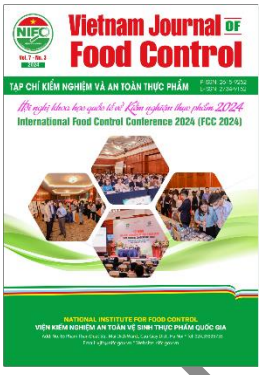
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Assessment of dietary exposure risk to benzoates and sorbates from starch-based processed foods among Bachelor of Nutrition students at Hanoi Medical University

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Assessment of dietary exposure risk to benzoates and sorbates from starch-based processed foods among Bachelor of Nutrition students at Hanoi Medical University

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Abstract

Starch-based processed foods are becoming increasingly popular in the daily diets of university students. A cross-sectional study was conducted among 185 first- and second-year Bachelor of Nutrition students at Hanoi Medical University during the 2025–2026 academic year to characterize consumption patterns and evaluate cumulative dietary exposure risks to benzoates and sorbates across 42 starch-based processed food items. Food consumption frequency and portion sizes were collected using a Food Frequency Questionnaire (FFQ) on REDCap integrated with a standardized Food Atlas; preservative concentrations in food samples collected from Dong Da district, Hanoi, were analyzed by high-performance liquid chromatography with ultraviolet detection (HPLC-UV) according to TCVN 8122:2009 [8]. Chronic dietary exposure was estimated using a deterministic point-estimate model under the Upper Bound (UB) scenario [1, 2]. Results indicated that instant noodles had the highest consumption prevalence among students (79.46%; mean intake of 14.99 g/day), followed by unpackaged bread (47.57%; 12.87 g/day) and fresh rice noodles (bún tươi) (28.65%; 9.76 g/day). Mean benzoate concentrations were highest in mung bean cake (199.4 mg/kg) and pia cake (115.1 mg/kg), whereas sorbate concentrations peaked in mung bean cake (297.2 mg/kg) and packaged pastries (284.9 mg/kg). All analyzed samples (100%) complied with the maximum allowable limits (ML) set by the Ministry of Health under Circular 24/2019/TT-BYT [4]. The cumulative mean estimated daily intake (EDI_mean) across all 42 food items was 0.03703 mg/kg bw/day for benzoate (equivalent to 0.7406% ADI) and 0.07151 mg/kg bw/day for sorbate (equivalent to 0.2860% ADI) [3]. Under the 95th percentile (P95) high-consumption scenario, cumulative exposure reached 2.3700% ADI for benzoate and 0.9872% ADI for sorbate [3]. Unpackaged bread was the primary contributor to total dietary exposure for both benzoate (42.42%) and sorbate (36.68%). Preservative exposure levels from starch-based foods among Bachelor of Nutrition students remain well within safe health thresholds (< 1% ADI for mean intake and < 2.5% ADI under the P95 scenario) [3]. Nutrition communication should guide students toward rational convenience food selection and product label reading skills rather than advocating an absolute prohibition of processed foods.

Từ khóa: Processed foods, Benzoates, Sorbates, Dietary exposure, ADI, Nutrition students.

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Abstract

Starch-based processed foods are becoming increasingly popular in the daily diets of university students. A cross-sectional study was conducted among 185 first- and second-year Bachelor of Nutrition students at Hanoi Medical University during the 2025–2026 academic year to characterize consumption patterns and evaluate cumulative dietary exposure risks to benzoates and sorbates across 42 starch-based processed food items. Food consumption frequency and portion sizes were collected using a Food Frequency Questionnaire (FFQ) on REDCap integrated with a standardized Food Atlas; preservative concentrations in food samples collected from Dong Da district, Hanoi, were analyzed by high-performance liquid chromatography with ultraviolet detection (HPLC-UV) according to TCVN 8122:2009 [8]. Chronic dietary exposure was estimated using a deterministic point-estimate model under the Upper Bound (UB) scenario [1, 2]. Results indicated that instant noodles had the highest consumption prevalence among students (79.46%; mean intake of 14.99 g/day), followed by unpackaged bread (47.57%; 12.87 g/day) and fresh rice noodles (bún tươi) (28.65%; 9.76 g/day). Mean benzoate concentrations were highest in mung bean cake (199.4 mg/kg) and pia cake (115.1 mg/kg), whereas sorbate concentrations peaked in mung bean cake (297.2 mg/kg) and packaged pastries (284.9 mg/kg). All analyzed samples (100%) complied with the maximum allowable limits (ML) set by the Ministry of Health under Circular 24/2019/TT-BYT [4]. The cumulative mean estimated daily intake (EDI_mean) across all 42 food items was 0.03703 mg/kg bw/day for benzoate (equivalent to 0.7406% ADI) and 0.07151 mg/kg bw/day for sorbate (equivalent to 0.2860% ADI) [3]. Under the 95th percentile (P95) high-consumption scenario, cumulative exposure reached 2.3700% ADI for benzoate and 0.9872% ADI for sorbate [3]. Unpackaged bread was the primary contributor to total dietary exposure for both benzoate (42.42%) and sorbate (36.68%). Preservative exposure levels from starch-based foods among Bachelor of Nutrition students remain well within safe health thresholds (< 1% ADI for mean intake and < 2.5% ADI under the P95 scenario) [3]. Nutrition communication should guide students toward rational convenience food selection and product label reading skills rather than advocating an absolute prohibition of processed foods.

