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# EVALUATING THE QUALITY OF DOMESTIC WATER AND DRINKING WATER FOR STUDENTS IN THANH HOA, VIETNAM

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***Abstract:*** **This study was conducted to evaluate the quality of domestic (non-drinking) and drinking water used by students in Thanh Hoa, based on 51 domestic water and 51 drinking water samples collected from student boarding houses and dormitories. The samples were analyzed against several parameters specified in the Ministry of Health's National Technical Regulation QCVN (Vietnamese Standard) 02/2009/BYT (Ministry of Health) and the recommendations of the EPA (2025). The results indicate that the majority of the water samples met the safety standards, satisfying the basic quality requirements for both domestic use and direct consumption. The water sources generally exhibited good clarity, were odorless and tasteless, maintained a stable pH level, and showed no significant contamination. However, some samples demonstrated variation in quality, particularly concerning the Total Dissolved Solids (TDS) index, which may be linked to differing storage conditions, piping systems, or water supply sources. The study affirms the crucial role of clean water quality in general, and clean water for students in particular. Furthermore, the research recommends the need for close monitoring of clean water quality, periodic inspection, and strengthened measures for maintaining water supply infrastructure. The research findings contribute a scientific basis for urban environmental management and the protection of student public health.**

***Keywords:*** **Domestic water; Drinking water; Water quality; Students; Thanh Hoa.**

## I. INTRODUCTION

Water is an essential component, playing a decisive role in the existence and development of life on Earth. According to biological studies, approximately 70% of the human body mass is water; metabolic activities and essential cell functions will be severely disrupted even with a short period of water deprivation. Furthermore, water is an indispensable factor in human daily life, production, and study. Therefore, ensuring a safe, sanitary, and stable source of domestic water is an essential requirement for sustainable development.

In Vietnam, along with the vigorous process of urbanization and industrialization, the quality of domestic water sources in many residential areas tends to decline, particularly in boarding houses, where the water supply system often lacks stability and undergoes infrequent maintenance. According to the Ministry of Health (MOH) (2023), in many localities, especially suburban areas, residents still use untreated water sources that do not meet standards, posing potential risks of chemical and microbial contamination. A study by Le Ngoc Tram and Ho Dac Thoan (2023) in Hau Giang province showed that only 43.3% of domestic water samples met the QCVN 01-1/2018/BYT (MOH) standard, while many samples had iron,

manganese, and ammonium content exceeding the allowable limits. Similarly, Nguyen Tri Quang Hung at el (2018) also found that in Trang Bang district, Tay Ninh province, many water samples were contaminated with E. coli and coliforms, reflecting alarming microbial and physico-chemical pollution. These figures indicate that although the water supply system has been expanded, the quality of domestic water remains truly unsafe in many residential areas.

Notably, student boarding houses and dormitories often have a high concentration of people, a small area of use and a water supply primarily dependent on shared pipelines or household drilled wells. The management, inspection and maintenance of the water supply system in these areas are often sporadic, leading to risks of contamination and a decline in domestic water quality. Meanwhile, students are a sensitive population group in terms of health and economic conditions. This makes access to safe water even more critical. Therefore, studying and evaluating the quality of domestic water in student rental rooms is extremely necessary to promptly detect influential factors and propose measures to ensure water safety.

In light of this reality, evaluating the quality of students' domestic water in Thanh Hoa is essential and holds practical significance. This is an area with a high concentration of students, high daily water usage demand, but limited water supply infrastructure. The study aims to survey and analyze the physico-chemical parameters of domestic water sources in boarding houses, evaluate the compliance level with current regulations, and concurrently propose solutions for safe water usage and treatment. The research results will not only help raise public and student awareness about health protection but also provide a scientific basis for local authorities in controlling and managing urban domestic water quality.

## II. THEORETICAL BACKGROUND

### *A. Basic Concepts*

In general human perception, clean water is often simply understood as water that is clear, colorless, odorless, and tasteless. However, from a scientific perspective, the concept of "clean water" has been defined and refined throughout each stage of social development, reflecting the level of awareness, customs, and the advancement of economy and science-technology in each country.

In Vietnam, according to Ho Thi Duyen et al. (2023) citing the definitions of national technical regulations - "clean water is sanitary water, ensuring safety for human health, characterized by being clear, colorless, odorless, tasteless, free of pathogenic microorganisms and toxic substances exceeding the allowable limits". According to the definition of the Ministry of Health (2023), clean water is understood as a water source that fully meets the standards for physico-chemical and microbial quality, contains no toxic components or pathogenic microorganisms, ensuring safety for human health when used for domestic and drinking purposes. Thus, water is considered clean not only when it satisfies sensory criteria (such as being clear, odorless, and tasteless) but, more importantly, when it ensures chemical, biological, and microbiological safety.

