

ORGANOLEPTIC INDICATORS OF WATER, THEIR FORMATION FACTORS, AND SANITARY ASSESSMENT

Oppoqxonov Mirzoxidxon Po‘latxon o‘g‘li
Clinical Resident of Fergana Medical Institute of Public Health

Feruza Tulkundjanovna Abduvaliyeva
Fergana Medical Institute of Public Health,
Department of Communal and Occupational Hygiene, Associate Professor, PhD

Abstract

This study examines organoleptic parameters of potable water from urban distribution systems through standardized sensory evaluation methods. Analysis of 240 samples revealed mean turbidity of 1.8 ± 0.4 NTU, color values of 12 ± 3 degrees, and temperature-dependent odor variations. Results demonstrate critical relationships between organoleptic deviations and anthropogenic contamination patterns requiring enhanced monitoring protocols.

Keywords: turbidity, odor, taste, color, temperature, mineralization, chlorination, contamination, standards, assessment, palatability, transparency, oxidation, compliance, monitoring

Introduction

Organoleptic indicators constitute fundamental parameters in sanitary-hygienic evaluation of drinking water quality, encompassing odor, taste, color, turbidity, and temperature characteristics detectable through human sensory perception. These indicators serve as primary warning signals for potential contamination events and technological process disruptions in water treatment facilities. Regulatory frameworks establish maximum permissible concentrations ensuring consumer acceptability and public health protection. The sanitary significance of organoleptic assessment extends beyond aesthetic considerations, as deviations frequently correlate with microbiological contamination, chemical pollutants, or infrastructure deterioration. Contemporary water quality standards mandate systematic organoleptic monitoring as integral component of comprehensive sanitary surveillance programs.

Literature Review

Extensive research within Russian and Uzbek scientific communities has established methodological frameworks for organoleptic water assessment. Onishchenko investigated correlations between seasonal variations and odor intensity fluctuations in surface water sources, demonstrating threshold detection limits at 20°C versus 60°C heating protocols. Rakhimova analyzed turbidity formation mechanisms in centralized water supply systems, identifying suspended particulate matter concentrations exceeding 2 NTU as critical intervention thresholds. Systematic studies by Karimov



documented anthropogenic influences on taste characteristics, particularly chlorophenol compound formation during disinfection processes. Comparative investigations revealed regional variations in acceptable color values ranging between 15-20 degrees on platinum-cobalt scale. These foundational works emphasize integration of instrumental measurements with sensory evaluation protocols for comprehensive sanitary characterization.

Methodology

The investigation employed cross-sectional analytical design examining organoleptic parameters across municipal water distribution network serving population of 850,000 inhabitants. Sample collection occurred during March-October 2024 period, encompassing 240 water specimens obtained from 30 designated monitoring points including treatment facility outlets, intermediate distribution nodes, and consumer endpoints. Sampling volumes of 2.0 liters were collected in sterile glass containers following three-minute preliminary flushing protocol. Organoleptic evaluation utilized standardized sensory assessment methodology conducted by trained panel of five certified specialists under controlled laboratory conditions at $20\pm 2^{\circ}\text{C}$ ambient temperature with illumination intensity of 500 lux. Temperature measurements employed calibrated mercury thermometers with 0.1°C precision. Turbidity quantification utilized nephelometric method with portable turbidimeter (Model 2100Q, Hach Company) measuring nephelometric turbidity units with detection range 0.01-1000 NTU and accuracy $\pm 2\%$. Color determination followed comparator method using platinum-cobalt standard solutions prepared according to national standard protocols, measuring apparent color in degrees on 0-50 scale against distilled water reference. Odor intensity assessment implemented five-point scoring system: 0 (no odor), 1 (very weak), 2 (weak), 3 (noticeable), 4 (distinct), 5 (very strong), evaluated at both 20°C room temperature and 60°C heated conditions to detect threshold concentrations of volatile organic compounds. Taste characteristics were categorized using descriptive terminology including chlorinous, metallic, earthy, bitter, salty, or absent, with intensity scored on parallel 0-5 scale. Panel members rinsed oral cavity with distilled water between consecutive samples maintaining 15-minute intervals. Reference standards applied included SanPiN 2.1.4.1074-01 establishing maximum permissible levels: turbidity ≤ 2.6 NTU, color ≤ 20 degrees, odor intensity ≤ 2 points, taste intensity ≤ 2 points, temperature $7-12^{\circ}\text{C}$ optimal range. Statistical analysis employed SPSS version 25.0 calculating descriptive statistics (mean, standard deviation, range), frequency distributions, and comparative analysis using Student's t-test with significance threshold $p < 0.05$.

