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Nutritional value of orthodox black tea (*Camellia sinensis* L. O. Kuntze) of Himachal Pradesh as influenced by different brew methods

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Abstract

The influence of different recipes of tea brewing such as boiling, filtering and repeated extraction on the minerals availability, pH and electrical conductivity was carried out. Boiled tea resulted in the high contents of available nutrients in comparison to filtering method. Addition of milk resulted in the significant enhancement of the nutrients except Fe, almost non-detectable levels and acidity was nearer to neutral pH (6.3-6.7) of tea brew. Addition of lemon juice resulted in enhancement of acidity and hence it is suggested to avoid the lemon tea during fasting. The repeated extraction resulted in the significant reduction in the minerals contents and electrical conductivity of tea infusion.

Key words: Tea, minerals, nutrients, infusion, brew.

Introduction

Tea cheers nearly half of the world's population. Tea obtained form *Camellia sinensis* (L). O. kuntze, plucked as two leaves and a bud. Tea is common and cheapest beverage, next to water. Tea is consumed by almost all age group of the population (Mann and Balachandran, 1996). In Himachal Pradesh the China type tea (Kangra Local) bushes grown on the gentle slopes of North-west Himalaya. Tea is no longer considered to be as non-alcoholic beverage but tea leaves naturally contain many minerals, which can be transfer in to tea liquor. Apart from the genetic makeup, the geographical location, agro-techniques methods of manufacture and brew preparation were reported to contribute to the mineral composition of black tea (Kalita and Mahanta, 1993; Subbarao *et al.*, 2003) Tea is consumed by most of the adults and type of tea consumed varies from country to country. For instance, oolong tea is favoured in China while green tea is preferred in Japan and China. Most of the other countries like India, Sri Lanka, Kenya and Russia prefer orthodox or CTC black tea (Venkatesan *et al.*, 2007). Tea infusion prepared by seeping the made tea in near boiling water was reported to contained proteins, vitamins, carbohydrates and some essential dietary metals (Powrll *et al.*, 1998).There are several recipes available for tea brew preparation to meet the personal preference of the consumer. The Main examples are lemon tea, milk tea, black tea and others. Diabetes patients consume anyone of the above tea without sugar. Mineral composition of tea infusion offered many health benefits (Atoui *et al.*, 2005). The nutritive value of the common black ta has been examined and reported by several researchers (Nattesan and Ranganathan 1990, Chen, 2003). Distribution of carbohydrates, protein, aminoacids, lipids and vitamins are well documented during 1975 (Stag and Mill, 1975). Although nutrient status of tea gardens (Sharma *et al.*, 2001) and study on the micro and macro nutrients of green tea shoots (Sud *et al.*, 1995)have been reported, however, till now, hardly any work has been done to identify the nutrient value of different kinds of preparation of Kangra orthodox black tea that are preferred by the consumer.It is somewhat natural that addition of milk, sugar and lemon juice would lead to some chemical reactions which may affect the availability of mineral contents of tea infusion and hence an attempt was made in this study to observe them.

It is common practice in tea stalls to prepare tea by repeat extraction methods. It means that to the same tea taken in a filter, hot water is added repeatedly and the brew is collected. The availability of tea nutrient in tea infusion is expected to vary depending on the number of such extractions. The present studies were conducted to evaluate mineral elements in the tea infusion up to third extraction.

Material and Methods

Orthodox black tea manufactured in pizzy miniature processing unit in the Department of Tea Husbandry and Technology during different flushing period (April–October) and blended together for this study. A dozen of lemon fruits and sugar were purchased from the local market

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and lemon juice was extracted by conventional method. Milk was purchased from the University dairy farm. According to the standard practice, 15 g sugar, 20 ml milk and 5 ml of lemon juice were used to prepare tea infusion under different recipes.

Boiling and filtering method of tea infusion

Tea infusions were prepared by different methods consist six treatments, type 1-6 by boiling method and type 7-12 by filtering respectively and the details are given in Table 1 in all treatment, the final volume was made to 100 ml with distilled water in a 100ml standard measuring flask.

Repeated extraction

2 g of orthodox black tea taken in conical flask, 100 ml of distilled water was added and boiled for 10 minutes. The content was filtered through tea filter and final volume made up to 100 ml by using standard measuring. The supernatant was retained in the filter for further extraction, infusion were prepared from the same tea by adding 100ml of boiling water successively twice, keeping an interval of half an hour between them.

Acid digestion

To 0.5g of made tea sample in a 150 ml conical flask, 10 ml of 9:4 mixture of perchloric acid was added. After keeping it overnight for cool digestion, the samples were digested on hot plate until the mixture became clear and colourless. The contents were transferred quantitatively to a 100ml volumetric flask and final volume made to 100 ml by using glass-distilled water (Bhargava and Raghupathi 2001) same procedure was followed for digesting milk and lemon juice by adding 0.5ml of each respectively to the above mixture and digested. Table 2 provides the details of nutrient contents in milk, lemon and sugar and made tea.

