200 mg of Zen

L-Theanine Boosts Alpha Waves, Promotes Alert Relaxation

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It is probably no surprise to learn that tea is—after water—the most consumed beverage in the world. Millions of people drink this soothing beverage, especially in the East, and its popularity continues to grow in the West. Of course, Oriental cultures have known about tea's medicinal benefits since ancient times and have used it as a general purpose tonic—and for its relaxation effects.

While there are hundreds of studies that clearly show the health benefits of tea (see box entitled Health Benefits of Green Tea), most people drink it because it has a pleasant flavor and a relaxing effect. This relaxing effect is caused by the presence of a neurologically active amino acid, L-theanine, found almost exclusively in tea plants (*Camellia sinensis*), in *Xerocomus badius* mushrooms, and in certain species of the genus *Camellia*, namely *C. japonica* and *C. sasanqua*.

Research with human volunteers has affirmed that L-theanine not only creates a sense of relaxation approximately 30–40 minutes after oral ingestion but that it accomplishes this via two different avenues of approach. First, this amino acid stimulates production of alpha brain waves directly, creating a state of deep relaxation and mental alertness such as is often achieved via meditation. Second, L-theanine appears to have a role in the formation of the inhibitory neurotransmitter gamma amino butrylic acid (GABA). GABA blocks release of the neurotransmitters dopamine and serotonin and may, therefore, have the key role in the relaxation effect.[1]

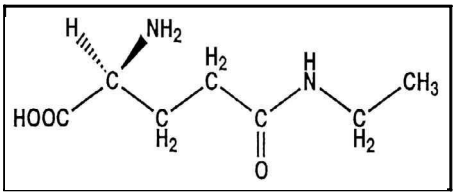
Amino Acid Content in Various Grades of Green Tea

(mg/100g)

Grade / Amino acid	Gyokuro		Sencha		Bancha	Hojicha
	Fine	Medium	Fine	Medium		
Thea	2,466.1	2,007.7	1,496.6	652.5	416.7	21.7
Glu	449.4	383.5	217.4	214.3	184.5	16.7
Asp	432.5	333.0	245.8	172.9	124.9	27.2
Arg	497.5	277.0	198.1	64.2	38.9	14.6
Ser	352.8	329.6	202.0	114.3	82.4	10.3
Thr	128.8	98.3	48.0	29.1	23.0	3.2
Ala	54.8	40.8	28.3	24.7	20.2	3.9
Val	25.2	21.5	18.9	14.2	8.2	1.1
Lys	39.1	32.7	28.7	14.0	10.1	1.4
Phe	37.7	41.2	31.4	24.8	14.2	1.1
His	28.2	22.1	10.3	7.6	6.6	0.9
Gly	4.8	4.3	5.0	3.8	3.0	1.0
Ile	36.1	28.6	14.4	11.7	7.5	0.9
Leu	32.6	26.6	15.5	10.7	3.2	0.6
Tyr	29.6	30.9	25.7	16.3	8.5	1.1
	4,615.2	3,678.7	2,586.1	1,375.1	951.5	105.7

In 1999, scientists at the Laboratory of Nutritional Biochemistry, School of Food and Nutritional Sciences, the University of Shizuoka, in Shizuoka, Japan, were able to confirm several unique properties of L-theanine.[2] Their research suggested that, in addition to facilitating relaxation, L-theanine (or the trademarked product, Suntheanine,™ from Taiyo Kagaku, Co., Ltd., in Yokkaichi, Mie, Japan) may also have applications in: (1) controlling hypertension; (2) improving learning performance; (3) heightening mental acuity; (4) promoting concentration; (5) reducing caffeine effects; and, (6) supporting the immune system.[3]

L-theanine constitutes between 1 and 2 percent of the dry weight of tea leaves, is the predominant amino-acid component in tea, and exists only in the free (nonprotein) form. The presence of L-theanine in tea leaves was discovered by Japanese researchers in 1949 and its chemical structure was determined to be gamma-ethylamino-L-glutamic acid. By 1964, after favorable toxicology studies, L-theanine was approved in Japan for unlimited use in all foods, with the exception of infant foods.[2,4] It is L-theanine that gives tea its characteristic, slightly brothy, *umami* taste. (See box entitled Umami or "5th Taste.")



Chemical structure of L-theanine (γ-ethylamino-L-glutamic acid).

