



# Effect of black tea consumption on radial blood pulse spectrum and cognitive health



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## ABSTRACT

Black tea consumption has been proven to improve endothelial function and to lower the risk of stroke and cognitive impairment. Several effects of black tea on cardiovascular system had been surveyed. However, the black tea effect on pressure pulse spectrum remains unknown. The study was aimed to investigate the influence of black tea on radial blood pressure and Pulse Spectrum. Fourteen healthy subjects received water and single doses of black tea (0.05 g/Kg) in separate weeks. The radial blood pressure and pulse wave were measured and the pressure pulses were evaluated using harmonic analysis. This report confirmed that black tea consumption (dose = 0.05 g/Kg) significantly increased third, fifth, ( $P < 0.1$ ), sixth, seventh, and eighth harmonics ( $p < 0.05$ ) of radial pressure wave comparing to water control. We proposed that black tea may increase cerebral blood flow (CBF), which was deduced from the results and from the conclusions of previous studies. The results also showed that the harmonic components of pressure pulse could be the vascular kinetic index that assessed the hemodynamic status in each time frame before and after consumption of black tea.

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## 1. Introduction

Tea is one of the most popular beverages in the world, which can inhibit the development of cancer,<sup>1</sup> lower the risk of cardiovascular disease,<sup>2,3</sup> and improve cognitive health in human.<sup>4</sup> Several surveys proved that black tea improved endothelial function.<sup>5,6</sup> The work of others supported this concept and proved that epigallocatechin gallate (EGCG), one of tea catechin polyphenols, was able to activate the endothelial nitric oxide synthesis (eNOS) via several signaling pathways.<sup>7</sup> The eNOS plays major role in the control of cerebral blood flow (CBF) regulation<sup>8</sup> and promotes the maintenance of CBF in early stages of cerebral ischemic syndromes.<sup>9</sup>

In spite of several studies focusing on the effect of black tea on cardiovascular system, few studies investigated the effect of tea consumption on the pressure pulse spectrum. Pulse wave analysis can be an effective method for investigate the response of the arterial system.<sup>10</sup> Researchers showed that arterial blood pressure drives the blood flow into the capillaries of the organ irrigated by the artery.<sup>11,12</sup> This phenomenon was first investigated in rats,<sup>13</sup> further modeled and demonstrated through tube simulation.<sup>14</sup> Lin

Wang et al. then derived a rigorous analytic equation of the PR wave to explain the meaning of the harmonic components, the main components of arterial pressure waveform, in cardiovascular physiology.<sup>15</sup> In summary, the ventricular-arterial coupling system distributes the energy in proportions to the harmonic components of pressure pulse to different organs and meridians.<sup>16,17</sup> The local pressure pulses in the arteries and arterioles then drive the flow into capillaries.<sup>11,18</sup> Hence, the pattern of harmonic components could reveal the blood flow condition of organs<sup>10</sup> or specific meridian.<sup>19</sup>

Therefore, the aim of this study was to investigate the short term effects of black tea consumption on the radial pressure pulse spectrum. The harmonic analysis of radial arterial pulse wave, which was highly correlated with twelve meridians of Traditional Chinese Medicine, was used in monitoring the cardiovascular system.

## 2. Materials AND methods

### 2.1. Subjects and diet restriction

A total of 14 health subjects (11male, 3 female) aged 27–60 years, and weighted 46–92 kg were enrolled in this study. All of the subjects were nonsmokers and were not heavy drinkers of coffee, tea, or cola (less than 3 cups per day). Subjects were recruited after receiving approval from the institutional review board of the RenAi