From a public health perspective, domestic water in student boarding areas is particularly important in ensuring the quality of life and health of students. The majority of students live away from their families and have limited economic resources, so access to a safe and sanitary water source plays an essential role in daily activities such as cooking, bathing and personal hygiene. Substandard water sources can pose potential risks of waterborne infectious diseases such as diarrhea, dermatitis, intestinal diseases or long-term health problems due to the accumulation of heavy metals and toxic chemicals. In addition to the direct impact on health, the quality of domestic water also affects the psychology, learning effectiveness and quality of life of students. The use of safe and stable water helps students feel secure in their studies and daily life, reducing medical expenses. Conversely, having to deal with contaminated or unstable water sources makes students susceptible to anxiety, reduces their ability to concentrate and affects learning performance.

### *B. Clean Water Evaluation Standards*

In the process of evaluating domestic water quality, researchers often rely on a system of physico-chemical and microbial standards to determine the safety level of the water source for human health. According to the U.S. Environmental Protection Agency (EPA, 2025), clean water evaluation standards are divided into two main groups: National Primary Drinking Water Regulations (NPDWRs) and National Secondary Drinking Water Regulations (NSDWRs). The Primary Standards group (NPDWRs) includes mandatory regulations that establish Maximum Contaminant Levels (MCLs) for pollutants in water to protect public health and prevent risks from heavy metals, chemical compounds, or harmful microorganisms. Meanwhile, the Secondary Standards group (NSDWRs) is non-mandatory and focuses on aesthetic sensory factors such as the color, odor, and taste of the water, helping to assess the acceptable level from an aesthetic perspective, specifically as follows:

**TABLE 1: SECONDARY DRINKING WATER STANDARDS ACCORDING TO THE EPA (2025)**

| Contaminant | Secondary MCL | Noticeable Effects above the Secondary MCL |
|---|---|---|
| **Aluminum** | 0.05 to 0.2 mg/L* | colored water |
| **Chloride** | 250 mg/L | salty taste |
| **Color** | 15 color units | visible tint |
| **Copper** | 1.0 mg/L | metallic taste; blue-green staining |
| **Corrosivity** | Non-corrosive | metallic taste; corroded pipes/fixtures staining |
| **Fluoride** | 2.0 mg/L | tooth discoloration |
| **Foaming agents** | 0.5 mg/L | frothy, cloudy; bitter taste; odor |
| **Iron** | 0.3 mg/L | rusty color; sediment; metallic taste; reddish or orange staining |
| **Manganese** | 0.05 mg/L | black to brown color; black staining; bitter metallic taste |
| **Odor** | 3 TON (threshold odor number) | "rotten-egg", musty or chemical smell |
| **pH** | 6.5 – 8.5 | low pH: bitter metallic taste; corrosion; high pH: slippery feel; soda taste; deposits |
| **Silver** | 0.1 mg/L | skin discoloration; graying of the white part of the eye |
| **Sulfate** | 250 mg/L | salty taste |
| **Total Dissolved Solids (TDS)** | 500 mg/L | hardness; deposits; colored water; staining; salty taste |
| **Zinc** | 5 mg/L | metallic taste |

*(Source: U.S.EPA, 2025)*

In Vietnam, this evaluation is performed according to the National Technical Regulation on the Quality of Domestic Water (QCVN 02/2009/BYT) issued by the Ministry of Health in 2009. This regulation specifies the allowable limits for characteristic parameters such as turbidity, pH, heavy metal content (iron, manganese, lead, arsenic, etc.), inorganic compounds (ammonium, nitrite, nitrate, chloride, sulfate, etc.), organic substances, and microbial indicators (E. coli, total coliforms, etc.). Based on the domestic water indicators according to the Ministry of Health's Vietnamese standard (2009), they are specifically as follows:

**TABLE 2: DOMESTIC WATER STANDARDS ACCORDING TO THE MINISTRY OF HEALTH'S REGULATION: 2009**

| Parameter | Maximum permissible value | | Unit | Testing Method |
|---|---|---|---|---|
| | I | II | | |
| Color | 15 | 15 | TCU | TCVN 6185:1996 (ISO 7887:1985) or SMEWW 2120 |
| Taste and Odor | No abnormal taste or odor | No abnormal taste or odor | - | Perceptible, or SMEWW 2150 B and 2160 B |
| Turbidity | 5 | 5 | NTU | TCVN 6184:1996 (ISO 7027:1990) or SMEWW 2130 B |
| Residual Chlorine | 0,3 - 0,5 | - | mg/l | SMEWW 4500Cl or US EPA 300.1 |
| pH | 6,0 - 8,5 | 6,0 - 8,5 | mg/l | TCVN 6492:1999 or SMEWW 4500-$H^+$ |
| Ammonium ($NH_4^+$) | 3 | 3 | mg/l | SMEWW 4500-$NH_3$ C or SMEWW 4500 - $NH_3$ D |
| Total Iron ($Fe^{2+}$ + $Fe^{3+}$) | 0,5 | 0,5 | mg/l | TCVN 6177:1996 (ISO 6332 - 1988) or SMEWW 3500 - Fe |
| Permanganate Index | 4 | 4 | mg/l | TCVN 6186:1996 or ISO 8467 - 1993 (E) |

