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Spectroscopic Study of Tea Products Available in Local Market of Pakistan

Haseeb Younas[1] and Malik Sajjad Mehmood [2*]

[1,2]Department of Basic Sciences, University of Engineering and Technology, 47050, Taxila, Pakistan

ABSTRACT:

Popular traditional beverage tea has a tremendous cultural impact all around the world. To satisfy consumer preferences, the quality of tea items sold locally must be ensured. Although it is time-consuming and expensive, laboratory analysis continues to be the most accurate way for determining the kind and grade of black tea. A potential answer to this problem is provided by molecular spectroscopy, which relies on the interaction of the target sample with electromagnetic radiation (EMR). In this study, four different kinds of black tea that were obtained at the neighborhood market were examined using UV-Vis spectroscopy. In the 200–800 nm region, the UV–Vis spectra of the tea extracts were captured, displaying unique absorbance patterns matching to the numerous chemicals present in tea. Anthocyanins, which are abundant in tea, absorb light between 520 and 590 nm, while methyl xanthines and catechins have an absorbance in the 200–350 nm range that is related with the np electronic transition. Theaflavins and thearubigins, which have absorption peaks between 500 and 600 nm, also have an impact on black tea's distinctively dark color and flavor.

Introduction

One of the popular traditional drinks is tea. Distinct nations have distinct perspectives on tea, which has led to the development of diverse tea cultures. This distinctive culture encompasses the aesthetics of drinking tea as well as the methods used to produce and consume tea. Chinese and British tea cultures are two significant examples of tea preparation and service, respectively. The tea beverage is made by brewing it with salt and butter in a certain region of China. In addition to being a refreshing beverage, tea has also been used traditionally as a herb with various health advantages for people, including enhanced cognitive function, weight loss, and a decreased risk of cancer. No matter why tea is consumed, it is critical to maintain its quality. A quality criteria that adheres to the taste preferences of the general public must be met for a particular quantity of tea drink. This means that for a given quantity, the density of a chemical compound that defines the flavor of tea must be rather constant. To this day, laboratory analysis is still regarded as the most precise and trustworthy way for identifying the kind and grade of black tea. However, this excellent solution is time- and money-consuming. Many efforts have been made to establish a method and equipment for quickly, affordably, and correctly analyzing Black tea in an effort to solve this issue. Among them are techniques and tools for figuring out how much black tea is in something [1–5] and for figuring out the different kinds of black tea [6].

The Molecular spectroscopy is a technique which is based on the interaction between electromagnetic radiations (EMR) with target sample/material, and is frequently used to study molecular structure of the sample. This technique is based on principle in which each molecule is composed of multiple atoms, and after absorbing the EMR the phenomenon of electronic transitions occurs while emitting the energy in the form of light of particular frequency. Each EMR regions have different feature and stand for the specific kind of the molecular transition that correspond to the exact spectroscopic technique. These transitions can be of IR active, Raman active, mission/absorption, and rotational type such as in Magnetic Resonance spectroscopy[7]. UV-Visible spectroscopy and fluorescence spectroscopy that can be understand as the interactions between EMR in the UV Visible regions (correspond to wavelengths 200 to 800 nm)

by sample that gives electronic transitions (UV Visible) even as mid IR spectroscopy that relates to the interactions between EMR on region of 4000-400 cm^{-1} that causes the vibrational transition of chemical bonds or functional group [8]. The chemical bonds and/or functional present in various tea products are the unique features and can be monitored with molecular spectroscopy for assessing its quality. It is therefore, the intensity of one or several wavelengths are enough to determine the tea characteristics in order to confirm tea product.

Materials and methods:

Solvent and samples

Ultra-pure water was used as extraction solvent. Samples of four different types of black teas have been purchased from local market and labeled as L-1, S-1, O-1, and I-1. Three of them are packed and one is unpacked. Among these two of them are international brands and one was from local brand. The names of these brands kept secret due to ethical reasons.

Apparatus and procedure:

Samples of 3g of tea were extracted in 100mL of water for 10 minutes under controlled heating. Suseqent to heating, the tea-extracts cooled down to room temperature and filtered for further testing and analysis.The UV VIS spectrum of each sample was acquired immediately. Absorbance was recorded in the range 200nm to 800nm.

Data Analysis

Graph of the UV vis data was plotted using Origin Software. Absorbance was taken along Y-axis and wavelength along X-axis. Different peaks seen at different wavelengths for different samples.

Results and discussion

The measurements were recorded in absorbance-mode for all products extracts from 200 nm to 800 nm. The whole spectra in general contain three major regions 1) from 200 nm to 350 nm which is attributed to np transitions of electrons of methyl xanthines and catechins, 2) the absorption between 520 and 590 nm that belongs to anthocyanins. There are plant coloring-pigments which are present in other plants such as red-grapes, blue-berries, egg-plant, purple sweet potatoes of purple color flowers etc. Black tea contains theaflavins and the arubigins, which affect the color of the tea and are produced when polyphenols ferment. To determine the caliber of teas, their contents can be assessed at 380 and 460 nm.

The spectral range from 380 to 590 nm might be helpful to address the classification problem because the aforementioned components are used for tea differentiation tasks (as seen in figure 2). Because of this, the extract dilution was modified to ensure a decent observation in this wavelength range. Due to the strong signals in the UV area, non-linear responses may result, necessitating the use of non-linear pattern recognition algorithms. The spectra for each variety of tea are shown in Figure 1. These findings suggest that tea types may be distinguished based on their UV-Vis spectra.

