How the Ayurvedic Herb Ashwagandha and the Amino Acid L-Tyrosine are Linked with the Thyroid Hormones and Neurotransmitters of the Endocrine System

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Abstract

The endocrine system is made up of the glands and organs in the body that secrete hormones into the blood. The thyroid gland and the adrenal glands are responsible for the hormones thyroxine, triiodothyronine, cortisol, epinephrine, and norepinephrine. These hormones influence metabolism and the stress response of the body. The Ayurvedic herb ashwagandha and the amino acid L-tyrosine, commonly referred to as tyrosine, have been shown to affect these hormones, and subsequently also affect metabolism and the body's response to stress. Over ten weeks, six plants will be studied to determine what effect watering with tyrosine and ashwagandha may have on them. Two plants will be watered with one of the supplements (each) in liquid coconut oil to establish whether there may be increased uptake of the supplement. I will discuss my observations of these supplements and the opinion of my customers, as a health enthusiast at the Vitamin Shoppe, along with my own supplementation of ashwagandha.

Keywords: endocrine system, hormones, thyroid gland, adrenal gland, thyroid hormones, thyroxine, triiodothyronine, cortisol, epinephrine, norepinephrine, Ayurvedic, ashwagandha, L-tyrosine, supplements

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The class of chemicals known as hormones are messengers produced by endocrine glands that are transported by the circulatory system to reach distant cells, "target cells", to regulate physiology and behavior. The chemical processes that occur within a living organism to maintain life are referred to as metabolism. Several hormones directly affect metabolism, the body's response to stress, and consequently have a great deal to do with a person's body weight. The thyroid hormones thyroxine and triiodothyronine are the main hormones responsible for metabolism regulation. Cortisol, a steroid hormone made in the adrenal glands, is released in response to stress and low blood glucose. In this paper, I will explore L-tyrosine, an amino acid and main building block of the thyroid hormones and epinephrine, and how supplementation of tyrosine may help stimulate the production of these hormones. I will also review the herb ashwagandha, which is an ayurvedic herb said to deal with stress and energy, possibly even influence the release of cortisol. I will monitor the effect of these supplements on tropical house plants during a 10-week watering plan. In addition, I will observe how and why people use these supplements, and whether they see positive results. Is it possible to aid the body with stress response, hormone production and regulation, and in turn keep metabolism at a healthy level, within a natural, non-prescription format?

To detect whether L-tyrosine or ashwagandha supplementation will affect the growth of tropical house plants, I am conducting an experiment in the form of a ten-week watering plan. The experiment will involve the watering of six plants weekly, for ten weeks. Each week plant one will be watered with 100mL of water; plant two with 100mL of water and 250mg of

ashwagandha powder; plant three with 100mL of water and 250mg of L-tyrosine powder; plant four with Miracle Grow and water; plant five with 100mL of water and 250mg of ashwagandha in liquid coconut oil; plant six with 100mL of water and 250mg of L-tyrosine in liquid coconut oil.

Week one the plants were all cut to about the same size and then watered. Week two the plants were watered and a leaf was taken from each plant. I examined a section of each leaf under the microscope at a magnification of 40 and 100, and took pictures. The pH of each plant's soil was checked; plant six had a pH of 6, all other plants had a pH of 5. A piece of each plant's root was also examined under the microscope, photos taken. Over the next few weeks, the plants were watered and pictures were taken to monitor their growth and their appearance under the microscope.

Week five a new experiment was introduced to check the uptake of the tyrosine in plant three, tyrosine with water only, and plant six, water with L-tyrosine in liquid coconut oil. Leaves were taken from each of the two plants watered with L-tyrosine and put into two containers with 70ml of sodium hydroxide and 170ml of water. Each of the two solutions were blended with leaves from one of the two plants; the blended mixtures were drained through filter paper into two beakers. The mixture from the plant watered with the coconut oil, L-tyrosine, and water (plant six) drained at a much slower rate than the plant watered with only water and L-tyrosine (plant three). After draining the solution while holding back the pulp, the two filtered solutions were compared. The solution in the beaker from plant six was noticeably darker than the other solution. When checked with the black light, both solutions appeared a purple color, the solution from plant six a deeper purple. The pulp from both plants appeared purple under the black light, very similar in shade. The deeper the purple, the greater the uptake of the supplement.

Week eight, the uptake experiment was preformed again, on both L-tyrosine plants (three and six) and this time also on the ashwagandha plants (two and five). The solution seemed to drain through the filter paper at about the same speed for all four plants. To the naked eye, the solution from the ashwagandha with coconut oil (plant five) leaves appeared much brighter than those from plant two, watered with only ashwagandha and water. The opposite was visible with the L-tyrosine plants. Unlike in week five, when the filtered solution from plant six (with oil) appeared darker and brighter than the filtered solution from plant three (without oil), week eight the solution from the plant with the oil appeared duller to the naked eye. However, both plants watered with coconut oil appeared a deeper purple under the black light compared to the plants watered with only tyrosine or ashwaganda, and water.

Finally, in week ten, the uptake experiment was completed for the last time. The filtered solution from both plants watered without oil, drained through the filter paper slower than the plants watered with the oil. Of the two plants watered with ashwagandha, the filtered solution from the plant watered with oil appeared brighter than the solution from the plant watered without oil (Figure A-13). The opposite was observed with the plants watered with L-tyrosine; the solution from the plant watered with oil appeared duller than the solution from plant watered without oil (Figure A-14). When the solutions were held under the black light, however, they all appeared a similar shade, only the plant given ashwagandha in oil (plant six) appeared a little lighter (Figures A-15 and A-16).

