

SI-2

## **BIOLOGICAL ACTIVITIES OF L-THEANINE (SUNTHEANINE™), AN AMINO ACID OF GREEN TEA, IN HUMANS**

**Yutaka Ogasawara, Tsutomu Okubo, Tomoko Ueda, Makoto Ozeki,  
Lekh R. Juneja<sup>1)</sup>, Hidehiko Yokogoshi<sup>2)</sup> and Seiichi Matsumoto<sup>3)</sup>**

<sup>1)</sup>Taiyo Kagaku Co., Ltd., 1-3 Takaramachi Yokkaichi-shi, Mie, 510-0844, Japan

<sup>2)</sup>The University of Shizuoka, 52-1 Yada, Shizuoka-shi, Shizuoka 422-8526, Japan

<sup>3)</sup>Japan Family Planning Association, Inc., 1-10, Ichigaya Tamachi, Tokyo, Japan

E-mail: yogasawara@taiyokagaku.co.jp

### **Abstract**

L-theanine is a unique amino acid, found almost solely in tea plants. It is the main component responsible for the exotic taste of green tea. In our studies of L-theanine, we have found a variety of biological activities including relaxation and the alleviation of PMS.

In general, animals generate very weak electric pulses on the surface of the brain, called brain waves. Brain waves are classified into four types, namely  $\alpha$ ,  $\beta$ ,  $\delta$  and  $\theta$ -waves, based on their frequency. Brain waves correlate with individual mental conditions. For example, generation of  $\alpha$ -waves is considered an index of relaxation. In human volunteers,  $\alpha$ -waves were generated on the occipital and parietal regions of the brain surface within 40 minutes after the oral administration of 50 or 200 mg Suntheanine™ without causing drowsiness.

Premenstrual Syndrome (PMS) is a symptom unique to women which appears in the luteal phase from the ovulation period through the first day of menstruation. It possesses characteristics of having a peak just prior to menstruation and disappearing 1 - 2 days following the start of menstruation. Symptoms of PMS are generally categorized as mental, physical and social symptoms. When comparing the reported Symptoms of PMS by the methods of MDQ score, the Suntheanine™ group was found to have a lower incidence of PMS symptoms, including physical, mental and social symptoms. Overall, a significant alleviation of PMS symptoms by the administration of 200 mg Suntheanine™ was observed.

With the successful industrial production of L-theanine, we are now able to supply Suntheanine™, offering a tremendous opportunity for designing functional foods targeting relaxation and the alleviation of PMS.

### **INTRODUCTION**

The physiological and pharmacological actions of various components of green tea such as

polyphenols, caffeine and  $\gamma$ -aminoisobutyric acid have been studied. <sup>(1-3)</sup> L-theanine, a unique amino acid found in the tea plant in 1949. <sup>(4)</sup> constitutes between 1 to 2% of the dry weight of tea leaves. It exists only in the free (non-protein) form and is the predominant amino acid component in tea, accounting for about 50% of the total free amino acids. <sup>(5,6)</sup> Its chemical structure was determined to be  $\gamma$ -ethylamino-L-glutamic acid. (Fig. 1)

We have been studying the physiological activities of L-theanine and found a variety of activities including relaxation, alleviation of PMS, lowering of blood pressure, improvement of insomnia and improvement on learning performance.

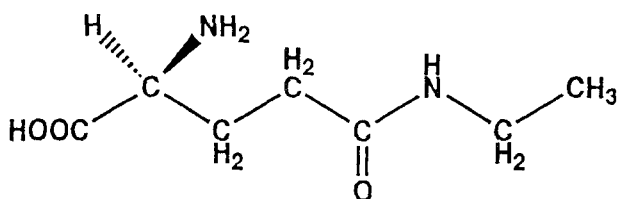


Figure 1. Chemical structure of L-theanine.