Keywords: Processed foods, Benzoates, Sorbates, Dietary exposure, ADI, Nutrition students.

1. INTRODUCTION

Starch-based processed foods are increasingly prevalent in the daily diets of the general population, particularly among young adults living and studying in urban areas. Convenience in consumption, affordable cost, extended shelf life, and short preparation time are the primary factors rendering these products well-suited to modern lifestyles. During food processing, preservatives of the benzoate group (benzoic acid and its benzoate salts) and the sorbate group (sorbic acid and its sorbate salts) are widely utilized to effectively inhibit the growth of molds, yeasts, and spoilage microorganisms [1,2].

Despite offering substantial technological benefits in food preservation, consuming food products containing additives beyond permissible thresholds may pose potential adverse risks to public health [1,2]. To control exposure risks, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) has established an Acceptable Daily Intake (ADI) of 0–5 mg/kg body weight/day for benzoic acid and benzoate salts, and 0-25 mg/kg body weight/day for sorbic acid and sorbate salts [3]. In Vietnam, the Ministry of Health promulgated Circular No. 24/2019/TT-BYT, which specifically regulates the management and Maximum Use Levels (ML) of individual food additives across food categories [4].

University students represent a demographic with distinctive lifestyle characteristics that directly influence food consumption patterns: intensive academic schedules, limited time for home cooking, a strong preference for convenience foods, and a high degree of autonomy in dietary choices [5]. Surveillance studies on food additive residues in Hanoi have indicated that the presence of benzoates and sorbates is relatively common in starch-based food groups [6]. However, cumulative quantitative assessment data on actual dietary exposure among Nutrition students—a group possessing specialized academic knowledge yet constrained by limited living allowances and collective living conditions-remain scarce.

Stemming from this practical context, the present study was conducted with three specific objectives: (1) To describe the consumption frequency and intake levels of 42 starch-based processed foods among Bachelor of Nutrition students at Hanoi Medical University during the 2025–2026 academic year; (2) To determine the concentrations of benzoates and sorbates in surveyed food samples collected from areas surrounding the study site; and (3) To estimate

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the chronic Estimated Daily Intake (EDI), the percentage of the Acceptable Daily Intake (%ADI at both mean and 95th percentile [P95] levels), and the percentage contribution of individual food groups to total preservative exposure among the study population.

2. MATERIALS AND METHODS

2.1. Study Subjects and Materials

Study Population (Consumers): The study encompassed all first-year (Y1) and second-year (Y2) students enrolled in the Bachelor of Nutrition program at Hanoi Medical University during the 2025-2026 academic year. Selecting Y1 and Y2 Nutrition students was predicated on the fact that this period represents a critical lifestyle transition from high school to university environment, wherein students must manage independent living, reside primarily in dormitories or shared rented accommodations, and navigate intensive theoretical and practical coursework, resulting in a high frequency of convenience food utilization. Concurrently, investigating this specific cohort serves as a foundational baseline/pilot study prior to expanding the risk assessment model to the broader medical student population. Inclusion criteria comprised students actively enrolled, present at the time of the survey, and voluntarily consenting to complete the questionnaire. Students who were absent or provided incomplete survey responses were excluded from the study.