Elemental analysis

The sample were analyzed for Ca, Zn, Cu, Fe and Mn (AOAC,1998) using atomic absorption spectrophotometer (AAS-4129). pH and electrical conductivity (EC) were measured using digital PC-510 Bench pH/conductivity meter after calibrating the equipment. K was analyzed using flame photometer. All the analytical estimations were carried out in triplicate to minimize any source of error. The data were analyzed statistically using randomize block design with the application of software CPCS-1.

Table 1. Methods of preparation of tea infusion under different recipes

Type	Recipe involved in preparation
Boiling method	
1	2g of orthodox black tea taken in conical flask, 100 ml of distilled water was added and boiled for 10 minutes. The content were filtered through tea filter and final volume made up to 100 ml by using standard measuring flask.
2	To type-1 preparation, 15g sugar was added along with water and 2g tea before boiling and the extraction was carried out as per type-1.
3	Extract was collected as per type-1 to which 5ml of lemon juice was added.
4	The extraction was done as per the type-2 to which 5 ml of lemon juice was added.
5	Along with the water and 2g tea , 20ml of milk was added before boiling and extract was collected as mentioned in type-1.
6	To water and black tea, 20 ml of milk and 15g of sugar were added before boiling and extract was collected as per type-1.
Filtering method	
7	2g of orthodox tea was placed in a filter to which 100ml of boiling water was slowly added. The filtrate was collected in a 100ml standard measuring flask and made up to volume with distilled water.
8	About 100ml of water was boiled with 15 g of sugar and this mixture was slowly added to 2 g of tea taken in a filter. The filtrate was collected as mentioned in type-7.
9	About 95 ml of water was heated to boiled and poured through a filter containing 2 g of black tea to which 5ml of lemon juice was added. The filtrate was collected as mentioned in type-7.
10	Tea infusion is prepared as per the method mentioned in type-8 to which 5 ml of lemon juice was added.
11	20ml of milk and 80 ml of distilled water boiled together and this mixture was slowly added to 2 g of tea taken in a filter. The filtrate was collected as mentioned in type-7.
12	15g of sugar, 20 ml of milk and 80 ml of water were boiled together which was then poured over 2 g of tea in a filter and extract was collected as per type-7.

Results and Discussion

Minerals availability of tea brew prepared by boiling and filtering method

Boiling tea with water resulted in higher amount of available minerals than filtering method (Table 2), which was evident by significant increased electrical conductivity of the boiled infusion Addition of milk significantly increased the electrical conductivity in both boiling and filtering method was due to the higher contents of K, Ca and Zn. Calcium was maximum in tea infusion prepared by addition of milk, which plays a vital role in strengthening of bones and teeth (Anonymous 1991). Addition of milk resulted in significant increased in pH almost neutral 6.3-6.6 in boiling method (type-5 and type -6) and 6.7 in filtering method (type-11 and type-12). It is advisable to add milk for those who are suffering from the problem of stomach acidity and ulceration. It was observed that the available iron content of tea with the addition of milk went down almost to zero, which could probably be due to the formation of insoluble Fe-polyphenol complexes formed by the interaction between iron of milk and polyphenols of tea (Gopalan *et al.*, 1999). Additions of sugar significantly decreased the pH and Electrical conductivity of tea infusion, which in turn decreased the availability of K, Zn and Mn. While comparing different methods of brew the boiling method resulted in significant higher electrical conductivity than filtering method. Addition of lemon juice significantly decreases the pH of tea infusion, which could be due to the citric acid content of lemon juice and therefore, it is better to avoid lemon-tea consumption during fasting, which may increase acidity. Addition of lemon juice also contributed to increase the electrical conductivity by increasing K, Ca and Fe. Increase in the conductivity reported significantly (0.89-2.07 dSm^{-1}) higher in the brew prepared by boiling methods (Table 3). Type-1 reported to be superior as compared to type-7 because of high minerals availability. Addition of sugar to type-1 and type-7 with or without other additive (milk or lemon juice) suppress the availability of most of the minerals. Type-5 recipe was reported to be high in pH, electrical conductivity and minerals availability in a cup of tea. Intervention-type research in humans has found that raising potassium intakes reduces blood pressure in the arteries i.e. arterial hypertension (Whelton *et. al.*, 1997). Because people with higher blood pressures have greater risks of death from heart disease e.g. heart attacks, blockage or leakage of blood vessels in the brain, (Van *et al.*, 2000) dietary potassium help in keeping blood pressures low. Milk tea provides the sufficient quantity of K and reduces the possibilities of heart related problems. Zinc supports the health of the immune system, normal synthesis of protein, and the health of reproductive organs especially in men (Shils, *et. al.* 1999) Zinc deficiency is common, and can adversely affect normal physical growth, skin and nerve health, natural healing ability, and immune function, especially in infants (Sandstead, 1994). Type-5 preparation reported to be having maximum availability of Zn. Copper is needed in adequate amount for blood, nerves, joints, heart, skin, liver and both the immune and nervous systems. Copper is critical to the absorption and utilization of both zinc and iron (Danks, 1998). A deficiency of copper has been linked to an inability to produce the important antioxidant enzyme, superoxide dismutase (SOD), and to a shortage of red blood cells (Jones *et al.*, 1997). Preparation type-2 provided adequate amount of Cu in tea infusion. Manganese is essential for the growth of bones and the body's general development. A deficiency of manganese may affect brain health, glucose tolerance, normal reproduction, and skeletal and cartilage formation (Keen *et al.*, 1999). Although it is known that tea is one the richest source of manganese in our diet, this study indicated that type-5 preparation is the best for supply adequate manganese. From the study it is incidental that the addition of milk to the boiling water plus tea (type-5 carries higher amount of nutrients when compared to the other types of recipes (type-1 to type-12).