Interestingly, the L-theanine content of certain specialty teas often correlates with the grade of tea. High-grade

A study of more than 3000 Japanese women who drank more than usual amounts of tea indicated that tea may be a protective factor against premature death.

Health Benefits of Green Tea

A 1992 article published in the *Tohoku Journal of Experimental Medicine* reviewed mortality rates of more than 3000 Japanese women who, as practitioners of a specific tea ceremony, drank more than usual amounts of tea. The results indicated "the possibility that tea is a protective factor against premature death."[a]

Research has also shown that tea is rich in catechin polyphenols, particularly epigallocatechin gallate (EGCG)—a powerful antioxidant.[b] The cancer-preventive and cancer-inhibiting effects of EGCG have been major foci of cancer research in recent years.[c] Research has also shown that EGCG is effective in lowering low-density lipoprotein cholesterol levels, thus, inhibiting the abnormal formation of blood clots—the leading cause of heart attacks and stroke.[d,e]

[a]Sadakata, S., Fukao, A., Hisamichi, S. Mortality among female practitioners of Chanoyu (Japanese tea-ceremony). *Tohoku J Exp Med,* 166:475–477, 1992; [b]Nakagawa, K., Ninomiya, M., Okubo, T., Aoi, N., Juneja, L.R., Kim, M., Yamanaka, K., Miyazawa, T. Tea catechin supplementation increases antioxidant capacity and prevents phospholipid hydroperoxidation in plasma of humans. *J Agric Food Chem* 47:3967–3973, 1999; [c]Suganuma, M., Okabe, S., Sueoka, N., Sueoka, E., Matsuyama, S., Imai, K., Nakachi, K., Fujiki, H. Green tea and cancer chemoprevention. *Mutat Res* 428 (1–2):339–344, 1999; [d]Ahmad N., Mukhtar, H. Green tea polyphenols and cancer: Biologic mechanisms and practical implications. *Nutr Rev* 57:78–83, 1999; [e]Kang, W.S., Lim, I.H., Yuk, Y., Chung, K.H., Park, J.B., Yoo, H.S., Yun, Y.P. Antithrombotic activities of green tea catechins and (-)-epigallocatechin gallate. *Thromb Res* 96:229–237, 1999.

L-Theanine Compared to Popular Antistress Herbs

L-Theanine	Kava kava (*Piper methysticum*)	Valerian (*Valeriana officinalis*)	St. John's wort (*Hypericum perforatum*)
Use			
Reduces anxiety and stress; increases mental acuity	Reduces anxiety and stress	Sleeping aid; reduces anxiety	Antidepressant; sedative; reduces anxiety
Dosage			
50–200 mg	100–200 mg (70 percent kavalactones)	100–1800 mg per day of extract; total internal daily dose is 15 g of root power	200–1000 µg per day
Reaction time			
30–40 minutes	40–60 minutes	1–3 hours	Several days of continued use
Cautions			
None	May impair judgment and reflexes; yellows skin and nails; contraindicated in patients with endogenous depression and in pregnant and nursing women	Promotes drowsiness and sleep; may damage liver; should not be used with alcohol; patients should not drive or operate motor vehicles; not recommended for use in pregnancy	May cause photosensitization; may reduce absorption of iron
Duration of administration			
Not limited	No longer than 3 months without medical supervision	Not limited	4–6 weeks
Adverse drug interactions			
None known	Alcohol, psychopharmaceuticals, and barbiturates, alprazolam, and dopamine	May potentiate effect of other central nervous system depressants; has an additive effect when taken with barbiturates and benzodiazepines.	Monoanimine oxidase inhibitors; selective serotonin reuptake inhibitors; indinavir; digoxin; photosensitizers; cyclosporin; reserpine; barbiturates; sertraline, nefazadine; ethinyloestradiol and desogesterol in combined form; warfarin, and theophylline
Purity/quality			
>99%	Variable	Variable	Variable

Adapted from *PDR for Herbal Medicines* (2nd ed.). Montvale, NJ: Medical Economics Company, 2000; and, with permission, from L-Theanine, a fact sheet from Taiyo International, Inc., Edina, Minnesota. ©2000.