| | | | | |
|---|---|---|---|---|
| Hardness, calculated by CaCO3 | 350 | - | mg/l | TCVN 6224:1996 or SMEWW 2340 C |
| Chloride ($Cl^-$) | 300 | - | mg/l | TCVN 6194:1996 (ISO 9297 - 1989) or SMEWW 4500-Cl-D |
| Fluoride ($F^-$) | 1.5 | - | mg/l | TCVN 6195:1996 (ISO 10359 -1 - 1992) or SMEWW 4500 - $F^-$ |
| Total Arsenic (As) | 0,01 | 0,05 | mg/l | TCVN 6626:2000 or SMEWW 3500 - As B |
| Total Coliforms | 50 | 150 | CFU/100ml | TCVN 6187-1,2:1996 (ISO 9308-1,2:1990) or SMEWW 9222 |
| *E. coli* or Thermotolerant Coliforms | 0 | 20 | CFU/100ml | TCVN 6187-1,2:1996 (ISO 9308-1,2:1990) or SMEWW 9222 |

**TCVN is the Vietnamese abbreviation for Tiêu Chuẩn Việt Nam, meaning Vietnamese Standard*

*(Source: National Technical Regulation on the quality of domestic water)*

Within the scope of the study, the research team focused on selecting and analyzing characteristic parameters that were highly feasible under field conditions, aiming to objectively and comprehensively reflect the quality of domestic water in the surveyed area. Specifically, the following indicators were analyzed: (1) Temperature, (2) Total Dissolved Solids (TDS), (3) Sensory factors such as odor, taste, and color of the water, (4) pH. These indicators were chosen because they are representative of overall water quality and can be determined quickly and accurately using standard measurement methods. Focusing on these parameters not only optimizes the inspection process and minimizes experimental errors but also ensures a correct assessment of the safety level of the domestic water source for users' health.

**Temperature.**

Studies on clean water indicators by the Vietnam Laboratories Association (VINALAB, 2022) suggest that water temperature is a crucial issue because it determines whether microbial components in the water will react and produce other microorganisms (both beneficial and harmful). The cause is attributed to the influence of ambient temperature during water supply or storage. Water heating or cooling equipment, however, is not a concern as they are already regulated to appropriate and standard levels. If harmful bacteria in the water meet the necessary temperature conditions, they will develop and cause dangerous diseases. Therefore, when observing abnormal water temperature (normal water temperature, determined by a thermometer, typically ranges from 22°C to 27°C, a thermometer should be used to measure the water temperature immediately, preferably directly at the water source.

**Total Dissolved Solids (TDS)**

Total Dissolved Solids (TDS) includes inorganic salts (mainly calcium, magnesium, potassium, sodium, bicarbonate, chloride, and sulfate) along with a small amount of organic matter dissolved in water (WHO, 2017). The measurement unit is mg/L or ppm. TDS is one of the important indicators for evaluating the quality of drinking and domestic water. According to WHO and the Vietnam Ministry of Health standards, drinking water with a TDS index of $\leq 500$mg/L is considered safe and ideal for domestic use. When the total dissolved solids (TDS) in drinking water exceed the safe level ( > 1000mg/L), it can cause many negative impacts on health and sensory properties. High TDS can make the water taste salty, astringent, bitter, or have an unpleasant metallic odor. Prolonged use of high-TDS water sources can cause digestive disorders and increase the risk of kidney stones due to the high calcium and sodium content in the water. Currently, there are two common methods to check the TDS index in water: using a TDS meter pen and using an electrolysis pen.

**Sensory Properties (Color, Odor, Taste)**

The sensory properties of clean water are factors perceived by the senses, such as the water's color, odor, and taste. These are important factors that directly affect consumer acceptance of the water supply. Research by Doria (2010) indicates that among the factors influencing public perception of drinking water quality, the water's sensory properties play a central role. The author emphasizes that public perception is not solely based on scientific information or technical testing results but is largely dominated by direct sensory perception, such as odor and taste, which affects public trust in the water supply.

Water color is an important sensory attribute, reflecting the presence of dissolved or suspended substances in the water. Ideally, pure water is colorless (WHO, 2017). Drinking water should not have any odor or taste, as this can reduce the quality of water consumption and affect health. According to QCVN 01-1/2018/BYT, ideal drinking water must be free of unusual odors and tastes, ensuring purity and pleasantness when consumed. Odor and taste directly affect the sensation of drinking water and the water quality. Drinking water with the odors and tastes mentioned above will affect the health of users. If water with strange odors caused by bacteria or algae is consumed, it may contain toxins leading to diarrhea, nausea, and digestive disorders. Prolonged consumption of water with chlorine or phenol odors can affect the nervous system. Therefore, drinking water must be colorless, odorless, and free of strange tastes according to standards to ensure health. If the water has an abnormal odor or taste, the water source needs to be checked, the filtration system replaced, and impurities causing the odor must be disinfected or removed.