• Food Samples: The analytical materials consisted of starch-based processed food samples belonging to the 42 surveyed product categories. To ensure a direct linkage between potential hazard sources and consumer exposure, all food samples were collected from retail outlets, convenience stores, bakeries, traditional pastry shops, local wet markets, and mini-supermarkets located within Dong Da District and adjacent areas surrounding Hanoi Medical University-where students reside and purchase food daily. All collected samples were required to be within their expiration dates and have intact packaging for coding, preservation, and laboratory analysis.

2.2. Study Design and Sampling

A cross-sectional descriptive study design was employed. The student sample size was calculated using the formula for estimating a proportion in a finite population (N = 185 Y1 and Y2 Bachelor of Nutrition students):

$$n = [Z^2(1-\alpha/2) \times p(1 - p)] / d^2$$

Where: $Z(1-\alpha/2) = 1.96$ (at $\alpha = 0.05$); $p = 0.822$ is the prevalence of processed food consumption reported by Truong Thi Thuy Duong et al. [7]; and $d = 0.055$ is the acceptable margin of error. Substituting these parameters into the formula yielded $n \approx 186$. Given that the total population of Y1 and Y2 Bachelor of Nutrition students was N = 185, applying the finite population correction formula $n' = n / [1 + (n - 1)/N]$ yielded a minimum required sample size of $n' \approx 93$ students. To maximize statistical reliability and population representativeness, a total enumeration survey of all 185 students was conducted. The final actual sample size included in the analysis was 185 students.

For food sampling, a total of 587 representative samples across the 42 starch-based processed food categories were randomly collected from retail points surrounding the university campus and dormitories in Dong Da District, Hanoi.

2.3. Data Collection and Laboratory Analysis

Food consumption data were collected using a Food Frequency Questionnaire (FFQ) designed on the REDCap electronic data capture platform. The questionnaire recorded demographic characteristics, self-reported anthropometric indicators (height, weight), consumption frequency (times/day, times/week, times/month), and portion size per eating occasion (g/occasion). Portion sizes were converted into grams based on commercial product labels and a standardized photographic Food Atlas.

Concentrations of benzoates and sorbates in food samples were quantified by high-performance liquid chromatography with ultraviolet detection (HPLC-UV) in accordance with the Vietnamese National Standard TCVN 8122:2009 [8] at an ISO/IEC 17025-accredited laboratory [9]. The analytical method was validated, achieving recovery rates ranging from 91.5% to 102.3% and precision (relative standard deviation, RSD) < 4.5%, meeting AOAC International performance requirements [10]. The Limit of Detection (LOD) was 10.0 mg/kg for benzoate and 2.0 mg/kg for sorbate; the corresponding Limit of Quantification (LOQ) was 33.0 mg/kg for benzoate and 6.6 mg/kg for sorbate.

To handle left-censored data (samples falling below the detection or quantification limits), the study applied the Upper Bound (UB) substitution approach in accordance with EFSA and FAO/WHO guidelines for food safety risk assessment [1, 2]: samples with concentrations below the LOD (< LOD) were assigned the value of the LOD (C = LOD), while samples between the LOD and LOQ were assigned the value of the LOQ (C = LOQ). The UB scenario ensures a maximally conservative precaution, preventing the underestimation or omission of potential public health risks.

2.4. Chronic Dietary Exposure Calculation and Risk Assessment Criteria

Daily dietary exposure levels and health risks associated with food preservatives among the study subjects were calculated and evaluated based on standardized methodologies promulgated by the Joint FAO/WHO Expert

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Committee on Food Additives (JECFA) [3]. All computational equations and evaluation indices were implemented under a unified methodological framework to ensure scientific rigor and international comparability.

2.4.1. Mean Daily Intake Rate of Food Item i (IRi):

The mean daily intake rate (IRi, expressed in kg/day) reflects the average quantity of food item i ingested by an individual per day. The IRi index is determined using the formula:

$$IRi\ (kg/day) = (Frequency_i \times Portion_i) / (7 \times 1000)$$

Where: Frequency_i represents the number of times the subject consumes food item i per week (unit: times/week); Portion_i represents the estimated weight of food item i consumed per eating occasion (unit: g/occasion); and 7 × 1000 is the conversion factor to kg/day.