L-Theanine is still comparatively unknown in the United States.

matcha green tea, which is one of the most expensive types of green tea, has the greatest percentage of L-theanine. Gyokuro and sencha green teas also contain fairly high amounts—between 26 and 46 mg of L-theanine per cup of tea. However, according to Scott Smith, senior manager at Taiyo International, Inc., the Edina Minnesota–based U.S. distributor for Taiyo Kagaku, other kinds of non–green tea also have high L-theanine contents. These include Ceylon pekoe from Sri Lanka, Darjeeling, and Earl Grey from China. The amount of L-theanine in tea depends on a variety of environmental factors, including climate, rainfall, and sunlight where the plant is grown.

Although scientists were aware of the physical and neurologic benefits associated with drinking tea, until 1990, there was no economically viable method for producing L-theanine. That is because extracting the amino acid from the leaves was a difficult, expensive, and inefficient process: It took a lot of tea leaves to yield a small quantity of L-theanine. Then, in 1990, food scientists at Taiyo Kagaku, in Japan, developed an enzymatic process for making a compound that is chemically identical to the L-theanine found in tea. The enzymatic process requires slow fermentation and it takes approximately 4 months to make one batch. However, pharmaceutical grade (>99 percent purity) L-theanine is the result and it does not require a mountain of tea leaves.

Once the process for creating L-theanine was standardized, Taiyo Kagaku trademarked the product as Suntheanine. After favorable toxicology studies, including the 28 Day Subacute Toxicity Study, the 78 Week Evaluation of Toxicity and Carcinogenicity, the Acute Toxicity/LD_{50} Determination, and the Ames Salmonella Mutagenicity tests, Suntheanine was shown to be safe for use as directed. Studies at Japanese universities, cited below, soon followed.

Umami or "5th Taste"

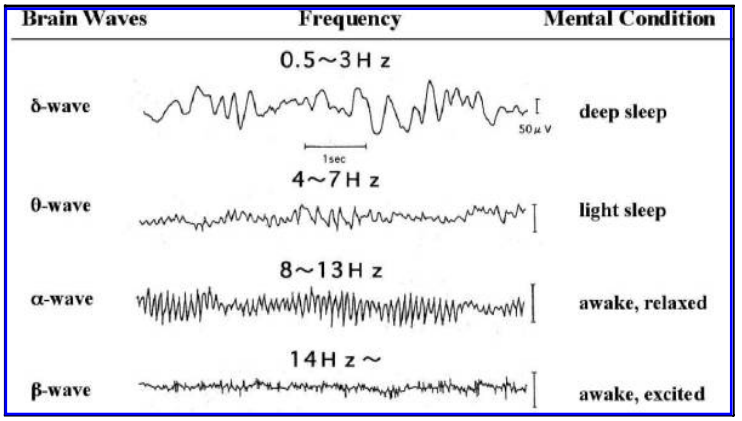
L-Theanine has the ability to improve the taste of processed foods and beverages, and is especially effective against certain bitter notes, including chocolate, zinc, caffeine, ginseng, grapefruit, and antioxidants.

The effect is caused by the so-called *umami* or "5th taste" (besides the four traditional tastes: sweet, salty, acid, and bitter). The umami is not particularly strong, but it is able to communicate to specific detecting cells a "mouthfeel" that significantly influences the taste perception. It is a signal for proteins, informing the brain of the availability of a source of essential nutrients. The umami is particularly effective when ribonucleotides, glutamic acid, and amino acids occur contemporaneously in a food or are added to it: This is a combination traditionally and empirically achieved in recipes around the world.

Adapted with permission from ref. 3.

Electrical Activity in the Brain

Brain waves can be measured on the surface of the head. The predominant frequency of electrical impulses correlates with different types of mental states and activities. Brain waves are classified into four categories, each with an associated mental state, as shown in the chart below.



Classification of brain waves and mental condition. Used with permission of Taiyo Kagaku Co., Ltd., Yokkaichi, Mie, Japan.

Historically, the roots of alpha brain-wave feedback training lie in a discovery made in 1908 by an Austrian psychiatrist, Hans Berger, M.D. He discovered the existence of oscillating electrical waves in the brain and he called them alpha waves because they were the first electrical activity to be discovered in the brain.

Dr. Berger also discovered that alpha waves were uncommon in anxious people and, if an anxious person did have a few alpha waves, they were smaller than usual (a weaker signal with lower amplitude). After he published his findings in 1918, interest in electrical waves in the brain spread rapidly around the world. Early scientists mapped the different types of brain waves (alpha, beta, delta, and theta), and began to do psychophysical studies on the "natural reactivity" of these brain waves to sensory stimulation.)