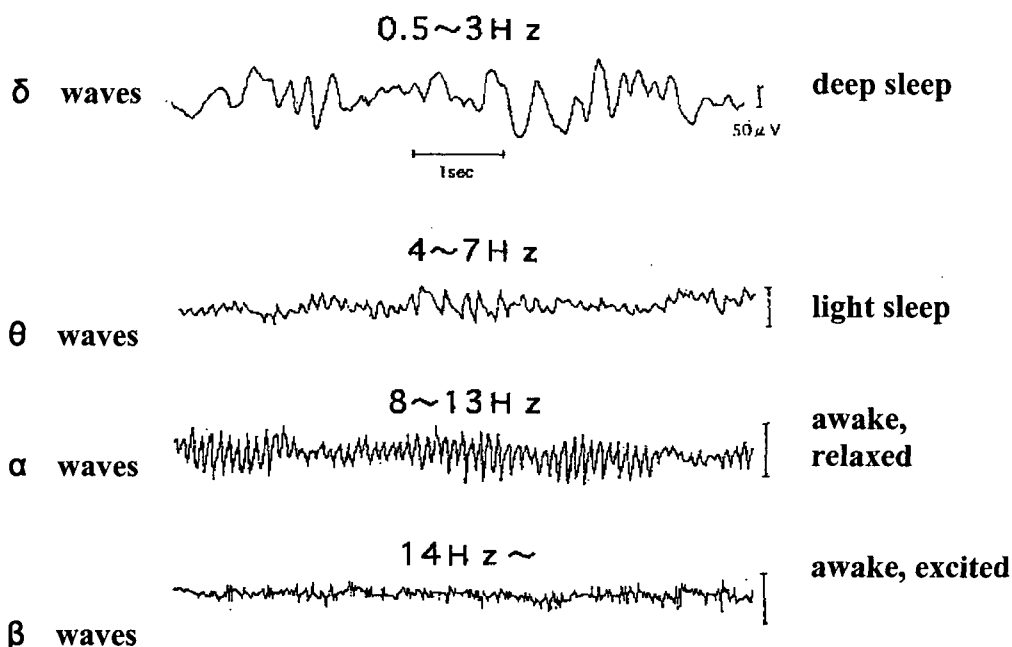
### Biological activities of L-theanine in humans

#### 1) Relaxing effect

It has been known that L-theanine not only provides the flavor of green tea but also a noticeable relaxation effect in humans. We investigated the key factor in green tea giving relaxation effect. The essential substance that causes a sense of relaxation is L-theanine.

In general, animals and humans always generate weak electric pulses on the surface of the brain called brain waves. Brain waves are classified into four categories, named  $\alpha$ ,  $\beta$ ,  $\delta$  and  $\theta$  waves according to their frequency. Each brain wave is related to individual mental condition. (Fig. 2) Generation of  $\alpha$ -waves are considered an index of relaxation.

To evaluate the efficacy of L-theanine on relaxation, a single blind cross over volunteer study was performed. As it was expected that mental reactivity to L-theanine could vary with anxiety level, fifty female subjects (18 – 22 years old) were divided into two groups, namely high anxiety and low anxiety groups, based on monitoring by manifest anxiety scale (MAS). Four subjects were then randomly selected in each group in the interest of complexity and time. Brain waves were measured for the four subjects in the high anxiety and the low anxiety groups, respectively. Each group was given water, a single dose of 50 or 200 mg of Suntheanine™ solution, with a one week washing out period and brain waves were measured for 60 minutes after the administration of Suntheanine™. Brain waves in each group and with each test solution were measured twice during the test period for



**Figure 2. Classification of brain waves.**

two months.

In the study,  $\alpha$ -brain waves were observed from the back to the top area of the brain surface about 40 min after the intake of Suntheanine™ solution. An oral administration of 200 mg Suntheanine™ dissolved in 100 ml of water resulted in the generation of  $\alpha$ -brain waves in the occipital and parietal regions of the subject's brain, while only small levels of  $\alpha$ -waves were observed in the subjects with water intake. (Fig. 3, Fig. 4) Accumulated intensity of  $\alpha$ -brain waves (Relative ratio) showed a dose dependent manner in the high anxiety group. <sup>(7)</sup> (Fig. 5)

It is well-known fact that  $\alpha$ -brain waves are generated during relaxed states and that the generation of  $\alpha$ -waves is considered an index of relaxation. As shown in our results, it was suggested that L-theanine would promote the generation of  $\alpha$ -brain waves and induce relaxed state in humans.