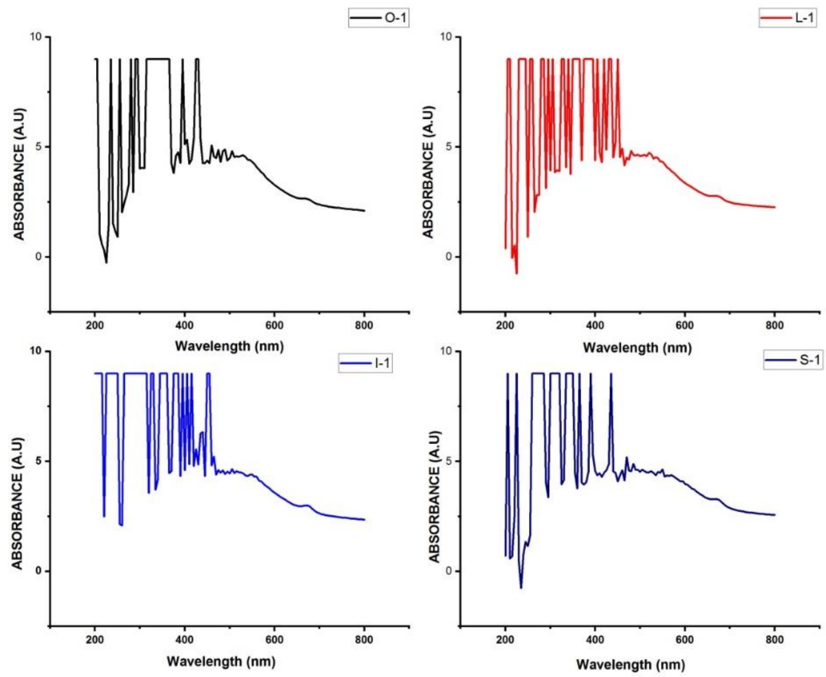

Figure 1: UV-VIS spectra of Tea Products Used in the study

Figure 2 shows absorption spectra of four different tea products in the range 460-600 nm.This region is different for different tea products.As in figure 1 overlapping was seen in the region 200-450 nm so no clear difference is seen. So figure 2 clearly shows difference in tea products which is responsible for the these teas give different taste.

Black tea UV-Vis spectra also show distinct absorption peaks in the visible (Vis) region, which are commonly found between 400 and 600 nm in wavelength. These peaks are connected to other polyphenols, such as theaflavins and thearubigins, which give black tea its distinctive dark color and flavor. Theaflavins and thearubigins, the main chemicals responsible for the dark color and distinctive flavor of black tea, exhibit absorption maxima in the visible area, particularly between 500 nm and 600 nm. These substances are produced as a result of the oxidation process used to make black tea

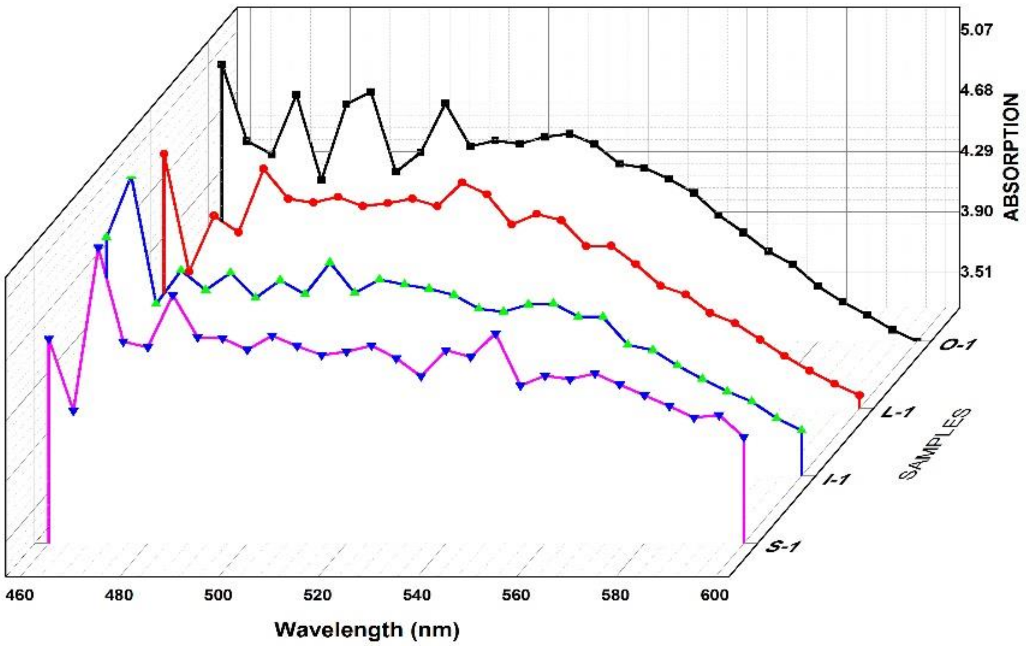

Figure 2: UV-VIS spectra from 400-600 which are belongs to Theaflavins and thearubigins compounds

Conclusion

Black tea sample quality analysis can benefit greatly from the use of UV-Vis spectroscopy. Black tea's UV-Vis spectra display distinctive absorption patterns and peaks that offer vital details on the chemical make-up and general qualities of the tea.Black tea sample chemical variations can be recognized using UV-Vis spectra.

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