Sources: Ref. 3 and www.biocybernaut.com/publications/history.html

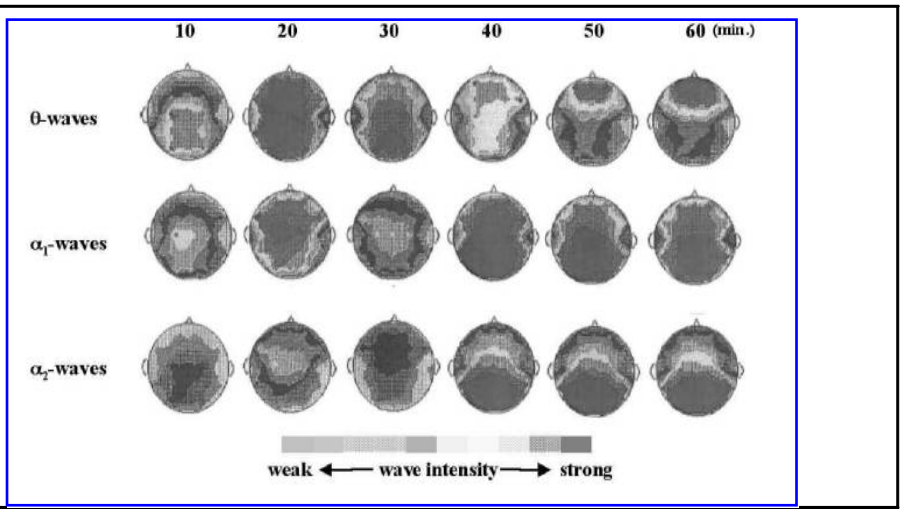
Studies consistently support the conclusion that consumption of 200 mg of L-theanine results in an increase of alpha-wave activity in the brain within 30–40 minutes.

Caffeine

Caffeine is a trimethyl derivative of purine 2,6-diol and is synthesized in the leaves of the tea plant. The occurrence of caffeine was first observed by Runge in 1820. Nakabayashi isolated a similar compound from tea and named it *theine*. Later, caffeine and theine were identified to be the same compound. The caffeine content of coffee beans is usually 1.5 percent, while that of green tea reaches a maximum of 5 percent.[5]

Tea has earned a popular reputation for having less caffeine than coffee because the L-theanine in the tea actually lessens the stimulant effect of caffeine on the human nervous system. As a result, tea—especially green tea—has gained in popularity as a beverage that has a calming, or relaxing effect.

Japanese scientists were fairly certain that it was the amino acid L-theanine that created this relaxation effect but had no research to support their hypotheses. Once Taiyo Kagaku had developed and standardized a process for producing L-theanine, it was possible for researchers to begin basic research with human volunteers. During the 1970s and 1980s, Japanese researchers investigated the influence of alkylamides of



Localization of alpha-frequency activity in the brain before and after consumption of L-theanine. Used with permission of Taiyo Kagaku Co., Ltd., Yokkaichi, Mie, Japan.

L-Theanine Products

In the United States, Taiyo Kagaku, Co., Ltd., the manufacturer of L-theanine (Suntheanine) is represented by:

Taiyo International, Inc.
4700 West 77th Street, Suite 175
Edina, MN 55435
(952) 832-5273

While L-theanine is still comparatively unknown in the United States, in Japan, it is not only marketed in capsule form, it also appears in more than fifty products, which include beverages, ice cream, jelly, candy, and gum—all created to induce relaxation.

Taiwan, Korea, and Europe also have products that contain Suntheanine. In the United States, the capsule form of Suntheanine is available from Weider Nutrition (Salt Lake City, Utah), Swanson Health Products (Fargo, North Dakota), Doctor's A–Z (Fargo, North Dakota), BioSynergy (Boise, Idaho), and Atkins Nutritionals (Ronkonkoma, New York).

Taiyo has determined that L-theanine does not degrade in beverages heated at 121°C for 5 minutes and is stable in solution with a pH between 3.0 and 6.6. With its excellent stability over a range of temperature and pH conditions, L-theanine can be formulated into candies, herb tea, cocoa drinks, various beverages, chocolates, puddings, jellies, chewing gums, and other snacks.

As of this writing, there are no food products marketed in the United States that contain L-theanine; approval is being sought.