2.4.2. Estimated Daily Intake (EDIi) and Cumulative Total Exposure (∑EDI):

The Estimated Daily Intake (EDI) reflects the long-term average daily intake load of a preservative per kilogram of body weight. Because an individual's actual dietary pattern involves varying combinations of foods across different days of the week (rather than consuming all 42 food items simultaneously on a single day), the cumulative exposure (∑EDI_total) represents the aggregate preservative load accumulated from the entire basket of starch-based processed foods present in the subject's habitual weekly diet:

$$EDIi\ (mg/kg\ bw/day) = (Ci \times IRi) / BW$$

$$\sum EDI_total\ (mg/kg\ bw/day) = \sum (EDIi)$$

Where: Ci represents the mean analyzed concentration of the preservative (benzoate or sorbate) in food item i (mg/kg); IRi is the mean daily intake rate of food item i (kg/day); and BW = 54.0 kg is the mean body weight of the participating student cohort.

2.4.3. Percentage of Acceptable Daily Intake (%ADIi):

The percentage of the Acceptable Daily Intake (%ADIi, expressed in %) serves as a quantitative metric of chronic health risk by directly comparing the estimated daily exposure (at both the mean level [EDI_mean] and the 95th percentile high-consumption level [EDI_P95]) against the health-based guidance values established by JECFA [3] (ADI_Benzoate = 5.0 mg/kg bw/day and ADI_Sorbate = 25.0 mg/kg bw/day):

$$\%ADIi = (EDIi / ADI) \times 100\%$$

If %ADIi ≤ 100%, the dietary exposure level is within the safe permissible threshold; if %ADIi > 100%, the exposure exceeds the safety threshold and indicates a potential chronic health risk.

2.4.4. Percentage Contribution to Total Exposure (%Contribution_i):

The percentage contribution (%Contribution_i, expressed in %) measures the relative proportion of preservative exposure attributable to an individual food item i compared to the cumulative preservative exposure across all 42 surveyed food categories:

$$\%Contribution_i = (EDIi / \sum EDI_total) \times 100\%$$

2.5. Statistical Analysis and Ethical Considerations

Questionnaire data collected via REDCap were cleaned, coded, and analyzed using SPSS version 26.0 and Python version 3.10. Food sample datasets were cross-checked for consistency between sample codes and food category classifications. Qualitative variables are presented as frequencies and percentages (%); quantitative variables are expressed as mean ± standard deviation (SD).

The study was approved by Hanoi Medical University. Investigators clearly explained the study objectives and obtained voluntary informed consent from all participating students prior to data collection. All personal information was anonymized, strictly kept confidential, and utilized solely for scientific research purposes.

3. RESULTS AND DISCUSSION

3.1. General Characteristics of the Study Population

The study was conducted on all 185 first- and second-year (Y1 and Y2) Bachelor of Nutrition students at Hanoi Medical University. The analytical results clearly reflect the distinctive demographic and living characteristics of the study cohort: females accounted for a predominant proportion at 84.3% (156 students), while males represented 15.7% (29 students), which aligns with the typical gender distribution of enrollments in the Nutrition program across academic years. Regarding living arrangements, the majority of students lived away from their families, with 58.9% residing in university dormitories or shared off-campus rentals with peers, and 9.2% living alone. Notably, the economic conditions of the students were relatively modest, as 61.1% reported a monthly living expenditure below 3 million VND/month, with financial support primarily relying on family allowances (58.4%). Nutritional status

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assessment based on Asian BMI classification criteria indicated that 60.5% of students had a normal body weight (BMI 18.5-22.9 kg/m²), 30.3% were underweight (< 18.5 kg/m²), and 9.2% were overweight or obese (≥ 23.0 kg/m²).

Constrained living budgets, living away from home, and academic pressure predispose students to frequently select starch-based processed foods due to their speed, affordability, and convenience [5]. However, because the surveyed subjects were Nutrition majors-individuals already possessing foundational knowledge of food safety-the obtained results may be subject to information bias. This student cohort typically exhibits greater health consciousness regarding dietary habits, reads food labels, and proactively limits the consumption of preservative-rich products. Consequently, the food intake levels and preservative exposure loads documented in this study primarily represent a 'health-conscious' subpopulation and may be lower than those of students in non-health disciplines or the general youth population. This distinction should be carefully considered when extrapolating these findings to other demographic groups.