**pH**

pH is an index that assesses the acidity or basicity of a solution. The pH value ranges from 0–14 with the following levels:

- pH < 7 : The water is acidic.
- pH = 7 : The water is neutral.
- pH > 7 : The water is alkaline.

pH is one of the important parameters reflecting water quality, indicating the acidity or alkalinity of the water sample. Determining the pH value helps select appropriate treatment methods and adjust the necessary amount of chemicals during the treatment process to ensure safety and effectiveness (Nguyen Van Bao, 2011). According to the National Technical Regulation QCVN 01-1/2018/BYT of the Vietnam Ministry of Health (2018), the pH value for drinking and domestic water is recommended to be in the range of 6.0–8.5, similar to the limit issued by the U.S. Environmental Protection Agency (EPA, 2025). This pH level ensures the water is in a stable neutral state, preventing corrosion of pipes, avoiding skin irritation, and facilitating the dissolution and absorption of minerals in the body.

## III. METHODOLOGY

### *A. Study Subjects and Scope*

The study focuses on surveying the quality of domestic water for students in Thanh Hoa, an area with a high density of rented student accommodation and non-uniform water supply infrastructure. The research subjects are the variables reflecting domestic water quality, including: color, odor, taste, pH level, temperature, and Total Dissolved Solids (TDS). These are basic indicators capable of generally reflecting the physical and chemical characteristics of the water source, and they can be measured directly at the site using standard testing equipment.

### *B. Water Quality Assessment Method*

The research team collected representative water samples from student boarding houses and dormitories in Thanh Hoa province using a random sampling method to ensure objectivity and representativeness for the surveyed area. Samples were taken directly from the faucets used daily, the main supply source for students' domestic and consumption needs—as well as from the direct drinking water sources, within a fixed time frame to limit deviations due to environmental factors. Immediately after sampling, basic parameters including temperature, pH level, Total Dissolved Solids (TDS), and sensory factors (color, odor, taste) were measured and recorded on-site using calibrated specialized equipment. All monitoring data were recorded in the field log, then aggregated, processed, and compared with the limits specified in the National Technical Regulation on the Quality of Domestic Water (QCVN 02/2009/BYT) of the Vietnam Ministry of Health, to assess the compliance level and safety of the domestic water source used by students.

## IV. RESULTS

### *A. Survey Results on Domestic Water Quality for Students in Thanh Hoa*

The research team measured and analyzed 51 domestic water samples taken from the daily use faucets at student boarding houses and dormitories in Thanh Hoa province. The samples were collected according to a uniform procedure, ensuring representativeness for different areas within the ward. Testing was conducted directly on-site for basic indicators including: temperature, Total Dissolved Solids (TDS), pH, and sensory factors (color, odor, taste). The results obtained are as follows:

**TABLE 3: DOMESTIC WATER SAMPLES AT STUDENT BOARDING HOUSES AND DORMITORIES IN THANH HOA PROVINCE**

| No. | Sample ture | Temperature ( $^{o}$C ) | TDS | pH | Sensory Evaluation (odor, taste, color) | Inspection Date |
|---|---|---|---|---|---|---|
| 1. | M01 | 27.1 | 119 | 6,6 | Colorless, odorless,tasteless | 16:40 19/10/2025 |
| 2. | M02 | 28,9 | 48 | 6,6 | Colorless, odorless,tasteless | 17:05 19/10/2025 |
| 3. | M03 | 27 | 31 | 6,6 | Colorless, odorless,tasteless | 17:24 19/10/2025 |
| 4. | M04 | 28 | 43 | 6,6 | Colorless, odorless,tasteless | 17:40 19/10/2025 |
| 5. | M05 | 27,4 | 43 | 6,6 | Colorless, odorless,tasteless | 17:57 19/10/2025 |
| 6. | M06 | 28,4 | 47 | 6,6 | Colorless, odorless,tasteless | 18:11 19/10/2025 |
| 7. | M07 | 27,9 | 46 | 7 | Colorless, odorless,tasteless | 18:36 19/10/2025 |
| 8. | M08 | 28,4 | 49 | 6,6 | Colorless, odorless,tasteless | 18:48 19/10/2025 |
| 9. | M09 | 27,5 | 44 | 7,6 | Colorless, odorless,tasteless | 19:02 19/10/2025 |
| 10. | M10 | 27,8 | 46 | 7,6 | Colorless, odorless,tasteless | 19:15 19/10/2025 |
| 11. | M11 | 28,4 | 48 | 7 | Colorless, odorless,tasteless | 15:10 20/10/2025 |
| 12. | M12 | 29,4 | 47 | 6,6 | Colorless, odorless,tasteless | 15:23 20/10/2025 |
| 13. | M13 | 28,1 | 47 | 6,6 | Colorless, odorless,tasteless | 15:42 20/10/2025 |
| 14. | M14 | 29,6 | 48 | 6,6 | Colorless, odorless,tasteless | 15:58 20/10/2025 |
| 15. | M15 | 27,6 | 44 | 6,6 | Colorless, odorless,tasteless | 16:12 20/10/2025 |
| 16. | M16 | 26,8 | 48 | 7 | Colorless, odorless,tasteless | 16:33 20/10/2025 |
| 17. | M17 | 26,7 | 43 | 7 | Colorless, odorless,tasteless | 16:00 21/10/2025 |
| 18. | M18 | 26,2 | 45 | 6,6 | Colorless, odorless,tasteless | 16:12 21/10/2025 |
| 19. | M19 | 26,5 | 43 | 7 | Colorless, odorless,tasteless | 16:30 21/10/2025 |
| 20. | M20 | 27,0 | 45 | 7 | Colorless, odorless,tasteless | 16:42 20/10/2025 |
| 21. | M21 | 27,5 | 48 | 6,6 | Colorless, odorless,tasteless | 17:03 20/10/2025 |
| 22. | M22 | 25,2 | 45 | 6,6 | Colorless, odorless,tasteless | 17:17 20/10/2025 |
| 23. | M23 | 26,7 | 48 | 6,6 | Colorless, odorless,tasteless | 17:27 20/10/2025 |
| 24. | M24 | 28,3 | 48 | 6,6 | Colorless, odorless,tasteless | 17:39 20/10/2025 |
| 25. | M25 | 26,9 | 48 | 6,6 | Colorless, odorless,tasteless | 17:52 20/10/2025 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 26. | M26 | 27,3 | 48 | 6,6 | Colorless, odorless,tasteless | 18:05 20/10/2025 |
| 27. | M27 | 24,1 | 44 | 7.0 | Colorless, odorless,tasteless | 15:36 27/10/2025 |
| 28. | M28 | 24,8 | 43 | 7.0 | Colorless, odorless,tasteless | 15:49 27/10/2025 |
| 29. | M29 | 25,9 | 44 | 7.0 | Colorless, odorless,tasteless | 16:02 27/10/2025 |
| 30. | M30 | 24,5 | 43 | 7.0 | Colorless, odorless,tasteless | 16:26 27/10/2025 |
| 31. | M31 | 24,3 | 44 | 7.0 | Colorless, odorless,tasteless | 16:38 27/10/2025 |
| 32. | M32 | 23,7 | 46 | 7.0 | Colorless, odorless,tasteless | 16:50 27/10/2025 |
| 33. | M33 | 24,6 | 46 | 7.0 | Colorless, odorless,tasteless | 17:16 27/10/2025 |
| 34. | M34 | 24,9 | 49 | 7.0 | Colorless, odorless,tasteless | 17:38 27/10/2025 |
| 35. | M35 | 25,6 | 53 | 7,6 | Colorless, odorless,tasteless | 15:33 28/10/2025 |
| 36. | M36 | 26,1 | 45 | 6,6 | Colorless, odorless,tasteless | 15:45 28/10/2025 |
| 37. | M37 | 26,1 | 51 | 7.0 | Colorless, odorless,tasteless | 15:58 28/10/2025 |
| 38. | M38 | 26,7 | 44 | 7.0 | Colorless, odorless,tasteless | 16:30 28/10/2025 |
| 39. | M39 | 25,6 | 226 | 7.0 | Colorless, odorless,tasteless | 17:00 28/10/2025 |
| 40. | M40 | 25,6 | 45 | 7.0 | Colorless, odorless,tasteless | 17:15 28/10/2025 |
| 41. | M41 | 26,2 | 249 | 7.0 | Colorless, odorless,tasteless | 17:35 28/10/2025 |
| 42. | M42 | 25,6 | 42 | 6,6 | Colorless, odorless,tasteless | 17:50 28/10/2025 |
| 43. | M43 | 24,4 | 39 | 7.0 | Colorless, odorless,tasteless | 18:10 28/10/2025 |
| 44. | M44 | 25.5 | 50 | 7.0 | Colorless, odorless,tasteless | 16:19 29/10/2025 |
| 45. | M45 | 25,3 | 43 | 7.0 | Colorless, odorless,tasteless | 16:38 29/10/2025 |
| 46. | M46 | 25,1 | 42 | 7.0 | Colorless, odorless,tasteless | 16:50 29/10/2025 |
| 47. | M47 | 25,8 | 45 | 7,6 | Colorless, odorless,tasteless | 17:05 29/10/2025 |
| 48. | M48 | 25,6 | 46 | 7.0 | Colorless, odorless,tasteless | 17:15 29/10/2025 |
| 49. | M49 | 25,6 | 50 | 7.0 | Colorless, odorless,tasteless | 17:38 29/10/2025 |
| 50. | M50 | 26,2 | 44 | 7.0 | Colorless, odorless,tasteless | 17:53 29/10/2025 |
| 51. | M51 | 26 | 43 | 6.6 | Colorless, odorless,tasteless | 18:15 29/10/2025 |

*(Source: Research team, sample testing and aggregation)*

Based on the results in Table 3, a detailed analysis of the clean water quality in the tested areas can be provided as follows:

- Temperature: Water samples had temperatures ranging from 23.7 oC to 29.6 oC, which falls within a stable range and is consistent with natural environmental conditions. This temperature level does not affect the physico-chemical properties of the water and does not create favorable conditions for the growth of harmful microorganisms.

