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# The Effect of Tea (*Camelia sinensis*) and Chocolate (*Theobroma cacao*) on Memory

Justin Himawan[1]*, Santoso[3], Mochamad Ali Sobirin[2], Endang Mahati[2]

[1]Undergraduate of Medicine, Faculty of Medicine, Diponegoro University, Prof. Soedharto SH Street, Tembalang, Semarang, 50275, Indonesia
[2]Department of Pharmacology and Therapy, Faculty of Medicine, Diponegoro University, Prof. Soedharto SH Street, Tembalang, Semarang, 50275, Indonesia
[3]Department of Biology of Medicine and Biochemistry, Faculty of Medicine, Diponegoro University, Prof. Soedharto SH Street, Tembalang, Semarang, 50275, Indonesia

*Corresponding author (justinhimawan1@gmail.com)

**Abstract**

Memory is often understood as an informational processing system with explicit and implicit functioning that is made up of a sensory processor, short-term (working) memory, long-term memory. Tea (Camellia sinensis) and chocolate (Theobroma cocoa) are common food beverages containing caffeine, theobromine, and flavonoid. Those substances in recent studies showed positive impact on cognitive performance. We examined the relation between the intake of both drinks on memory. The objectives are to determine the effect of black tea and chocolate on visuospatial memory. Eighteen males, 20 – 35 g body weight mice used as the subject that given by tea and chocolate for 28 days and experimented with Morris Water Maze Test. The study showed that there is significant effect on mice that given both tea (p=0.006) and chocolate (p=0.006) on memory as compared to control mice. However, there is no significant difference between the effect of tea and chocolate on memory. There is positive impact of consumption on both tea and chocolate on memory, especially visuospatial memory. Tea and chocolate significantly decrease the time of the mice to locate the platform.

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## Introduction

Cognitive define as ability to develop intellect. This intellectual potential consists of stages (knowing, understanding, applicating, analyzing, synthesizing, and evaluating) (Pitrowski, 2003). Cognitive function consists of several domains, among them social cognition, executive function, memory, attention, and psychomotor (Green, 1996). One of those domains is memory where the information is stored that can be called anytime (Sherwood, 2010). An individual with memory impairment will experience confusion related to time, place, and people. They also may encounter getting lost in a place where they usually visit, asking the same questions repeatedly, and forgetting promise and social meeting. These problems can their social life, profession, quality life, and even cause death (Krishner and Ally, 2016).

Chocolate and Tea are those drinks that widely consumed in our society which consist of several substances like flavonoid, caffeine, and theobromine. Those substances play important roles on memory (Feng et al, 2008; Spencer, 2007; Fenny and Gwee, 2010). Several researches showed that administration of green tea extract improve brain activity on front-parietal part that effect short term memory, also consuming flavonoid contained food escalate neuro-cognition function on MMSE test (Drevon et al, 2008; Camfielda et al, 2012; Bricknen et al, 2016; Neshat et al, 2016). This study aims to evaluate the effect of administration both tea and chocolate on one of the cognitive functions which is memory, especially visuospatial memory.

## Methods

Subject

18 males, 20 – 35 g body weight mice used as the subject which in healthy condition without anatomy and physiology abnormality.

Research Procedure

Ethical clearance was published by Health Research Ethics Commission Medical Faculty Diponegoro University with No. 154/EC/H/KEPK/FK-UNDIP/XII/2019. Experimental study was used in this research with pre and post-test design. Subjects were adapted through seven days. Then, subjects were divided in to three groups equally and tested with Moris Water Maze Test as pre-test data. Subjects were administrated accordingly with 5,2mg/g black tea and 26 mg/g cocoa for 28 days. At the end, subjects were tested again with Moris Water Maze Test as post-test data.

Analysis

The obtained data consist of total, mean, median, minimum and maximum with confidence interval 95%. First, numerical data was tested with Normality Test, then Kruskall Walis and Saphiro Wilk to see the comparison between groups, while to see the comparison the difference time between pre and post-test are used Wilcoxon Test.

## Results

Total subjects that were used in this research are 15 mice, that divided into three groups, control group (C), black tea administration group (T) and cocoa administration group (K). Each group consist of five mice. Subjects had average body mass for control group (C) 24±1.125kg, black tea administration group (T) 26.17±0.47kg, and cocoa administration group (K) 24.67±1. 11kg.The average time to complete Moris water maze test for pre-test were 57±3 seconds on control group (C), 51±4 seconds on cocoa administration group (K) and 54.44±3,44 seconds on black tea administration group (T). However, the average time to complete Moris Water Maze Test for post-test were 55.80±2.57 seconds on control group (C), 33.4±6.16 seconds on cocoa administration group (K), dan 35.4±7.27 black tea administration group (T). The results showed that mice administrated with black tea have the shortest time to complete the test, followed by cocoa administration, and control group at the last position. Subject characteristics shown on (Table 1).

