Stangl, K., & Stangl, V. (2007). Addition of milk prevents vascular protective effects of tea. *European Heart Journal*, *28*(2), 219-223. https://doi.org/10.1093/eurheartj/ehl442
23. Mao, X., Gu, C., Chen, D., Yu, B., & He, J. (2017). Oxidative stress-induced diseases and tea polyphenols. *Oncotarget*, *8*(46), 81649-81661. https://doi.org/10.18632/oncotarget.20887
24. Nikora, R. D., & McFarlane, D. R. (2010). Closing the Gap in a Generation : Health Equity Through Action on the Social

Determinants of Health. *Journal of Health Politics, Policy and Law*, *35*(3), 438-442. https://doi.org/10.1215/03616878-2010-010
25. Otemuyiwa, I. O., Williams, M. F., & Adewusi, S. A. (2017). Antioxidant activity of health tea infusions and effect of sugar and milk on in-vitro availability of phenolics in tea, coffee and cocoa drinks. *Nutrition & Food Science*, *47*(4), 458-468. https://doi.org/10.1108/NFS-08-2016-0134
26. Owen, G. N., Parnell, H., De Bruin, E. A., & Rycroft, J. A. (2008). The combined effects of L-theanine and caffeine on cognitive performance and mood. *Nutritional Neuroscience*, *11*(4), 193-198. https://doi.org/10.1179/147683008X301513
27. Pampel, F. C., Krueger, P. M., & Denney, J. T. (2010). Socioeconomic Disparities in Health Behaviors. *Annual Review of Sociology*, *36*, 349-370. https://doi.org/10.1146/annurev.soc.012809.102529
28. Radeva-Ilieva, M., Stoeva, S., Hvarchanova, N., & Georgiev, K. D. (2025). Green Tea : Current Knowledge and Issues. *Foods*, *14*(5). https://doi.org/10.3390/foods14050745
29. Stangl, V., Lorenz, M., & Stangl, K. (2006). The role of tea and tea flavonoids in cardiovascular health. *Molecular Nutrition & Food Research*, *50*(2), 218-228. https://doi.org/10.1002/mnfr.200500118
30. Stoeva, S., Hvarchanova, N., Georgiev, K. D., & Radeva-Ilieva, M. (2025). Green Tea : Antioxidant vs. Pro-Oxidant Activity. *Beverages*, *11*(3). https://doi.org/10.3390/beverages11030064
31. Tanaka, T., & Kouno, I. (2003). Oxidation of Tea Catechins : Chemical Structures and Reaction Mechanism. *Food Science and Technology Research*, *9*(2), 128-133. https://doi.org/10.3136/fstr.9.128
32. Truong, V.-L., & Jeong, W.-S. (2021). Cellular Defensive Mechanisms of Tea Polyphenols : Structure-Activity Relationship. *International Journal of Molecular Sciences*, *22*(17). https://doi.org/10.3390/ijms22179109
33. WHO. (2023). *Country Desease Outlook Burundi*. World Health Organization, African Region.
34. Worsley, A. (2002). Nutrition knowledge and food consumption : Can nutrition knowledge change food behaviour? *Asia Pacific Journal of Clinical Nutrition*, *11*(s3), S579-S585. https://doi.org/10.1046/j.1440-6047.11.supp3.7.x
35. Yang, C. S., & Wang, H. (2016). Cancer Preventive Activities of Tea Catechins. *Molecules*, *21*(12). https://doi.org/10.3390/molecules21121679