Table 2. Mineral Contents in black tea, milk, lemon and sugar

	K ($g100g^{-1}$)	Ca ($g100g^{-1}$)	Zn ($g100g^{-1}$)	Cu ($g100g^{-1}$)	Fe ($g100g^{-1}$)	Mn ($g100g^{-1}$)
Tea	2.5	1.05	46.13	20.6	87.8	520.8
Milk	0.16	0.05	0.01	DN	3.1	ND
Lemon	0.07	0.05	ND	2.4	4.2	ND
Sugar	0.008	120.6	0.49	ND	2.40	ND

ND – Non detectable

As far the minerals are concerned, the availability is higher when tea is boiled in water (with or without other additives). Hence it can be concluded that benefits of tea drinking would be higher when they are boiled together as per the method (type-1 to type-6).

Minerals availability of tea brew prepared by repeat extraction method

It is common practice in the most of tea stalls to use repeated extraction to have more cups per unit weight. The present study indicated that there is significant influence on the availability of the minerals (K ,Ca, Zn, Cu, Fe and Mn) as well as on pH and electrical conductivity of tea infusion after second extraction (Table 4). It was reported that third extraction reduced the mineral availability to great extent. The low availability of nutrients and electrical conductivity at second and third extractions indicated the poor quality of tea infusion.

Table 3. Nutrient content of tea infusion in boiling and filtering method

Type	Treatment	pH	EC (dSm^{-1})	K ($g100g^{-1}$)	Ca ($g100g^{-1}$)	Zn ($g100g^{-1}$)	Cu ($g100g^{-1}$)	Fe ($g100g^{-1}$)	Mn ($g100g^{-1}$)
1	Tea in boiling water	4.5	1.15	2.1	2.62	40.8	5.7	10.4	215.5
2	Tea in boiling water +Sugar	4.3	0.89	2.1	3.51	32.2	8.4	15.2	179.4
3	Tea in boiling water + Lemon juice	3.4	1.48	2.5	2.51	21.7	7.8	12.2	210.7
4	Tea in boiling water + lemon juice +Sugar	3.2	1.26	2.1	2.67	16.5	5.7	21.8	320.1
5	Tea in boiling water + Milk	6.3	2.07	2.8	4.3	47.4	3.8	0.0	381.0
6	Tea in boiling water + Milk + Sugar	6.6	1.49	2.7	3.6	39.5	6.0	0.0	225.8
7	Tea in Filter	5.1	1.01	1.6	2.1	20.4	3.2	4.7	135.5
8	Tea in Filter +Sugar	4.4	0.67	1.3	1.9	19.5	8.0	8.03	96.0
9	Tea in Filter + Lemon juice	3.5	1.41	1.8	2.2	23.6	3.5	10.3	112.8
10	Tea in Filter + lemon juice +Sugar	3.3	1.08	1.8	2.2	21.8	3.0	19.2	60.2
11	Tea in Filter + Milk	6.7	1.99	2.0	3.38	45.8	6.8	0.0	178.5
12	Tea in Filter +Milk + Sugar	6.7	1.51	2.0	3.0	32.8	4.6	0.0	164.2
CD (P=0.05)		0.12	0.71	0.15	0.22	0.49	0.38	0.43	0.8

Table 4. Nutrient content of tea infusion after successive extraction

Sr. No.	Treatment	pH	EC (dSm^{-1})	K ($g100g^{-1}$)	Ca ($g100g^{-1}$)	Zn ($g100g^{-1}$)	Cu ($g100g^{-1}$)	Fe ($g100g^{-1}$)	Mn ($g100g^{-1}$)
1	First Extraction	4.5	1.15	2.1	2.62	40.8	5.7	10.4	215.5
2	Second Extraction	5.5	0.183	0.53	1.4	10.5	1.8	2.4	86.5
3	Third Extraction	5.6	0.054	0.25	0.55	4.6	0.0	1.4	34.7
CD (P=0.05)		0.15	.003	0.12	0.09	0.61	0.41	0.66	1.6

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