Biosynthesis of L-Theanine and Its Metabolism in the Tea Plant

L-Theanine is synthesized in the root of the tea plant starting from ammonium as the nitrogen source. The glutamic acid produced in the root conjugates with ethylamine by the catalytic reaction of L-glutamate ethylamine ligase. Ethylamine is derived from alanine by decarboxylation or de novo synthesis via pyruvic acid. It is known that *Camellia sinensis* produces ethylamine from alanine.

L- Theanine synthesized in the root is immediately transferred to growing shoots and accumulated there. A remarkable accumulation of theanine in buds and young leaves is caused by the continuous transport of it from roots, because the catabolism of theanine in young shoots is slow relative to the transportation rate of theanine.

L-Theanine accumulated in young shoots is hydrolyzed into glutamic acid and ethylamine by an enzyme. The ethylamine produced is used to synthesize catechins under the sunlight. A part of ethylamine is degraded into acetaldehyde, hydrogen peroxide, and ammonia by an enzymatic oxidation reaction. The released ammonia is used as a nitrogen source again.

Courtesy of Taiyo International, Inc., Edina, MN; Adapted with permission from reference 3.

L-Theanine does not make patients drowsy nor does it promote sleep—this amino acid does not produce theta waves.

glutamic acid and related compounds on the central nervous system and the effects of L-theanine on mice and rats.[2,6,7]

L-Theanine Stimulates Alpha-Wave Activity in the Brain

A volunteer study was undertaken to investigate the mental response to L-theanine.[2] Because it was anticipated that the mental response could vary with an individual's anxiety level, test subjects (18–22 years old) were divided into high-anxiety and low-anxiety groups, as determined by the Manifest Anxiety Scale. Tests were conducted on four high-anxiety and four low-anxiety subjects. Over a 2-month period, each volunteer was given test solutions of water, water containing 50 mg of L-theanine, or water containing 200 mg of L-theanine. Brain waves were measured for 60 minutes after each administration. The experiment indicated that alpha brain waves were observed from the back to the top surface of a person's head within approximately 40 minutes after the subject had taken the L-theanine solutions.

In a separate study[8] it was noted that "[the]he intensity of alpha waves were determined to be dose dependent and detectable after thirty minutes. The perceived relaxation effect was incidental with the detection of alpha waves." These results are consistent with the previously mentioned study,[1] which reported that L-theanine reached the brain within 30 minutes.

These studies consistently support the conclusion that consumption of 200 mg of L-theanine results in an increase of alpha-wave activity in the brain within 30–40 minutes. This fosters a state of alert relaxation. (See box entitled Electrical Activity in the Brain.)

Stress Control Products

Stress and anxiety are debilitating conditions that can shorten one's life while lessening performance, well-being, and the overall enjoyment of activities. Stress can also impair the ability to perform mental tasks and may also result in reactions to situations that cause frustration, hostility, and damage. Stress can impair the immune system, thus lowering resistance to disease and creating the possibility for opportunistic diseases to occur. Stress can also cause depression.

According to the National Institutes of Health, in any given 1-year period, 9.5 percent of the population, or about 18.8 million American adults, suffer from depressive illness.[9] In 1998, pharmaceutical sales of antidepressants totaled $4.79 billion; sales of anxiety drugs totaled $722 million. The annual sales of antistress herbs, such as kava kava (*Piper methysticum*), St. John's wort (*Hypericum perforatum*) and valerian (*Valeriana officinalis*), totaled $83.2 million for the period ending April 1999.[10]

L-Theanine Versus Antistress Herbs

The principal difference between L-theanine and antistress herbs is that L-theanine does not make patients drowsy nor does it promote sleep—this amino acid does not produce theta waves.

This is significant. People who are in stressful situations—whether they are environmental, personal, or medical in origin—can mitigate the harmful effects of stress significantly with L-theanine, without becoming sedated in the process. As mentioned previously, research studies have not only confirmed L-theanine's safety; there is a very long history of its consumption in tea. Unlike other orally administered amino acids, L-theanine is not affected (either positively or negatively) by the consumption of food and may be taken at any time. It should also be noted that if one is already relaxed, the taking of L-theanine will not produce further relaxation.

Conclusion

Currently, L-theanine is available in the United States only in capsule form. As the U.S market comes to appreciate this benevolent—and powerful—component of green tea, there is likely to be a proliferation of L-theanine–enriched foods and beverages, such as are sold in Japan today. □

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