Table 1. Saphiro Wilk Test on different group of mice before and after treatment

| Group | Visuospatial Memory<br>Mean ± Standard Deviation | | | | | | Body Mass (kg) |
|---|---|---|---|---|---|---|---|
| | Pre-Test (s) | p Value | Post Test (s) | p Value | Time Difference (s) | p Value | |
| C (n =5) | 57±3 | 0.005 | 55.8±2.57 | 0.073 | 1.2 ±0.97 | 0.285 | 24 ±1.12 |
| T (n=5) | 51±4 | 0.377 | 33.4±6.16 | 0.382 | 17.6±5.31 | 0.043 | 26.17±0.47 |
| K (n=5) | 54.4 ±3.44 | 0.017 | 35.4±7.27 | 0.032 | 19 ±5.17 | 0.043 | 24.67±1.11 |

Comparation of Visuospatial Memory Between Groups Before Administration

As data shown on (Table 1), Saphiro Wilk Test was conducted to show the normality of data distribution, p 0.005 on control group (C, p 0.382 on black tea administration group (T), and p 0.017 on cocoa administration group (K). These indicated data were distributed abnormally. Then, Saphiro Wilk Test was conducted to compare between groups. Result showed p score 0.073 for control group, p 0.382 for black tea group, and p 0.032 for cocoa group. These scores showed that there was no significance different between the three groups before administration. This test was done to show each group has slightly different time before administration.

Comparation of Visuospatial Memory Between Groups After Administration

As data shown on (Table 1), Saphiro Wilk Test was conducted to observe the normality of data distribution after administration, result was obtained with p 0.073 for control group, p 0.382 on black tea administration group, and p 0.032 on cocoa administration group. These results show no significant difference between groups. Then, Kruskall Walis and Mann Whitney Test were used (shown on Table 2), the results were p 0.018 between control and black tea administration group, p 0.018 between control and cocoa administration group, and p 0.69 between black tea and cocoa administration group. These results showed there were significant difference both black tea and cocoa compare to control group. However, there are no difference between black tea and cocoa administration group.

Table 2. Kruskall Walis and Mann Whitney test between different group of mice after treatment

| Group | Control | Tea | Chocolate |
|---|---|---|---|
| Control | - | 0.016 | 0.016 |
| Tea | 0.016 | - | 0.69 |

Discussion

In this experimental study on mice, both tea and chocolate had significant association on memory improvement especially visuospatial memory when tested on Moris water maze test. Recent studies shown that the effect of both, tea and chocolate on neurological system. One study in Finland for 13 years on human with age range from 25-74 years, people who consumed tea 3 times daily had a lower risk to have Parkinson (Khan and Mukhtar, 2013). This relation between tea and memory was similar to recent researches such as experiment on snail (*Lymnea sp)* that administrated by tea and the result shown an enhancement on long term memory (Swinton et al, 2018). Other research found that consumption of food-rich flavonoid increased memory function (Drevon et al, 2008). This research was conducted on human whom divided into two groups based on their daily consumption. They found people with high consumption of food rich flavonoid tend to have higher memory function compare to people who didn't consume food rich flavonoid on Kendrick Object Learning Tests (KOLT). At the other hand, other research found that administration green tea on mice for ten days with 6,5mg/kg didn't improve memory significantly although there was enhancement of memory (Ambarsari, 2009).

Chocolate as we known with variety of the content, has positive and negative effect. One of the positive effects of memory, and this research want to observe its effect on part of the memory, the visuospatial memory. From the analyze result, found that chocolate has positive effect on enhancing memory function especially, visuospatial memory. Other researches also support this result, consumption of cocoa enhance cognitive ability and mood (Scholey et al., 2010). They divided subject into who usually consumed cocoa as their daily consumption and others who rarely consumed it. The result explained that there are significant enhancement on the group who usually consumed cocoa than group who doesn't on KOLT score. Other research also shown that administration of cocoa to snail (*Lymnea sp.)* improve its cognitive (Swinton et al, 2018). The research was done on snail the Pond Water, but on this research using mice as subject and used moris water maze as the test.

According to this research shown that both of them have significant effect on memory as the result shown above, although neither tea or chocolate shown a significant enhancement when compares to each other. Recent research shown that cocoa administration improve memory with $p<0.01$ and tea $<0.02$. (Drevon et al, 2008). There are several substances that may have effect on memory. Studies about the substances such as flavonoid, caffeine, and theobromine explained their effect on memory. One of the studies shown that caffeine play role on enhancing serotonin concentration on brain stem by inhibiting deamination of monoamine oxidase enzyme that improve memory formation. Flavonoid, as we known as polyphenol group also enhance neurogenesis on dentate gyrus on hippocampus by increasing neurotropin and synaptic factor, flavonoid also increased phosphorylation of CREB on CA 1, part of the hippocampus. As we known, hippocampus play role one restoring memory by (Bakoyiannis I, 2019). The last, theobromine is one of the caffeine's metabolites, associated with memory through its role as messenger by CaMK, that cause phosphorylation of CREB, that activate transcription of BDNF. This process play role on neuron plasticity that induce long term memory (Islam R et al, 2019).

Nevertheless, we do have some certain limitations. (1) We couldn't explain substances that play major role in this experiment on memory function, so there will be bias as each product have variety content. (2) Dosage that were used on this research are based on daily consumption on human, and may vary when it's administrated on human may improve memory function or not at all. (3) Dosage we used on this research on tea and chocolate are not equally same so there are bias which has better cognitive function, may future experiment to research with stages of dose either tea or chocolate on memory function.

**Conclusion**

Administration of both tea and chocolate improve visuospatial memory function on BALB/C mice. Although, there weren't any significant different between them, but chocolate shown better score than tea.

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