## 2) Effects on alleviation of PMS

Premenstrual Syndrome (PMS) is a symptom unique to women, which appears in the luteal phase from the ovulation period through the first day of menstruation. It possesses characteristics of having a peak just prior to menstruation and disappearing 1 - 2 days following the start of menstruation. (Fig.6) Typical symptoms of PMS are generally categorized as mental, physical and social symptoms.

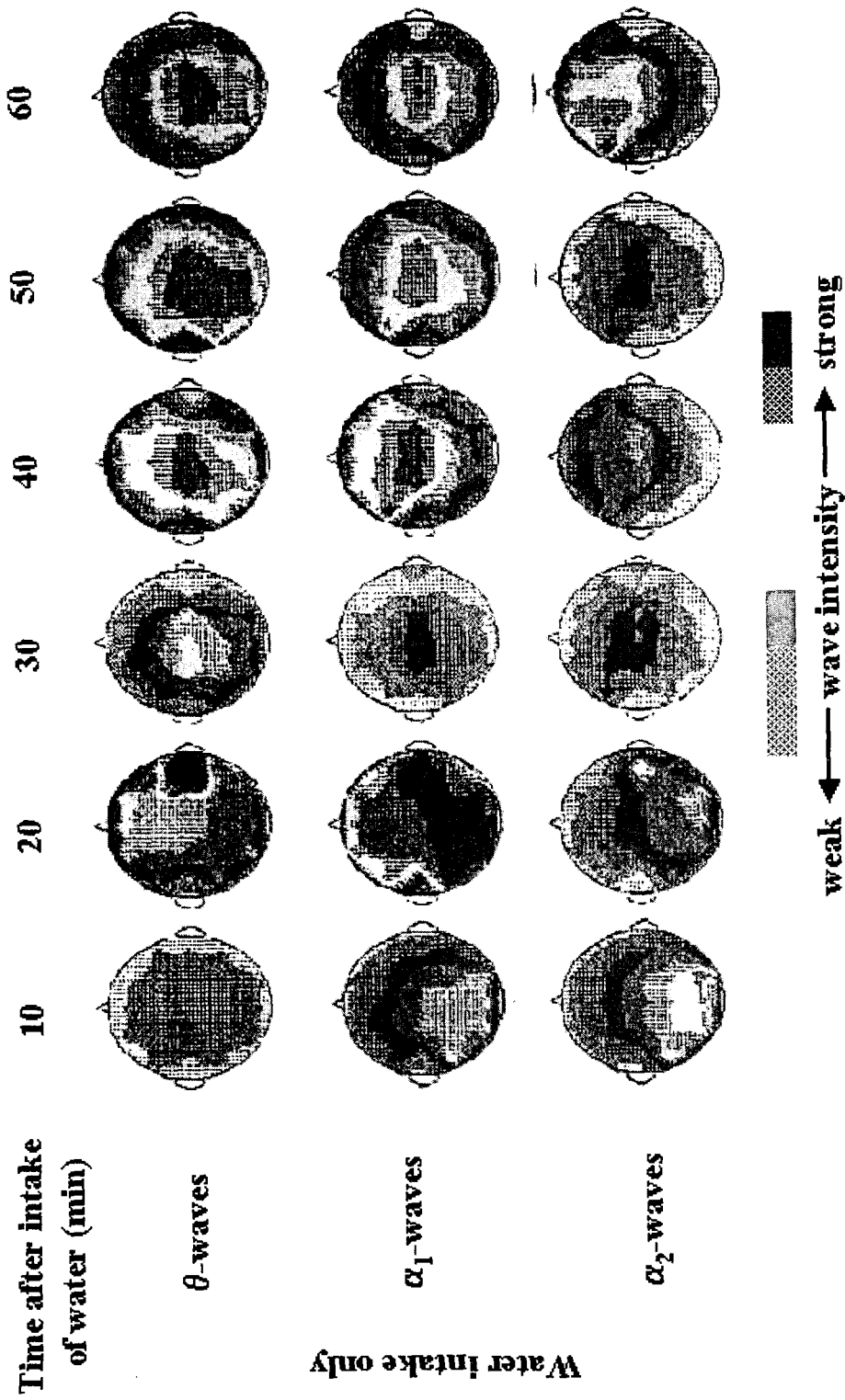


Figure 3. Topographies converted from data of brain waves on brain surface measured for 60 min after intake of water in human volunteers.

