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Study of seasonal variation in total polyphenol content in fresh leaves of tea [*Camellia sinensis* (L.) Kuntze]

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Abstract
Experiment was conducted in the year 2018 and 2019 with an aim to study the variation in total polyphenol content in fresh green leaves of *Camellia sinensis* (L.) Kuntze var. *assamica* grown in Kangra Valley of Himachal Pradesh. The samples were collected at an interval of 14 days during three plucking seasons *viz*. April-June(Summer flush),July-August (Monsoon flush) and September- October (Back end flush). Samples of fresh green shoots collected in the 1st week of June recorded significantly highest total polyphenols (240.154g/kg) but was at par with the total polyphenols obtained in the samples of fresh green shoots collected in the 3rd week of May (237.136g/kg) during 2018. The fresh green shoots collected in 1st week of September recorded significantly lower TP than the rest of the treatments except the TP obtained from the fresh green shoots collected in the 3rd week of September,1st week of October,3rd week of October and 3rd week of July.

Keywords: TP-total polyphenol, flush season, plucking, nutraceutical

Introduction
Tea is one of the most popular beverages consumed all over the world (Chaturveda and Prakash, 2011) [2]. In recent years; lots of work has been done to establish nutraceutical qualities of tea. Quality of tea infusion depends upon the relative composition of various constituents present in tea leaves. Several reports have shown that composition of TP in leaves is one of the parameters responsible for its quality (Gramza *et al.*, 2005) [3]. Polyphenols constitute an important class of secondary metabolites of plants. These bioactive compounds accumulate in the plant in specific cells and are involved in natural defensive system for protection from ultraviolet radiation and pathogens (Pandey and Rizvi, 2009) [12]. Tea polyphenols (TPs) were found to reduce oxidative stress in H_2O_2-stimulated SH-SY5Y cells by activating the Keap1-Nrf2 signaling pathway and the TrkB/CREB/BDNF pathway (Qi *et al.*, 2017) [10]. Total polyphenols are characterized by multiple phenolic hydroxyl groups and include flavonoids, tannins (hydrolysable and condensed), stilbenes *etc*. Along with tea and coffee, fruits, vegetables, cereals and dry legumes are also known to contain polyphenol (Spencer *et al*., 2008) [11]. Polyphenols are known to possess various biological properties, such as anti-aging, antibacterial, anti-cardiovascular (Oskoueian *et al.*, 2011) [8], antioxidant, anti-inflammatory and anti-tumour (Karimi *et al.*, 2013) [5]. Environmental factors such as exposure of the light, day length, rainfall, cultural practices have major effect on the total polyphenol contents (Macheix, 1990) [7].

Material and Methods
The experiment was conducted to explore fresh green tea shoots of Kangra tea for their TP as influenced by their variation in weather conditions during harvesting flush seasons *viz*. April to October. Samples of fresh green shoots at two leaves and a bud stage were collected from the tea orchard situated in Department of Tea Husbandry and Technology, CSKHPKV, Palampur at an interval of 14 days during the months of April- October in two consecutive years 2018 and 2019. Samples were subjected to microwave heat treatment within 20 minutes of plucking for 3 minutes to deactivate the enzymes preventing the process of oxidation. Treated leaves were then dried in hot air oven at 45±5 °C for 6 hrs.

Aqueous extract was prepared and used for further analysis of total polyphenol content. Total polyphenol content was determined by spectrophotometry using gallic acid as standard. One ml of diluted sample extract was transferred to tube containing 5 ml of 0.1 dilution of FCR in water. Four ml of sodium carbonate (7.5%) was added and the tube was allowed to stand for 60 minutes at room temperature. A calibration curve for the GA standards (at concentrations of 0.02, 0.04, 0.06, 0.08, and 0.10 mg/ml) was prepared. The absorbance was measured at 765 nm using spectrophotometry (ISO 14502-1:2005).

Results and Discussion

A perusal of data in the Table 1 indicates that mean fortnightly variations in the levels of total polyphenol lies in the range of 240.154 to 134.763 g/kg during the year 2018 and 212.434 to 114.356g/kg during 2019. Different flush seasons had significant effect on total polyphenols which could be due to the variation in the weather conditions (Lecour and Lamont, 2011) [6]. reported that green tea grown in area with high temperature, long sun exposure time and high rainfall contain low levels of total polyphenols than those grown in areas with relatively low temperature, short sun exposure time and low rainfall. Samples of fresh green shoots collected in the 1st week of June recorded significantly highest total polyphenols (240.154g/kg) but was at par with the total polyphenols obtained in the samples of fresh green shoots collected in the 3rd week of May (237.136g/kg) during 2018.The fresh green shoots collected in 1st week of September recorded significantly lower TP than the rest of the treatments except the TP obtained from the fresh green shoots collected in the 3rd week of September,1st week of October,3rd week of October and 3rd week of July. Fresh green shoots collected in 3rd week of May without differing with the TP obtained from the samples of 1st week of May recorded significantly higher TP, whereas TP obtained from the fresh green shoots collected in the 1st week of July recorded the lowest TP in the year 2019. On an average, fresh green shoots harvested from 1st week of April to 3rd week of June recorded 25.52 per cent higher total polyphenols over the fresh green shoots harvested from 1st week of July to 3rd Week of October. The samples of summer season had higher total polyphenols than the samples of monsoon and back- end seasons. This might be due to the fact favorable temperature and longer day time during summer might have helped tea shoots to accumulate higher level of total polyphenols. Oskoueian (2011) [8] also reported that total polyphenols in fresh tea shoots was lower in cooler months and was higher in warmer months.

Table 1: Mean Total Polyphenol Content in g/kg in fresh tea shoots during 2018 and 2019

Date of Sampling	Total Polyphenol Content		
	2018	2019	Mean
1st Week of April	149.134	165.745	157.439
3rd Week of April	177.798	199.562	188.680
1st week of May	220.324	205.348	212.836
3rd week of May	237.136	212.434	224.785
1st Week of June	240.154	190.076	215.115
3rd Week of June	170.463	158.237	164.350
1st week of July	154.479	114.356	134.417
3rd week of July	145.634	133.435	139.534
1st week of August	176.170	161.276	168.723
3rd week of August	146.210	165.008	155.609
1st week of September	134.763	198.006	166.384
3rd week of September	136.549	210.523	173.536
1st week of October	141.219	175.887	158.553
3rd week of October	145.175	132.432	138.803
CD 5%	12.18	14.36	-

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