1. INTRODUCTION

Tea, throughout its history, has been one of the most popular non-alcoholic beverages in the world. Tea originated in China where its legendary history dates to as far back as 2737 B.C. Several centuries later, tea was brought to Japan in the 6th century and to Europe in 1559 A.D. (Wickremasinghe 1978). Although the first tea plantation was established in 1839 with seeds brought from China; however, it is believed that the indigenous tea [Camellia sinensis var. assamica] was cultivated by one of the indigenous north-east tribes, Singhpo, since time immemorial. The East India Company was the first to develop plantation in North-East India which was subsequently extended across Brahmaputra valley, Darjeeling and other Himalayan hills in North India. In the equatorial South, tea cultivation was taken up in the Nilgiris, Karnataka and Highlands of Kerala, simultaneously (Jain 2007). Tea plant grows best in slightly acidic soil conditions under tropical and sub-tropical areas with adequate rainfall and good drainage; however, presently it is cultivated all over the world in a wide range of soil types under diverse climatic conditions (Graham 1999). Although all cultivated tea is generally assigned to one species Camellia sinensis (L) O Kuntze (Eden 1976), most of the tea grown in the world today is highly heterogeneous (Kingdon-Ward 1950) as a result of the large-scale dispersal of the tea plant during the long history of its cultivation, its out-breeding nature, and the free hybridization between geographical races. Accordingly, the eco-physiology of the commercially grown tea plant has been closely linked with the climate to which it adapts (Carr 1972).

Although all teas are derived from the tea shoots (two leaves and a tender apical bud) of Camellia sinensis plant; different processing methods produce tea with diverse attributes. Based on the extent of fermentation the tea shoots undergo during processing, teas may be divided into three major groups: unfermented tea (green tea), semi-fermented tea (oolong tea) and fully fermented tea (black tea). Fresh tea leaves are rich in flavonoids - a group of phenolic compounds known as catechins. These catechins and polyphenol oxidase enzyme which are present in separate compartments in the leaf comes in contact with each other during rolling step in tea processing and ferment to transform catechins into dimeric theaflavins and polymeric thearubigins (Roberts 1958; Roberts and Williams 1958). Steaming or firing of green tea leaves inactivates polyphenol oxidase enzyme and the fermentation process is stopped.
Tea is being advocated to be a functional food and an important source of dietary flavonoids (Dulloo et al. 1999; Rajgopal 2001; Wu and Wei 2002). The major catechins characterized by C₆-C₃-C₆ skeletal structure that corresponds to 2-phenylchromone parent composed of three phenolic rings A, B and C (Figure 1.1), are (+) catechin, (−) -epicatechin, (−) -epigallocatechin, (−)-epicatechin gallate and (−) – epigallocatechin gallate (Figure 1.2) and account for about 30 per cent (on dry weight basis) in tea leaf (Horie and Kohata 2000). Green tea was reported to constitute 59 per cent epigallocatechin gallate (EGCG), 19 per cent epigallocatechin (EGC), 13.6 per cent epicatechin gallate (ECG) and 6.4 per cent epicatechin (EC) of the total of catechins (Cabrera et al. 2006).

Epidemiological studies carried out during the last three decades suggested that green tea catechins have nutraceutical and therapeutic attributes. Green tea catechins have been reported to possess antimicrobial (Mbata et al. 2008), antiallergic (Sano et al. 1999), anti-carcinogenic (Lin and Liang 2000) and antioxidant (Chung et al. 1998; Karori et al. 2007) activities. The scavenging effect of green tea catechins on free radicals was reported to be in the order EGCG > ECG > EC > EGC (Zhao 2003). EGCG was reported to be the most active compound with 32% potency (Pham-Huy et al. 2008).
Figure 1.2 Structures of major catechins

Tea [Camellia sinensis (L) O Kuntze] has been growing in the Kangra valley of Himachal Pradesh, India, on gentle slopes of outer Himalayas (elevation 1290 m above
mean sea level, latitude 32° 27' 15.68" N, longitude 76° 31' 42.26" E), where the annual potential transpiratory demand of 1100 mm is totally met by the annual mean rainfall of 2500 mm, with somewhat hot and humid summers (mean temperature maximum 36°C, minimum 16.5°C) and cold winters, since 1850s. There has been noticeable decline in the annual production of tea (black and green) during the beginning of 21st century (Figure 1.3).

Competitions due to opening up of international trade due to the World Trade Organization agreements and changing consumers’ preferences have challenged the sustainability of tea in small tea growing regions like Himachal Pradesh. Once famous for its quality and aromatic characteristics (Hannangan 1988), the tea of Kangra valley is trying to regain its position in the world market after a long period of obscurity. The first flush tea (orthodox) of Kangra valley is well known for its flavour characteristic (Gulati and Ravindranath 1996).

Although a great deal of work on agrotechniques, plant protection, nursery and quality (Sud and Bhattacharjee 1990; Vashist et al. 2004; Rawat and Gulati 2008) has been carried out, however, information pertaining to phytochemicals of nutraceutical significance from Kangra tea is scanty (Sud et al. 2007; Sud et al. 2007a; Sud et al. 2010).

The present study aims to explore the occurrence and nature of phytochemicals of nutraceutical significance from Kangra tea [Camellia sinensis (L) O Kuntze] of Himachal Pradesh with the following objectives:

1. To determine seasonal profile of total polyphenols and flavan-3-ols of green tea shoots
2. To investigate flavan-3-ols profile of green tea
3. To evaluate antioxidant and antibacterial activities of Kangra tea

It is anticipated that the results of the proposed studies will help in promoting the potential of tea industry of Himachal Pradesh.
Figure 1.3 Annual production of tea in Himachal Pradesh from 2000 to 2009

Data Sources: Tea Technical Officer, Chai Bhawan, Kallu-di-Hatti, Palampur and Development Officer, Regional Office, Tea Board of India, Mission Road, Palampur (H.P)