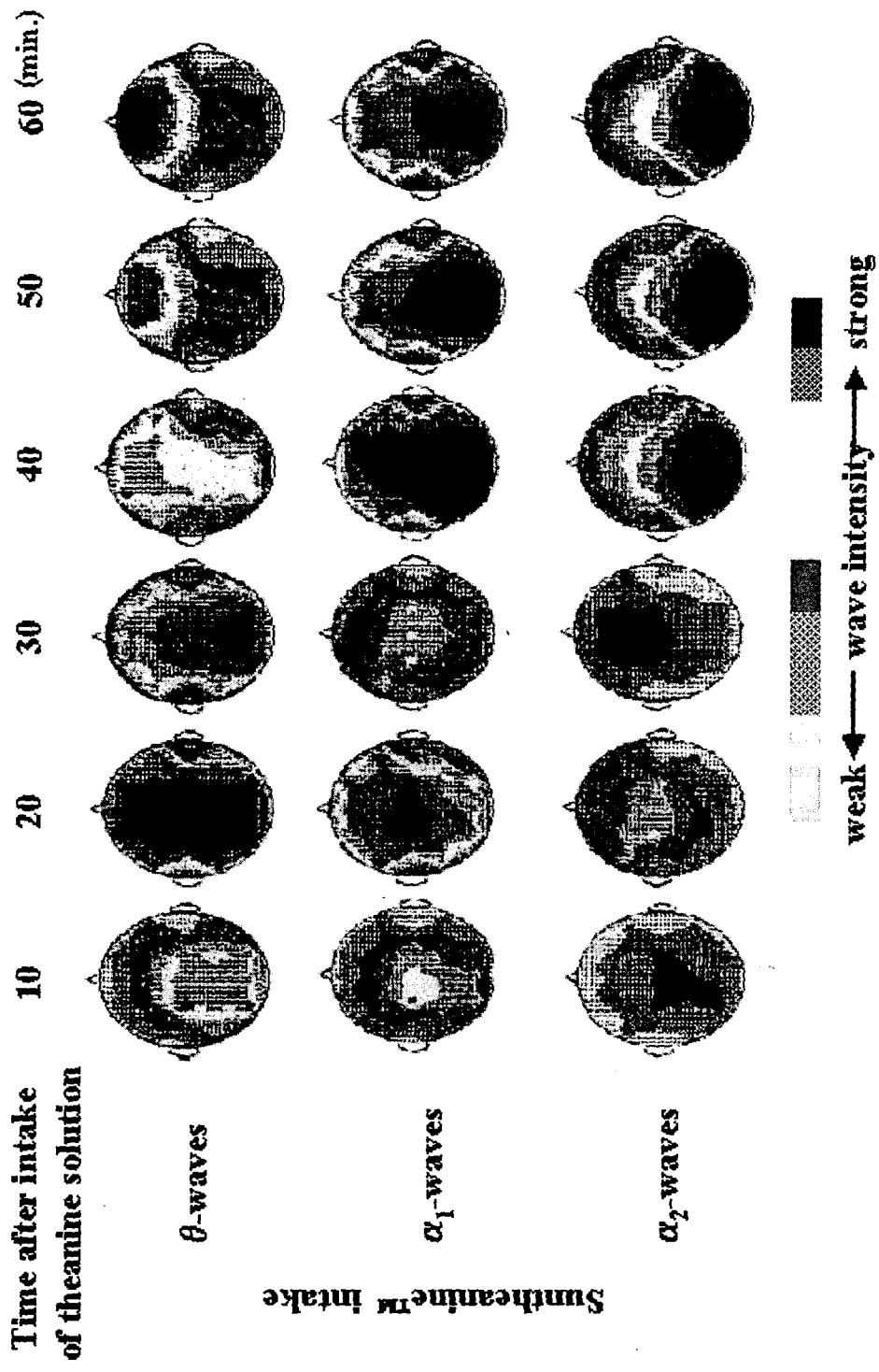


Figure 4. Topographies converted from data of  $\alpha$ -brain waves on brain surface within 40 min aft intake of Suntheanine™ in human volunteers.