- Total Dissolved Solids (TDS): Total Dissolved Solids (TDS) is an index that reflects the total amount of inorganic and organic substances dissolved in water, including salts, metals, ions, and organic compounds. The lower the TDS value, the purer the water and the less affected it is by pollution sources. According to the analysis results, the majority of domestic water samples (94.1%) had TDS ranging from 31-35 mg/L, indicating a low content of dissolved solids, reflecting the cleanliness and stability of the water source. This TDS level falls within the ideal threshold for domestic water according to QCVN 02/2009/BYT, ensuring safety for health and not affecting sensory properties such as odor, taste, or color. However, a few individual samples (approximately 5.9%) recorded TDS exceeding 100 mg/L, indicating a localized accumulation of minerals or dissolved substances, which may result from pipe corrosion, long-uncleaned storage tanks, or metal leaching from building materials. Although these values are still lower than the maximum threshold of 500 mg/L according to the national standard, the local variation in TDS reflects the non-uniform quality of water sources across different supply areas, emphasizing the necessity of periodic monitoring and maintenance of the water supply system to sustain the long-term stability and safety of domestic water.

- Sensory Properties: The survey results show that all water samples were free of unusual odor, taste, or color, indicating that the water source met the sensory standards according to current regulations. This reflects that the water was not contaminated by volatile organic compounds, residual chlorine, detergents, or foreign impurities—factors that commonly cause changes in the water's odor and color. The water maintaining its clear, odorless, and tasteless state is an important indicator of microbial and chemical safety, and also shows that the water supply and storage systems in the boarding houses are maintained at a relatively good sanitary level.

- pH: The pH values of the water samples ranged from 6.6–7.6, which falls within the ideal limit according to the Vietnam Ministry of Health's QCVN 02/2009/BYT standard (6.0–8.5), and is also consistent with the recommendations of the U.S. Environmental Protection Agency (EPA, 2025) on the optimal pH level for domestic and drinking water, as presented in Table 1 – Secondary Drinking Water Standards. This result indicates that the water source has stable neutral properties, is safe for human health, does not corrode pipes or containment equipment, does not cause skin irritation when used, and facilitates the dissolution and absorption of essential minerals in the body. This proves that the chemical environment of the domestic water in the surveyed area achieved a standard balance, reflecting a well-maintained water supply system that is minimally affected by external pollution factors.

General Observations:

- The survey results show that the quality of domestic water in student boarding houses in Thanh Hoa basically meets the QCVN 02/2009/BYT standard and the EPA (2025) recommendation for safe domestic water.

- Parameters such as temperature, pH, and TDS are all within the allowable limits, reflecting the physico-chemical stability and safety of the water source.

- In general, the quality of domestic water for students in Thanh Hoa is assessed as meeting requirements, ensuring good service for students' daily needs. However, continuous monitoring and periodic inspection are necessary to detect early changes in physico-chemical parameters and to sanitize the water storage system (especially in boarding areas with old pipes or tanks) to promptly identify and address issues.

***A. Survey Results on Drinking Water Quality for Students in Thanh Hoa***

The research team measured and analyzed 51 drinking water samples taken from sources of boiled and cooled water or bottled water (5-liter to 20-liter containers), which are the main drinking water supplies currently used by students in Thanh Hoa. Samples were collected randomly, representing areas with high student populations, to assess the safety level and quality of the drinking water consumed daily by students.

