

## Association between Cerebral Blood Flow and Cognitive Improvement Effect by *B. mori* Extracted Component

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### ABSTRACT

To investigate whether BF-7, extracted from *Bombyx mori*, improved learning and memory of ordinary people, K-WAIS (Korean version of Wechsler adult intelligence scale) was performed in 4 normal students. Treatment with 400 mg of BF-7 increased mean IQ from 103 to 114. To know how BF-7 plays such a positive role, we measured blood flow to the brain, especially in the area concerned with learning and memory, with Single Photon Emission Computed Tomography (SPECT). Our results showed that blood flow to parahippocampal gyrus and medial temporal areas was increased. Also, our results showed images representing increased blood supply in these areas. Our results suggest that BF-7 effectively helps brain function concerning learning and memory.

**Key words :** *B. mori* fibroin and memory, BF-7, SPECT, Blood flow

### Introduction

The brain consists of more than 10 billion neurons and many more neuroblasts (Chklovskii *et al.*, 2004; Montgomery and Madison, 2004). These neurons mutually form synapses to perform higher cerebral functions. In order to effectively maintain higher cerebral functions such as memory and learning ability, it requires health of neurons and exchange and integration of mutual information. Therefore, it can be said that the maintenance and development of memory and learning ability are important for maintaining brain health. (Riekkinen *et al.*, 1998; Gibbs *et al.*, 2004; Seeger *et al.*, 2004). Recently, there have been reports that silk fibroin

hydrolysate BF-7 enhanced memory and learning ability (Chae *et al.*, 2004; Lee *et al.*, 2004). Moreover, results have shown that BF-7 protects the brain from various forms of daily stress. Brain physiological protection and functional improvement have great medical value.

In order to medically verify the effects of BF-7, this study was conducted on four volunteers in their early 20s to investigate whether BF-7 improved memory and learning ability and how it has such effects if it really does. For these purposes, this study confirmed the active brain regions related to memory and learning ability using single photon emission computed tomography (SPECT) to measure local cerebral blood flow.

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## Materials and Methods

### 1. Silk Fibroin Hydrolysate

The silk fibroin hydrolysate was provided by National Institute of Agricultural Science and Technology. It was prepared by the method previously represented (Yeo *et al.*, 2004).

### 2. Examinees and Brain Function Tests

The 4 volunteers (2 males and 2 females) in their early 20s were administrated 2 capsules of BF-7 twice a day (400mg per day) for 3 weeks. K-WAIS (Korean version of Wechsler adult intelligence scale) for measuring intelligence and SPECT for investigating brain blood flow was tested before and after taking BF-7.

### 3. SPECT Scanning

Siemens MultiSPECT III (Siemens Medical Systems, Inc. Hoffman Estates, Ill, USA) was used to obtain Tc-99m ECD SPECT images. With regard to the image acquisition, 120 frames were obtained by rotating 360 degrees at 3-degree intervals with the use of a low energy high resolution collimator. Scanning was performed 30 minutes after administering Tc-99m ECD 11.1 MBq/kg (0.3 mCi/kg) to the subjects. During the scanning, they minimized the movement of their heads in a comfortable position. Scanning was performed again after administration of BF-7 for 3 weeks.

### 4. Analysis of SPECT Images

Statistical parametric maps consisting of cerebral blood flow SPECT images were created by analyzing SPECT images in SPM99 (Statistical Parametric Mapping 99) using Matlab (Mathworks Inc. USA).

## Results and Discussion

Students in their early 20s were used to investigate whether BF-7 improved memory and learning ability and how it has such effects if it really does. For these purposes, this study confirmed the active brain regions related to memory and learning ability using single photon emission computed tomography

(SPECT) to measure local cerebral blood flow.

The average age of four volunteers (2 males and 2 females) participated in this study was 23 years. The mean IQ was 103 before taking BF-7 and increased to 114 after daily administration of 400 mg of BF-7 for 3 weeks (Table 1). This agrees with the results in many various reports that BF-7 improved memory and learning ability.

### 1. Comparison of Blood Flow before and after Administration of BF-7

The results showed that there was a significant increase in brain blood supply in parahippocampal gyrus and medial temporal areas which mainly control memory and learning ability after administration of BF-7 (Table 2).

Recently, many studies have been conducted to investigate mental activities and functions in the brain with imaging techniques. Brain SPECT provides important data for determining the function of the brain because it can effectively measure and visualize an increase in brain blood flow. Figure 1 shows brain areas with significant differences before and after taking BF-7 (paired t-test,  $p < 0.05$ ) by quantifying the degree of brain blood flow.

The yellow colored area shows an increase in blood flow and glucose consumption after administration of BF-7 compared to before taking it. Brain tomography enables us to check where there was increase in

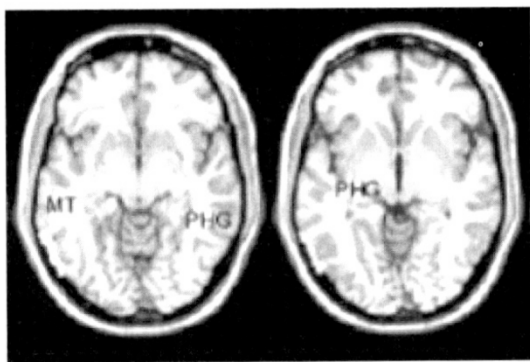
**Table 1.** Demographic and psychometric variables in patients and controls

Variables / groups	Characteristics	
	Pre-Treatment	Post-Treatment
Number	4	
Male : Female	2 : 2	
Age(yrs)	23	
K-WAIS score	103	114*
Range	98-107	109-122

K-WAIS : Korean version of Wechsler intelligence adult scale  
\* :  $p = 0.5$

**Table 2.** Comparison of Tc uptake(%) before and after BF-7 administration

Regions	Pre-Treatment	Post-Treatment	Significance
parahippocampal gyrus	101.1	105.4	$p < 0.05$
medial temporal area	95.2	104.4	$p < 0.05$



**Fig. 1.** Cross-sectional view from SPM 99 displaying the cortical regions showing significant change between pretreatment and posttreatment. SPM map threshold was  $P < 0.05$  corrected.

blood flow and glucose consumption. According to the results of this study, an increase in glucose consumption colored in yellow was found in the parahippocampal gyrus and medial temporal areas. This means that the regions controlling cognition memory and learning ability effectively function by administration of BF-7 and there is an increase in blood supply and glucose consumption.

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