3.2. Consumption Levels of Starch-Based Processed Foods

The consumption frequency (times/week) and mean daily intake rate (IR, g/day) of the 42 starch-based processed food items among the study subjects are summarized in Table 1.

Table 1. Consumption prevalence, frequency, and mean daily intake of starch-based processed foods (n = 185)

No.	Food Item	Consumption Prevalence (%)	Frequency (times/week)	Mean Daily Intake (IR, g/day)
1	Instant noodles	79.46	1.21	14.99
2	Unpackaged bread	47.57	0.76	12.87
3	Fresh rice noodles	28.65	0.39	9.76
4	Packaged bread	30.81	0.50	4.91
5	Dried rice noodles	9.19	0.12	4.68
6	Unpackaged pastries/cakes	18.38	0.13	4.02
7	Steamed buns	22.70	0.26	3.95
8	Fresh pho noodles	21.62	0.21	3.64
9	Pre-packaged snacks/chips	28.65	0.38	3.41
10	Instant pho	20.00	0.33	2.95
11	Packaged pastries/cakes	24.86	0.45	2.74
12	Steamed rice rolls / wet rice paper	15.68	0.09	2.37
13	Instant cereal	7.57	0.15	2.01
14	Instant porridge	18.38	0.16	1.56
15–34	Bulk snacks, pho rolls, rice leaf cake, glass noodles, pyramidal rice dumpling, pia cake, mung bean cake...	0.54–9.19	0.00–0.05	0.05–0.86
35–42	Instant dried rice vermicelli, plain rice flan, Nian gao, steamed rice discs, flat rice dumplings), honeycomb cake...	0.00	0.00	0.00

Data in Table 1 demonstrate that among the 42 surveyed food categories, instant noodles were overwhelmingly predominant, with a student consumption prevalence reaching 79.46%, a consumption frequency of 1.21 times/week, and a mean daily intake of 14.99 g/day. Unpackaged bread ranked second with 47.57% of consumers (12.87 g/day), followed by fresh rice noodles (bún tươi) (28.65%; 9.76 g/day), packaged bread (30.81%; 4.91 g/day), and dried rice noodles (mì chũ / mì gạo) (9.19%; 4.68 g/day). Product groups including packaged pastries, steamed buns (bánh bao), fresh pho noodles, and pre-packaged snacks maintained consumer prevalences between 18% and 30%, with daily intakes ranging from 2.7 to 4.0 g/day. Notably, eight traditional starch-based food items (No. 35 to 42) recorded zero consumption among the surveyed students during the investigation period.

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The pronounced preference for instant noodles and bread reflects the pragmatic food selection behavior of university students: low cost, high convenience, rapid energy provision, and widespread availability at local grocery stores and street bakeries surrounding the university campus and dormitories [5]. This finding is highly consistent with a study by Huh et al. in Seoul, South Korea, which reported that instant noodles and bread consistently topped the list of processed foods consumed by university students [11]. Similarly, research by Truong Thi Thuy Duong et al. in Thai Nguyen indicated that instant noodles and bread accounted for the largest proportions in the fast-food consumption patterns of medical and pharmacy students [7]. These observations confirm that such dietary habits are pervasive among young adult students, underscoring an urgent need to monitor and control the quality and levels of preservative additives in these staple convenience food groups.

3.3. Concentrations of Benzoates and Sorbates in Food Samples

The concentrations of benzoate and sorbate preservatives analyzed via high-performance liquid chromatography (HPLC-UV) in market-collected food samples are presented in Table 2.

Table 2. Mean concentrations of Benzoates and Sorbates in representative food samples

No.	Food Item	Sample Size (n)	Mean Benzoate (mg/kg)	Mean Sorbate (mg/kg)	Compliance with Circular 24/2019/TT-BYT
1	Mung bean cake	26	199.40	297.23	Compliant (≤ ML)
2	Pia cake	26	115.10	195.00	Compliant (≤ ML)
3	Conjugal cake	30	79.40	91.57	Compliant (≤ ML)
4	Unpackaged bread	26	65.90	110.03	Compliant (≤ ML)
5	Green rice flake cake	30	53.00	187.10	Compliant (≤ ML)
6	Packaged pastries/cakes	51	45.90	284.90	Compliant (≤ ML)
7	Packaged bread	26	15.20	78.74	Compliant (≤ ML)
8	Instant noodles	57	13.20	12.29	Compliant (≤ ML)
9	Fresh rice noodles	26	11.40	4.95	Compliant (≤ ML)
10	Samples < LOD	—	10.00 (LOD)	2.00 (LOD)	Compliant (≤ ML)

Note: ML: Maximum Use Level in accordance with Circular No. 24/2019/TT-BYT [4]; LOD for Benzoate = 10.0 mg/kg; LOD for Sorbate = 2.0 mg/kg.