Results

Comprehensive analysis of 240 water samples yielded detailed characterization of organoleptic parameter distributions. Temperature measurements demonstrated mean value of $9.2\pm 1.8^{\circ}\text{C}$ with observed range $6.5-14.3^{\circ}\text{C}$. Approximately 89% of samples remained within optimal $7-12^{\circ}\text{C}$ range, while 11% exceeded upper threshold during summer months at peripheral distribution points experiencing prolonged residence time. Turbidity determinations revealed mean concentration of 1.8 ± 0.4 NTU across sampling locations. Frequency analysis indicated 94.2% compliance with regulatory limit of 2.6 NTU. Six percent of samples demonstrated elevated turbidity values ranging 2.7-3.9 NTU, predominantly originating from older infrastructure sections experiencing pipe



corrosion and sediment accumulation. Treatment facility effluent exhibited consistently low turbidity of 0.3 ± 0.1 NTU, while distribution system endpoints showed progressive increase correlating with distance from source. Color measurements averaged 12 ± 3 degrees on platinum-cobalt scale, maintaining full compliance with 20-degree regulatory threshold. Spatial distribution revealed minimal variation between sampling points, with 98.8% of determinations falling within 8-18 degree range. Three samples from industrial district periphery demonstrated marginally elevated values of 21-23 degrees attributed to potential groundwater infiltration through deteriorated pipe joints. Odor intensity assessment at 20°C ambient temperature yielded mean score of 1.2 ± 0.6 points. Distribution analysis showed 91.7% compliance with maximum permissible level of 2 points. Twenty samples registered scores of 2-3 points, characterized predominantly as chlorinous odor resulting from residual disinfectant concentrations. Heated evaluation at 60°C increased mean intensity to 2.1 ± 0.7 points, with 78.3% maintaining acceptable levels. Enhanced thermal conditions revealed latent organic contamination signatures in 52 samples scoring 3-4 points, manifesting earthy-musty characteristics indicative of microbial metabolic products.

Taste evaluation demonstrated mean intensity of 1.4 ± 0.5 points with 93.3% regulatory compliance. Chlorinous taste dominated sensory profiles in 67% of samples, while 18% exhibited metallic characteristics associated with elevated iron concentrations from corroded distribution infrastructure. Sixteen samples displayed combined chlorinous-metallic perception scoring 2-3 points, localized to specific network sections requiring rehabilitation. Correlation analysis revealed statistically significant relationships between turbidity elevation and concurrent increases in color values and taste intensity. Temperature variations demonstrated inverse correlation with odor perception at ambient conditions but positive association at heated evaluation temperatures.

Discussion

The formation mechanisms of organoleptic deviations reflect complex interactions between natural water composition, treatment processes, and distribution system conditions. Odor development primarily originates from volatile organic compounds including geosmin and 2-methylisoborneol produced by actinomycetes and cyanobacteria in surface water sources, with threshold detection concentrations ranging 4-10 nanograms per liter. Chlorination reactions with natural organic matter generate chlorophenolic compounds imparting characteristic medicinal odor detectable at microgram concentrations. Turbidity elevation mechanisms encompass multiple pathways including inadequate coagulation-flocculation efficiency during treatment, pipe corrosion releasing iron and manganese particulates, biofilm detachment during hydraulic disturbances, and external contamination through distribution system integrity breaches. The observed correlation between turbidity and color parameters confirms shared causative factors, particularly suspended iron hydroxide colloids contributing simultaneously to light scattering and chromatic properties.

Color intensification results predominantly from dissolved organic substances including humic and fulvic acids characteristic of surface water sources, iron and manganese oxidation products, and industrial effluent contamination. Natural organic matter concentrations typically range 2-8 mg/L as dissolved organic carbon, with color values proportional to aromatic compound content and molecular weight distribution. Taste alterations reflect diverse chemical constituents including residual chlorine concentrations exceeding 0.5 mg/L threshold, metallic ions particularly iron above



0.3 mg/L and manganese above 0.1 mg/L, sulfate concentrations exceeding 250 mg/L imparting bitter characteristics, and sodium chloride levels above 250 mg/L producing salty perception. Temperature influences organoleptic perception through multiple mechanisms including altered chemical equilibria affecting volatile compound vapor pressures, modified sensory receptor sensitivity, and accelerated biochemical degradation processes. Elevated temperatures exceeding 12°C promote microbial proliferation and metabolic activity generating odorous compounds while simultaneously enhancing human olfactory detection capabilities. The sanitary significance of organoleptic deviations extends beyond aesthetic considerations, as correlational studies demonstrate associations with increased consumer complaints, reduced water consumption patterns, and potential health risks from underlying contamination sources. Research by Uzbek investigators documented 40% increase in gastrointestinal illness reporting during periods of elevated turbidity and odor intensity, attributable to concurrent pathogen presence rather than organoleptic parameters themselves serving as sentinel indicators. Comparative analysis with previous regional investigations reveals consistency in mean parameter values but identifies concerning temporal trends toward increased deviation frequency in aging infrastructure networks. Systematic monitoring data demonstrates progressive deterioration requiring strategic rehabilitation investments and enhanced treatment optimization.

Organoleptic indicators constitute essential surveillance parameters revealing water quality deterioration requiring immediate intervention. The documented deviations emphasize critical importance of systematic monitoring protocols integrating sensory evaluation with instrumental measurements. Infrastructure rehabilitation and treatment process optimization remain fundamental strategies ensuring sustained compliance with sanitary-hygienic standards protecting public health.

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