**TABLE 4: DRINKING WATER SAMPLES USED BY STUDENTS IN THANH HOA PROVINCE**

| No. | Sample ture | Temperature (°C ) | TDS | pH | Sensory Evaluation (odor, taste, color) | Inspection Date |
|---|---|---|---|---|---|---|
| 1 | L01 | 28,1 | 14 | 6,6 | Colorless, odorless,tasteless | 16:40 19/10/2025 |
| 2 | L02 | 29,2 | 28 | 6,6 | Colorless, odorless,tasteless | 17:05 19/10/2025 |
| 3 | L03 | 27,6 | 25 | 6,6 | Colorless, odorless,tasteless | 17:24 19/10/2025 |
| 4 | L04 | 28,5 | 0 | 5,0 | Colorless, odorless,tasteless | 17:40 19/10/2025 |
| 5 | L05 | 29,1 | 12 | 5,0 | Colorless, odorless,tasteless | 17:57 19/10/2025 |
| 6 | L06 | 28,6 | 292 | 8,5 | Colorless, odorless,tasteless | 18:11 19/10/2025 |
| 7 | L07 | 28,1 | 33 | 6,6 | Colorless, odorless,tasteless | 18:36 19/10/2025 |
| 8 | L08 | 29,6 | 28 | 6,6 | Colorless, odorless,tasteless | 18:48 19/10/2025 |
| 9 | L09 | 28,4 | 19 | 6,6 | Colorless, odorless,tasteless | 19:02 19/10/2025 |
| 10 | L10 | 27,6 | 1 | 5,0 | Colorless, odorless,tasteless | 19:15 19/10/2025 |
| 11 | L11 | 28,2 | 51 | 6,6 | Colorless, odorless,tasteless | 15:10 20/10/2025 |
| 12 | L12 | 29,8 | 4 | 6,0 | Colorless, odorless,tasteless | 15:23 20/10/2025 |
| 13 | L13 | 28,4 | 201 | 7,6 | Colorless, odorless,tasteless | 15:42 20/10/2025 |
| 14 | L14 | 29,2 | 5 | 6,0 | Colorless, odorless,tasteless | 15:58 20/10/2025 |
| 15 | L15 | 28 | 28 | 8,0 | Colorless, odorless,tasteless | 16:12 20/10/2025 |
| 16 | L16 | 27,8 | 58 | 7,6 | Colorless, odorless,tasteless | 16:33 20/10/2025 |
| 17 | L17 | 27,6 | 27 | 6,6 | Colorless, odorless,tasteless | 16:00 21/10/2025 |
| 18 | L18 | 27,1 | 7 | 6,0 | Colorless, odorless,tasteless | 16:12 21/10/2025 |
| 19 | L19 | 27,7 | 8 | 5,0 | Colorless, odorless,tasteless | 16:30 21/10/2025 |
| 20 | L20 | 27,7 | 49 | 7,0 | Colorless, odorless,tasteless | 16:42 20/10/2025 |
| 21 | L21 | 27,9 | 34 | 6,6 | Colorless, odorless,tasteless | 17:03 20/10/2025 |
| 22 | L22 | 27,5 | 5 | 6,0 | Colorless, odorless,tasteless | 17:17 20/10/2025 |
| 23 | L23 | 26,8 | 20 | 6,6 | Colorless, odorless,tasteless | 17:27 20/10/2025 |
| 24 | L24 | 28,3 | 60 | 6,0 | Colorless, odorless,tasteless | 17:39 20/10/2025 |
| 25 | L25 | 27,8 | 16 | 6,0 | Colorless, odorless,tasteless | 17:52 20/10/2025 |

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|---|---|---|---|---|---|---|
| 26 | L26 | 27,6 | 42 | 6,6 | Colorless, odorless,tasteless | 18:05 20/10/2025 |
| 27 | L27 | 25,3 | 2 | 6,3 | Colorless, odorless,tasteless | 15:36 27/10/2025 |
| 28 | L28 | 25,1 | 25 | 7 | Colorless, odorless,tasteless | 15:49 27/10/2025 |
| 29 | L29 | 24,9 | 48 | 7,6 | Colorless, odorless,tasteless | 16:02 27/10/2025 |
| 30 | L30 | 25,8 | 1 | 6 | Colorless, odorless,tasteless | 16:26 27/10/2025 |
| 31 | L31 | 24,9 | 23 | 6,6 | Colorless, odorless,tasteless | 16:38 27/10/2025 |
| 32 | L32 | 23,7 | 23 | 7 | Colorless, odorless,tasteless | 16:50 27/10/2025 |
| 33 | L33 | 24,5 | 38 | 6,6 | Colorless, odorless,tasteless | 17:16 27/10/2025 |
| 34 | L34 | 25,0 | 23 | 6,6 | Colorless, odorless,tasteless | 17:38 27/10/2025 |
| 35 | L35 | 24,7 | 19 | 6,6 | Colorless, odorless,tasteless | 15:33 28/10/2025 |
| 36 | L36 | 26,1 | 26 | 7,0 | Colorless, odorless,tasteless | 15:45 28/10/2025 |
| 37 | L37 | 26,3 | 207 | 8,0 | Colorless, odorless,tasteless | 15:58 28/10/2025 |
| 38 | L38 | 27,3 | 20 | 6,0 | Colorless, odorless,tasteless | 16:30 28/10/2025 |
| 39 | L39 | 26,6 | 5 | 6,0 | Colorless, odorless,tasteless | 17:00 28/10/2025 |
| 40 | L40 | 26,1 | 13 | 6,6 | Colorless, odorless,tasteless | 17:15 28/10/2025 |
| 41 | L41 | 26,6 | 14 | 6,6 | Colorless, odorless,tasteless | 17:35 28/10/2025 |
| 42 | L42 | 27 | 11 | 6,6 | Colorless, odorless,tasteless | 17:50 28/10/2025 |
| 43 | L43 | 25,5 | 4 | 5,5 | Colorless, odorless,tasteless | 18:10 28/10/2025 |
| 44 | L44 | 26,5 | 5 | 6,0 | Colorless, odorless,tasteless | 16:19 29/10/2025 |
| 45 | L45 | 25,6 | 18 | 7,0 | Colorless, odorless,tasteless | 16:38 29/10/2025 |
| 46 | L46 | 25,1 | 0 | 6,0 | Colorless, odorless,tasteless | 16:50 29/10/2025 |
| 47 | L47 | 25,5 | 0 | 5,0 | Colorless, odorless,tasteless | 17:05 29/10/2025 |
| 48 | L48 | 25,2 | 49 | 7,0 | Colorless, odorless,tasteless | 17:15 29/10/2025 |
| 49 | L49 | 25,7 | 3 | 6,0 | Colorless, odorless,tasteless | 17:38 29/10/2025 |
| 50 | L50 | 26,1 | 28 | 7,0 | Colorless, odorless,tasteless | 17:53 29/10/2025 |
| 51 | L51 | 25,2 | 3 | 6,0 | Colorless, odorless,tasteless | 18:15 29/10/2025 |

