Chemical Profiling of Sri Lankan Black Tea: Regional and Grade-Based Variations in Caffeine, Polyphenols, and Dry Matter

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The chemical composition of tea, especially its dry matter content, caffeine, and polyphenols, has a significant impact on its quality. The purpose of this study was to examine the dry matter content, caffeine concentration, and total polyphenol content (TPC) of specific black tea grades that were gathered from two main Sri Lankan tea-growing regions: Ruhuna (low-grown) and Dimbula (high-grown). Standard ISO methods were used to analyze four tea grades (BOP, OP, Dust, PF1), with ten samples per grade collected from different factories. Total polyphenol content was measured by the Folin–Ciocalteu method (ISO 14502-1) and caffeine by UV-Visible spectrophotometry (ISO 3103). Dry matter was determined by oven-drying at 105 °C. Significant differences were observed across regions and grades, with Dimbula BOP showing the highest polyphenol content (24.55 ± 1.81% DW). Low-grown tea showed lower TPC with Ruhuna OP (18.31 ± 1.30% DW). Caffeine was highest in Ruhuna PF1 (879.39 ± 39.54 mg CE/L (Caffeine Equivalents)) and lowest in Ruhuna Dust (504.11 ± 6.51 mg CE/L). Dry matter ranged from 91.65 ± 0.79% to 96.56 ± 0.95%, indicating consistent processing. These results clearly show that high-grown and low-grown teas have very different chemical compositions. Analysis of variance (ANOVA) was performed using Minitab (2022), revealing statistically significant differences in total polyphenol content (TPC) and caffeine content across tea grades and regions ($F = 4.96\text{-}8.17$, $p < 0.001$).These differences are extremely useful for creating analytical tools, particularly sensor-based devices like electronic tongues (E-tongues) that can distinguish between different types of tea based on geographic location. The chemical variations identified in this study represent strong identifiers that can be integrated into equipment calibration and classification models, thereby enhancing tea authenticity verification and quality control.

Keywords: Black tea, Caffeine content, Total Polyphenol content, Regional variation, UV-Visible spectrophotometry