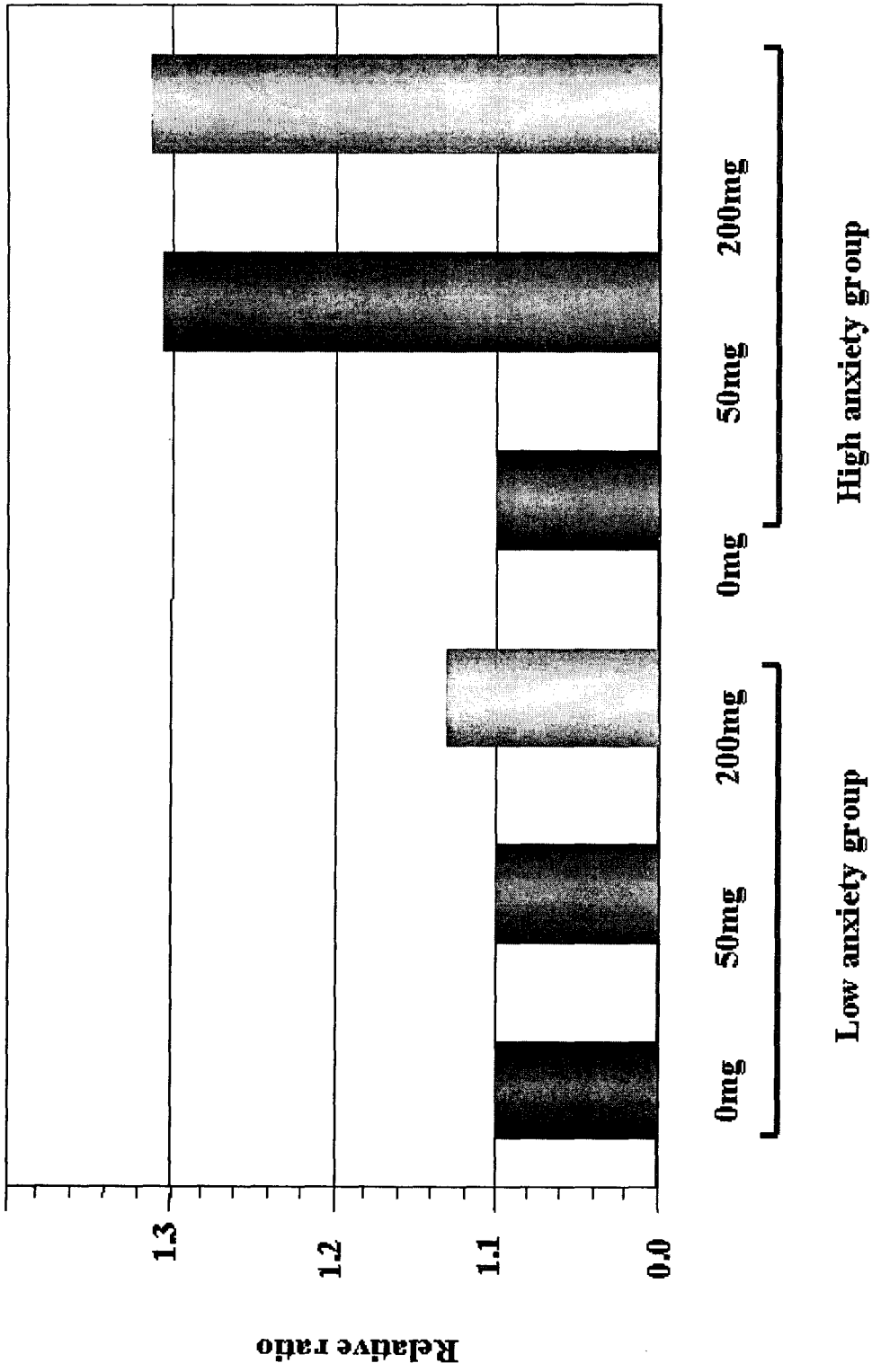


Figure 5. Effect of L-theanine on Emission of  $\alpha$ -waves Based on Anxiety.