*(Source: Research team, sample testing and aggregation)*

Based on the results in **Table 4**, a detailed analysis of the clean water quality in the tested areas can be provided as follows:

- Temperature: The drinking water samples had temperatures ranging from 27.3°C to 29.8°C, which falls within a stable range and is consistent with natural climate conditions. The water temperature did not fluctuate significantly, indicating that the water source was preserved in a relatively stable environment, not directly affected by ambient temperature or sunlight, thereby limiting microbial growth.

- TDS (Total Dissolved Solids): The TDS values ranged from 0-292 mg/L, showing a significant difference between samples. Of these, 48 samples (94.1%) had TDS below 100 mg/L, indicating high purity and low mineral content, suitable for direct human consumption. Three samples (5.9%) had TDS exceeding 100 mg/L, reflecting non-uniformity in the quality of students' drinking water. Although all were below the maximum limit of 500 mg/L according to QCVN 02/2009/BYT, the samples with high TDS show differences in the supply source or water treatment process, requiring filtration through RO or Nano systems to ensure quality when used as drinking water.

- Sensory Properties: All samples were odorless, tasteless, and colorless, proving that the water met the sensory requirements according to the national standard. The water being clear and free of strange odors indicates that the source was not contaminated by volatile organic compounds, residual chlorine, or odor-causing microbial decomposition, and also reflects a relatively adequate water treatment and storage process.

- pH: The pH values of the water samples ranged from 5.0–8.5, with the majority (88.2%) falling within the standard limit (6.0–8.5) set by the Ministry of Health. The samples with low pH (5.0–5.5) show mild acidity, possibly due to prolonged storage in plastic bottles, allowing CO2 to dissolve and form a weak acid. In general, most samples had stable pH, but periodic inspection is needed to ensure that the water samples have a neutral pH index to guarantee suitability as drinking water.

General Assessment:

- The analysis results show that the majority of students' drinking water samples in Thanh Hoa met safety standards, with TDS, pH, and sensory indicators within the allowable limits. However, some samples with high TDS may originate from non-uniform treatment processes, storage conditions, or unstable supply sources.

- Furthermore, some students reported purchasing drinking water from local refill stations or grocery stores near their rented rooms, but lacked clear information about the origin and treatment process. The repeated reuse of plastic bottles or long-term storage of water also increases the risk of bacterial contamination and changes in chemical indicators. - Although most of the drinking water used by students meets standards, there is a need to increase periodic inspection and promote awareness of safe water usage. Drinking water supply facilities should be transparent about the source and treatment process, while students should limit long-term storage, use appropriate filtering equipment, and store water correctly to protect long-term health.

## V. CONCLUSION

The research results indicate that the quality of domestic and drinking water for students in Thanh Hoa generally meets the requirements of the National Technical Regulation QCVN 02/2009/BYT of the Ministry of Health and some indicators set by the U.S. Environmental Protection Agency (EPA, 2025). Basic indicators such as temperature, pH level, Total Dissolved Solids (TDS), and sensory properties are all within the allowable limits, reflecting a relatively good level of safety and sanitation for the water source. However, there still exist some samples with higher-than-average TDS or signs of colored precipitation, indicating a disparity in water quality between boarding houses and dormitories, and a predicted risk of contamination due to storage conditions or the internal piping systems of the rented accommodations.

This study has significant practical implications by providing both reliable quantitative and qualitative data on the domestic water quality for students renting accommodation and in dormitories. This data provides a scientific basis for local authorities, accommodation/water supply businesses, and the student community to raise awareness, improve water supply conditions, and protect the health of users. Concurrently, the results contribute to supplementing the empirical documentation for future research and urban environmental management at the local level.

Nevertheless, the study still has certain limitations, such as heavy metals, and complex organic compounds, due to constraints in time, equipment, and research scope. Furthermore, while the sample size is representative, it does not fully reflect the seasonal or source-dependent fluctuations in water quality. In subsequent research directions, the authors propose

expanding the survey scope to other residential areas and schools in Thanh Hoa province, while also incorporating deeper analysis of microorganisms, heavy metals, and microplastics in the water. Additionally, further research is needed on the correlation between water quality and public health factors, thereby establishing a set of policy recommendations and a sustainable domestic water management model for urban areas with large student populations.

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