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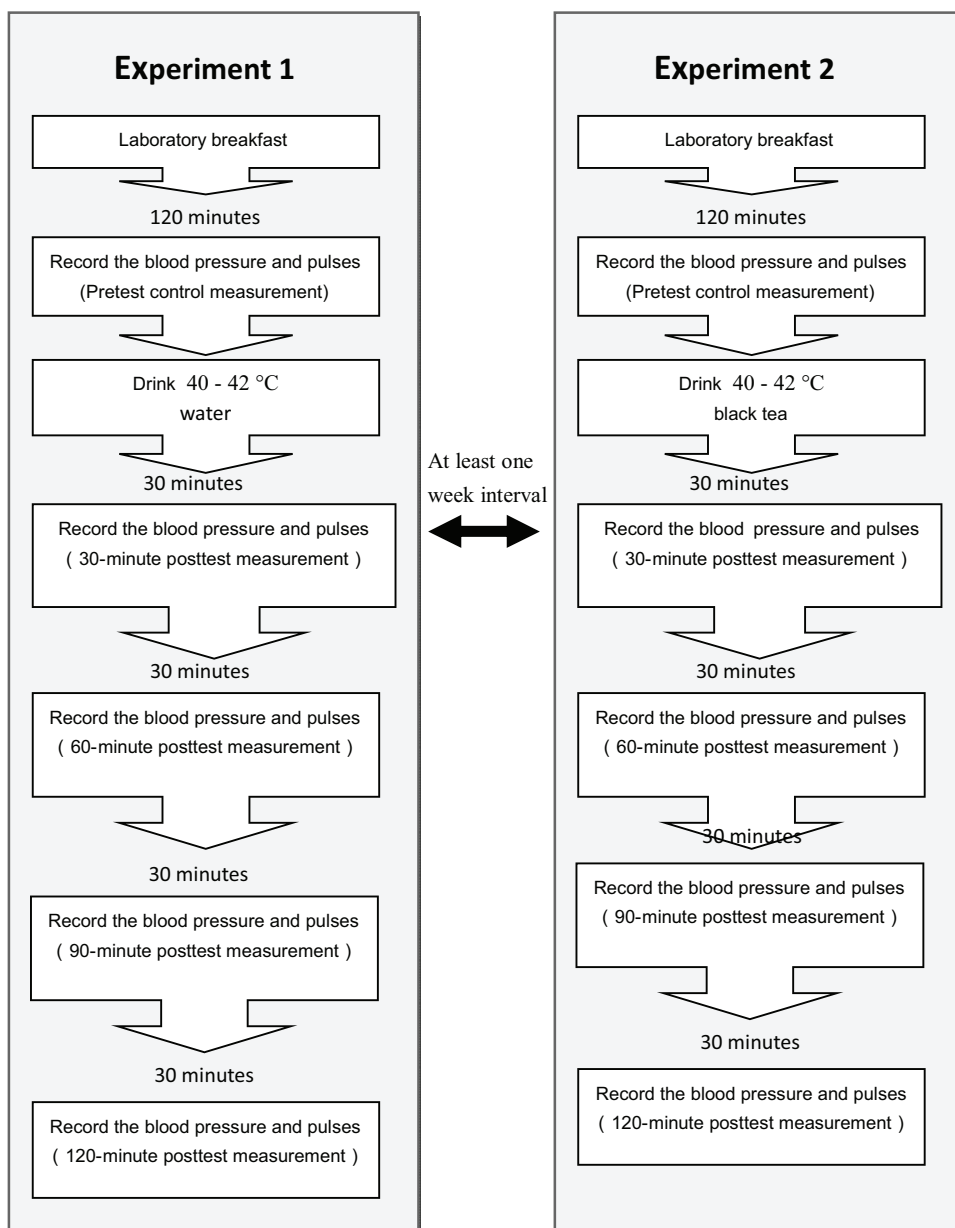


Fig. 1. Detail of experimental profiles.

Branch of Taipei City Hospital (IRB number: TCHIRB1010710). Oral and written information about the study was given. All subjects provided signed informed consent before their participation.

Diet restrictions were in place for all subjects during the course of the study. No concomitant medications (prescription, over-the-counter, or herbal) were to be administered for 3 days before the experiments. Cocoa, alcoholic, and caffeinated beverages were withheld 24 h prior to the experiment.

## 2.2. Study protocol

A self-controlled repeated measure designed study with consumption of water and black tea was performed separately in two weeks. This study aimed to evaluate the short-term effect of black tea on the radial pressure waveform in healthy human.

Experiment 1 measured the radial artery pressure wave before and after the consumption of 40–42 °C warm water, where the volume of warm water were equal to the volume of black tea needed for each subject. Experiment 2 measured the radial artery pres-

sure pulse before and after the consumption 0.05 g/Kg dose of black tea, with at least one week interval between experiment 1 and experiment 2. Experiment 1 was treated as the control treatment comparing to the black tea treatment. All the experiments were conducted in a room maintained at 23–25 °C.

In each experiment, subjects visited in the morning and we provided a standard breakfast served with egg sausage muffin and 250 ml of warm soybean milk. The first measurement was carried out at 120 min after the first bite of food as the pretest control. The treatments were performed 120 min after the first bite of food because the arterial pulse wave was relatively stable in the period.<sup>20,21</sup>

Each test subject received single dose of the Lipton black tea immediately after pretest measurement finished. The other four measurements were then recorded at 30 min, 60 min, 90 min, and 120 min after consuming the black tea as the posttest measurements. Totally five measurements of the radial arterial pulse wave were performed. (Fig. 1)

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