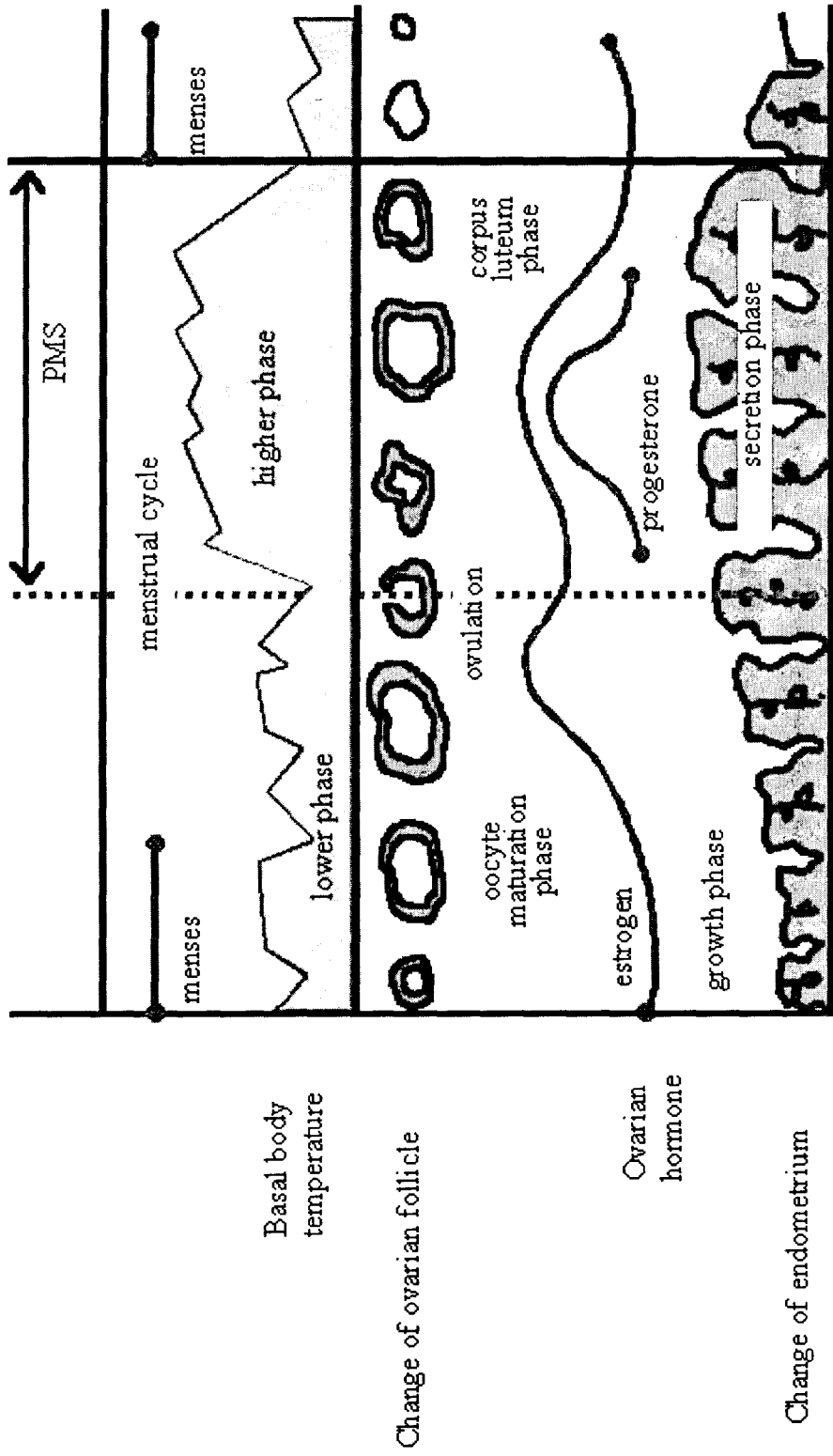


Figure 6. Stages of Premenstrual Syndrome.

In a volunteer study, twenty subjects were treated with tablets containing either 50 mg Suntheanine™ per tablet or a placebo. Subjects took two tablets twice a day for a total of 200 mg Suntheanine™. The test duration consisted of 3 menstruation cycles.

Test subjects were required to answer a Menstrual Distress Questionnaire (MDQ)<sup>(8)</sup> survey 3 days prior to expected menstruation date and at the time of first and second administrations. The MDQ survey, developed by Moos, R, et. Al., contains 47 questions, divided into the 8 categories shown in Table 1. Moos scores reported symptoms with six grades. For this study, four of the grades were used. Higher scores indicate an increased acknowledgement of physical and mental symptoms associated with PMS.

The first cycle was regarded as the control. Crossover tests were conducted using Suntheanine™ and / or a placebo for the second and third cycles.

**Table 1. Categories of Menstrual Distress Questionnaire (MDQ)**

Categories	Symptoms
Physical Symptoms	
Pain	Muscle stiffness, headache, cramps, backache
Concentration	Insomnia, forgetfulness, lowered judgment
Behavioral change	Stay at home, avoid social activities
Autonomic reactions	Dizziness, cold sweats, vomiting
Water retention	Weight gain, skin disorders, swelling
Negative affect	Depression, anxiety, loneliness, irritability
Mental Symptoms	
Arousal	Orderliness, excitement, bursts of energy
Control	Feelings of suffocation, ringing of ears, pounding of heart

Suntheanine™ was found to have a lower score compared to that of the placebo in both mental and physical symptoms by the method of MDQ Questionnaire, with the effect on mental symptoms being the greatest. Overall, a significant alleviation of PMS symptoms by Suntheanine™ was observed. (Fig. 7)

## CONCLUSIONS

Since ancient times, it has been said that drinking green tea induces relaxation. We investigated this particular effect and have found that L-theanine had a noticeable relaxation effect. Additionally, L-theanine was found to alleviate various symptoms of PMS.

Suntheanine™ (L-theanine) is an effective food ingredient leading to an improved quality of life.