Results in Table 2 indicate that mean benzoate concentrations reached their highest values in traditional pastries and bread: mung bean cake (199.40 mg/kg), pia cake (115.10 mg/kg), conjugal cake (bánh phu thê) (79.40 mg/kg), and unpackaged bread (65.90 mg/kg). Mean sorbate concentrations peaked in mung bean cake (297.23 mg/kg), packaged pastries (284.90 mg/kg), pia cake (195.00 mg/kg), and unpackaged bread (110.03 mg/kg). Conversely, staple products such as instant noodles, fresh rice noodles (bún tươi), and fresh pho noodles exhibited very low preservative residues (below 20 mg/kg). Regulatory comparison confirmed that 100% of the analyzed samples strictly complied with the Maximum Use Levels (ML) stipulated under Circular No. 24/2019/TT-BYT [4].

From a food technology perspective, the distribution of additive residues across different food matrices is directly governed by intrinsic moisture characteristics (water activity, aw) and required shelf life. Traditional Vietnamese cakes (mung bean cake, pia cake, green rice flake cake) contain high levels of sugar and protein alongside moderate moisture content, making them highly susceptible to fungal spoilage; furthermore, because they are typically distributed at ambient temperatures, manufacturers incorporate higher levels of sorbates and benzoates to extend their shelf life [6]. In contrast, dried instant noodles possess extremely low water activity ($a_w < 0.3$), which virtually inhibits microbial proliferation, resulting in minimal technological need for chemical preservatives. The finding that 100% of surveyed samples met regulatory standards demonstrates strong legal compliance regarding food additive usage among food production facilities in the study area [4].

3.4. Estimation of Cumulative Chronic Exposure (EDI), %ADI, and Percentage Contribution

The cumulative mean daily exposure load (EDI_mean), high-consumption scenario exposure (EDI_P95), and percentage contribution of major food groups are presented in Table 3 and Table 4.

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Table 3. Cumulative chronic dietary exposure (EDI) and %ADI under Mean and High-Consumption (P95) scenarios

Exposure Metric	Benzoate (Mean)	Benzoate (P95)	Sorbate (Mean)	Sorbate (P95)
Cumulative daily exposure ∑EDI (mg/kg bw/day)	0.03703	0.11850	0.07151	0.24680
Percentage of safety threshold (%ADI)	0.7406%	2.3700%	0.2860%	0.9872%
Health risk assessment	Very safe	Very safe	Very safe	Very safe

Data in Table 3 show that the cumulative mean estimated daily intake (∑EDI) reached 0.03703 mg/kg bw/day for benzoate (equivalent to 0.7406% ADI) and 0.07151 mg/kg bw/day for sorbate (equivalent to 0.2860% ADI). Even under the 95th percentile (P95) high-consumption scenario, cumulative exposure reached only 2.3700% ADI for benzoate and 0.9872% ADI for sorbate. All estimated values are substantially below the 100% ADI safety threshold established by JECFA [3].

Table 4. Estimated daily intake (EDI), %ADI, and percentage contribution of major food groups to total Benzoate and Sorbate exposure (BW = 54.0 kg)

Food Group	EDI Benzoate (mg/kg bw/day)	%ADI Benzoate	% Contribution Benzoate	EDI Sorbate (mg/kg bw/day)	%ADI Sorbate	% Contribution Sorbate
Unpackaged bread	0.015708	0.3142%	42.42%	0.026227	0.1049%	36.68%
Packaged pastries/cakes	0.002326	0.0465%	6.28%	0.014439	0.0578%	20.19%
Packaged bread	0.001381	0.0276%	3.73%	0.007153	0.0286%	10.00%
Steamed buns	0.000899	0.0180%	2.43%	0.006789	0.0272%	9.49%
Instant noodles	0.003664	0.0733%	9.89%	0.003411	0.0136%	4.77%
Other groups (37 items)	0.013052	0.2610%	35.25%	0.013492	0.0539%	18.87%
Total cumulative exposure	0.037030	0.7406%	100.00%	0.071511	0.2860%	100.00%

Note: ADI Benzoate = 5.0 mg/kg bw/day; ADI Sorbate = 25.0 mg/kg bw/day [3]. %ADI and % contribution were calculated across all 42 food items.

