Potential of Sri Lankan black tea (*Camellia sinensis* L.) in dissolution of human kidney stones *in vitro*

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Introduction

Previous studies have disclosed that black tea contains between 1.5 - 6.5 mg of soluble oxalates/g tea and thus regular consumption of black tea will lead to a moderate intake of soluble oxalate each day (Savage et al., 2003). Therefore, consumption of black tea may increase the urinary oxalate concentration, possibly leading to an increased risk of kidney oxalate stone formation (Brinkley et al., 1990). On the contrary, it is claimed that its consumption reduces the risk of kidney stones formation and in fact leads to a reduced risk of kidney stone formation by 14% in males (Curhan et al., 1996) and 8% in females (Curhan et al., 1998). Human kidney stones are predominantly made of calcium oxalate (more than 75%) (Savage et al., 2003). Three main mechanisms have been suggested for dissolving oxalate based kidney stones (Savage et al., 2003): an increased urinary flushing leading to high oxalate excretion; an increased level of calcium consumption via food and beverages leading to reduced oxalate absorption in the digestive tract; and by dissolving of calcium oxalate present in the kidney stones by chemical constituents ingested in to the body.

The aim of this study was to examine the ability of black tea infusion (BTI) to dissolve kidney stones, since BTI has been shown to reduce urinary oxalate levels (Savage et al., 2003). The study was conducted *in vitro* on human kidney stones collected following surgery using low grown BOPF grade Sri Lankan orthodox black tea infusion.

Materials and Methods

Orthodox black tea sample (1 kg) of BOPF grade was collected from a randomly selected tea factory (low grown; 382 m, average mean sea level), and medium size (1-3 g by weight) calcium oxalate based kidney stones removed from patients by surgery obtained from the Department of Urology Surgery Clinical Ward, National Hospital Sri Lanka were used in the present study.

Assessment of dissolving potential of kidney stones

Different concentrations of black tea infusions (BTI) were freshly prepared: 30, 60 and 240 mg/kg bw/day which is equivalent to 1½, 3 and 12 cups respectively (n = 6/ concentration). One gram of crushed kidney stones of particle size < 1000 µm and < 500 µm were placed in 100 ml glass beakers. Then, either 25 ml of different concentrations of warm (40 ± 3 °C) BTI or water (control) was added and covered with a watch glass. This was incubated at room temperature (30 °C) for 24 hrs. Oxalic acid contents in incubated samples were determined at 6, 12 and 24 hrs using high performance liquid chromatography as described by Savage et al., (2003). Oxalate concentrations of the incubated samples were expressed as mg/ml.

Statistical analysis

Statistical comparisons were made using the Mann Whitney U test. The results (n = 6/concentrations) are expressed as mean ± SEM. The probability level, $p \leq 0.05$ was considered as significant.

Results

The oxalate contents in incubated BTI samples and water (control) are presented in Table 1. The results show that the BTI increases the soluble oxalate levels in the incubated samples. The highest dissolution was evident at 24 hrs in crushed kidney stones containing particle size < 500 µm, with 60 mg/kg bw/day concentration of BTI (by 72%) followed by 240 mg/kg bw/day (by 70%), whereas, 30 mg/kg bw/day concentration showed 48% dissolution at 24 hrs. The kidney stones of particle size < 1000 µm resulted in a dissolution of 12%, while the solid kidney stones did not dissolve with 60 mg/kg bw/day concentration of BTI at 24 hrs. This effect was time- and dose- dependent ($r^2 = 0.8921$, $p < 0.01$).

Discussion

This study examined the calcium oxalate dissolving potential of BTI of Sri Lankan low grown BOPF grade orthodox black tea on human kidney stones *in vitro*. The results showed a dose and time dependant (maximum dissolution at 24 hrs) oxalate dissolving potential of BTI. This is a novel finding for Sri Lankan black tea. Further, the finding of the present study is in agreement with the clinical study of Curhan et al., (1996; 1998). It is concluded that, the Sri Lankan BOPF grade orthodox BTI has the potential to dissolve human kidney stones *in vitro* and thus the consumption of BTI may reduce the risk of kidney stone formation.

References

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Table 1: Oxalate contents (as determined by oxalic acid) in different concentrations of BTI incubated with solid human kidney stones, and with crushed k stones of particle size <1000 and < 500 µm, for 6, 12 and 24 h. (Mean ± SEM

BTI Concentration	Oxalic acid concentration, mg/ml, n = 6/concentration								
	Solid kidney stone			Crushed kidney stones of particle size < 1000 µm			Crushed kidney stones of particle size < 500 µm		
	6 h	12 h	24 h	6 h	12 h	24 h	6 h	12 h	24 h
Water (Control)	0.00±0.00	0.01±0.00	0.00±0.00	0.00±0.00	0.01±0.00	0.010±0.001	0.010±0.002	0.010±0.001	0.020±0.002
BTI, 30 mg/kg bw/day	0.02±0.00	0.03±0.00	0.03±0.00	0.04±0.00	0.09±0.00	0.011±0.002	0.010±0.003	0.012±0.002	0.030±0.001*
BTI, 60 mg/kg bw/day	0.03±0.00	0.03±0.00	0.04±0.00	0.06±0.00	0.01±0.00	0.012±0.001	0.013±0.001*	0.016±0.002*	0.034±0.002*
BTI,240 mg/kg bw/day	0.02±0.00	0.02±0.00	0.03±0.00	0.06±0.00	0.01±0.00	0.012±0.002	0.014±0.002*	0.017±0.003*	0.033±0.003*

* the value is significant at $p < 0.05$, compared to the control value.