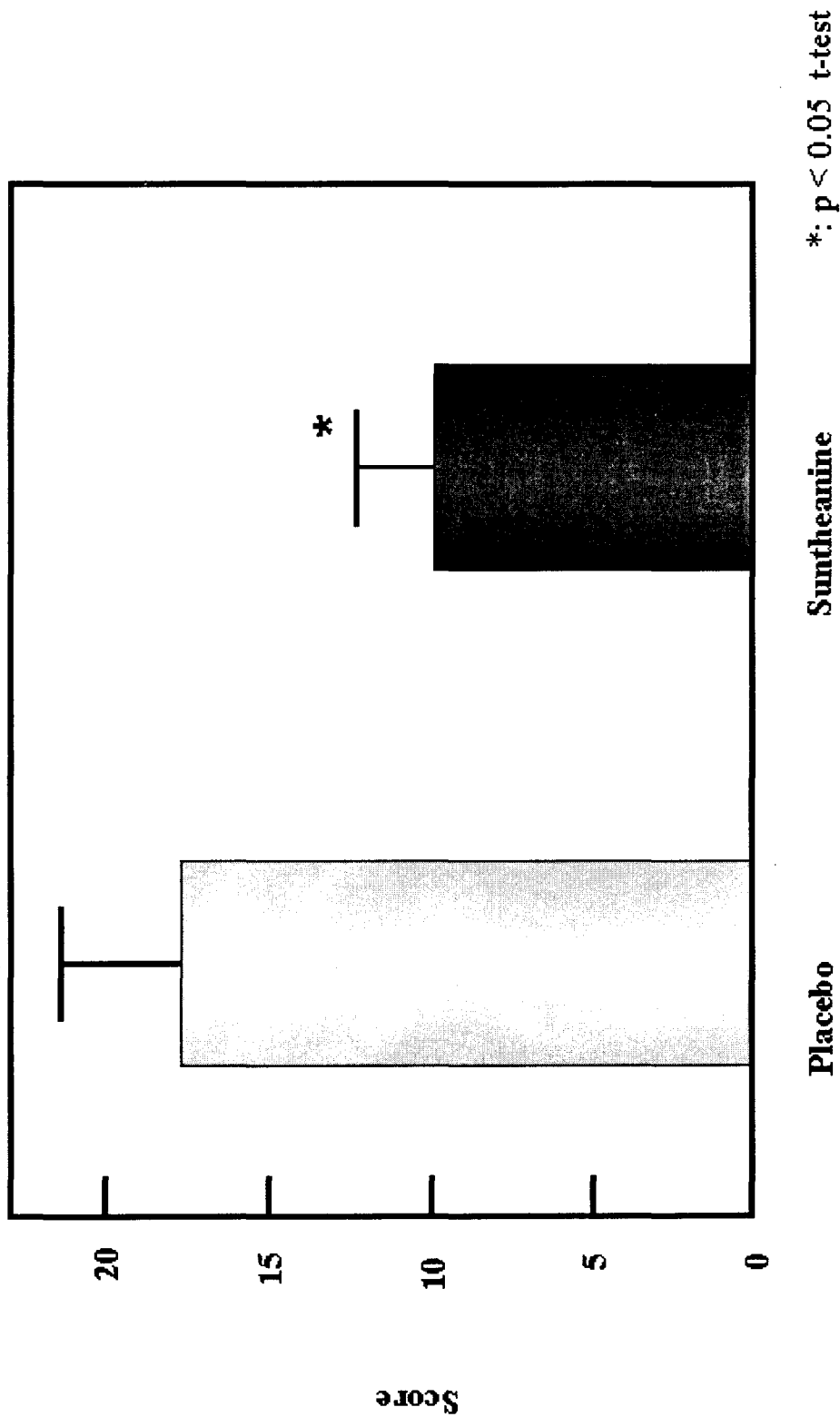


Figure 7. Overall alleviation of PMS symptoms.

## References

1. Chemistry and Applications of Green Tea ed. by Yamamoto, T., et al.: pp:160., CRC-Press, New York (1997)
2. Neims, A. H. and Borstel, R. W.: Nutrition and the brain, ed. by Wurtman, R. J., Raven Press, New York:1-30 (1983)
3. Omori, M. Yano, T., Okamoto, J., Tushida, T., Murai T. and Higuchi, M.: Nippon Nogeikagaku Kaishi **61**, 1449-1451 (1987)
4. Sakato, Y.: The chemical constituents of tea. III. A new amide theanine, J. Agri. Chem. Soc. **23**, 262-267 (1949)
5. Mukai, T., Horie, H. and Goto, T.: Differences in free amino acids and total nitrogen contents among various prices of green tea, Tea Research Journal **76**, 45-50 (1992)
6. Research Group of Green Tea Brewing: Brewing Condition of tasty cup of green tea, J. Tea Research **40**, 58-66 (1973)
7. K. Ito, Y. Nagato, N. Aoi, L. R. Juneja, M. Kim, T. Yamamoto and S. Sugimoto: Effects of L-theanine on the release of  $\alpha$ -brain waves in human volunteers, Nippon Nogeikagaku Kaishi **72**, 153-157 (1998)
8. Moos.,R.H.: The development of a menstural distress questionnaire, Psychosom Med. **30**, 853-867 (1968)