Table 4 demonstrates that unpackaged bread was the single largest dietary source of preservative exposure, contributing up to 42.42% of total benzoate exposure and 36.68% of total sorbate exposure. Although instant noodles had the highest consumer prevalence, they accounted for only 9.89% of benzoate exposure and 4.77% of sorbate exposure. Meanwhile, packaged pastries ranked second in contributing to total sorbate exposure (20.19%).

In-depth analysis reveals that unpackaged bread emerged as the leading contributor not because it contained excessive additive concentrations, but due to the synergistic combination of a substantial daily intake volume (12.87 g/day) and moderate preservative levels in the product. Quantitative findings confirm that the risk of preservative exposure from starch-based foods among Bachelor of Nutrition students currently lies entirely within absolute safety thresholds (< 1% ADI at the mean level and < 2.5% ADI under the P95 scenario) [3]. Nevertheless, this conclusion is delimited to the surveyed starch-based food categories. Although toxicological risks from chemical preservatives are negligible, overly frequent consumption of processed convenience foods can still induce nutritional imbalances (such as dietary fiber and micronutrient deficiencies) [5]. Therefore, university nutrition communication should focus on guiding students toward dietary diversification and food label literacy rather than enforcing absolute restrictions.

3.5. Study Limitations

This study has four primary limitations that warrant consideration when interpreting the findings:

First, dietary intake data collected via the FFQ are inherently susceptible to recall bias and potential under-reporting among Nutrition students regarding their consumption of processed convenience foods.

Second, applying the Upper Bound (UB) substitution scenario-which assigns LOD/LOQ values to non-detected or unquantified samples-ensures maximum public health conservatism [1, 2] but may result in an overestimation of actual exposure levels.

Third, utilizing a fixed cohort mean body weight (54.0 kg) rather than individual-specific body weights in deterministic equations may introduce minor variations for severely underweight or overweight/obese students.

Fourth, the scope of this investigation was restricted to 42 starch-based processed food items; consequently, the findings do not represent total cumulative preservative exposure from the entire daily diet (which also includes soft drinks, condiments/sauces, jams, and jellies).

4. CONCLUSION

This study provides a comprehensive overview and quantitative scientific evidence regarding consumption patterns and chronic dietary exposure risks to benzoate and sorbate preservatives from starch-based processed foods among Bachelor of Nutrition students at Hanoi Medical University. The findings indicate that instant noodles, unpackaged bread, and fresh rice noodles (bún tươi) accounted for the highest consumer prevalence and mean daily intake volumes within the convenience diet. From a food safety standpoint, 100% of the tested food samples across the surveyed categories strictly complied with the Maximum Use Levels (ML) stipulated under Circular No. 24/2019/TT-BYT of the Ministry of Health, with the highest preservative concentrations observed in traditional cakes and bread. Cumulative exposure assessment confirmed that the total Estimated Daily Intake (EDI) for both benzoates and sorbates remained exceptionally low under both the mean intake and 95th percentile (P95) high-consumption scenarios (< 2.5% ADI). Unpackaged bread was identified as the primary contributor to total dietary exposure for both preservatives. Overall, dietary exposure risks to benzoate and sorbate additives from starch-based processed foods among Bachelor of Nutrition students lie entirely within safe health thresholds according to international and national standards.

Based on these empirical findings, two key sets of recommendations are proposed to optimize student health promotion and food safety management: (1) Regarding school nutrition education and risk communication, universities and specialized departments should strengthen educational programs to guide students in establishing healthy eating habits, rationally combining convenience foods with fresh food sources rich in dietary fiber and micronutrients, and practicing product label reading skills, rather than issuing unnecessary absolute prohibitions against processed foods; (2) Regarding food safety regulatory and testing agencies, periodic surveillance of food additive residues should be continuously maintained, focusing specifically on small-scale street bakeries and traditional pastry production facilities surrounding university campuses to ensure sustainable regulatory compliance and safeguard public health..

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