Ayurveda is a Sanskrit word, meaning the knowledge or science of life (Chopra, 2017). Ashwagandha, a perennial shrub, has been used in Ayurvedic medicine for thousands of years. This member of the nightshade family is native to India, the Middle East, and Northern Africa, and may grow up to 3 feet tall in favored dry regions. From Sanskrit, the name ashwagandha is

formed from the words ‘ashva’, meaning horse, and ‘gandha’, meaning smell. The name most likely comes from odor of the plant’s fresh roots, described as ‘horse-like’. It is believed that the use of this plant may bestow the strength and vigor of a horse. Ashwagandha has been referred to as Indian ginseng, because it is an adaptogen herb that is beneficial for the immune system and the body’s adaptation to stress.

The herb has been traditionally prescribed by Ayurvedic, Siddha, and Unani healers for a variety of uses. The medicinal use of ashwagandha was documented as early as 2000 B.C. in India. Alexander the Great was said to have drank wine made with ashwagandha as a general tonic in 327 B.C. (Johnson, Foster, Low Dog, & Kiefer, 2014, p. 317). Besides its ability to help the body cope with stress, ashwagandha is coveted as a geriatric tonic, a tonic for the youth, and even to help those trying to reproduce. The many uses of ashwagandha over the years include: arthritis, anxiety, asthma, backache, bronchitis, chronic liver disease, fibromyalgia, insomnia, leukoderma, and tumors. People have also used the herb for improving cognitive function and to prevent the effects of aging.

Although ashwagandha has been utilized for thousands of years in eastern medicine, the idea of one herb having so much power has put doubt in the minds of critics. However, according to Johnson et al. (2014), “modern science has confirmed that specific compounds in the ashwagandha root exhibit antioxidant, anti-inflammatory, immune system modulating, neuroprotective, and anti-stress activity” (p. 319). There is little in the way of research being done on adaptogens in the West though. Western medicine has no “adaptogen” equivalent drug, and hence no “rigorous research model to test the theory” (Johnson et al., 2014, p. 319). The consensus of studies I reviewed is that ashwagandha is a safe and effective way to manage stress and lower cortisol levels. A study by Chandrasekhar, Kapoor, and Anishetty (2012) suggested

that “ashwagandha root extract improves an individual's resistance towards stress and thereby improves self-assessed quality of life.” Cortisol levels are a typical biological measure of stress, and so were used to monitor the effects of ashwagandha during their study. Their data showed that the level of cortisol was statistically, significantly lower in the ashwagandha group (Figure B-1). In another study, Choudhary, Bhattacharyya, and Joshi (2016) found that “ashwagandha root extract can be used for body weight management in adults under chronic stress” (p. 96). Although ashwagandha is usually safe and tolerated well, Johnson et al. (2014), explained that “some evidence suggests it may stimulate thyroid hormonal activity, so it should be used cautiously by those taking thyroid medication” (p. 319).

Amino acids are the building blocks of protein, and have many vital roles in the human body. Bobick and Balaban (2008) explain that the “major groups of hormones are amine hormones, peptide and protein hormones, and steroid hormones” (p. 162). The protein and peptide hormones are varied length chains of amino acids. Protein hormones, thyroid stimulating hormone for example, are long chains of amino acids, comprised of 50 to 200 or even more; while peptide hormones, including antidiuretic hormone, are shorter chains, consisting of only 3 to 49 amino acids (Bobick & Balaban, 2008). Steroid hormones, including cortisol and the reproductive hormones, are made of cholesterol rather than derived from amino acids. Amine hormones, including epinephrine, norepinephrine, serotonin, dopamine, melatonin, and the thyroid hormones, are small molecules that are similar in structure to amino acids (Bobick & Balaban, 2008, p. 162).

L-tyrosine, a non-essential amino acid, is a key component of thyroid hormones. It may be found in animal products, such as meat dairy, and fish; however, as a non-essential amino acid, the body is not dependent on the consumption of L-tyrosine, as it may make it on demand

(Martini, 2015, p. 613, p. 953). L-tyrosine plays a role in combating depression, weight management, and energy production (Sharon, 2014). Epinephrine, a derivative of tyrosine, is a neurotransmitter that is released during the fight or flight stage of stress response (Martini, 2015, p. 645). Thyroxine, one of the two thyroid hormones, is produced with iodine and L-tyrosine.

The thyroid gland, shaped like a butterfly and located in the neck inferior to the thyroid cartilage, produces thyroxine and triiodothyronine; which are responsible for stimulating metabolism and managing cellular growth and function. The metabolism of macromolecules fat and carbohydrate are directly linked to T3 and T4 levels, and both hypothyroidism and hyperthyroidism may affect resting metabolism and weight control. Biagioli (2012) explained that an elevation of the thyroid hormones may result in EPOC, or excess post-exercise oxygen consumption, "through an increase in the resting metabolic rate of cells, thereby possibly adding to the effect exercise has on weight loss through heightened metabolic activity and increased use of fatty acids for fuel" (p. 66).

During the first stage of stress response, the alarm phase, frequently referred to as fight or flight, the body readies itself to cope with the stressor by releasing energy, in the form of glucose, along with epinephrine, and norepinephrine. This reaction is under the control of the autonomic nervous system via the sympathetic division. If under constant stress, epinephrine and norepinephrine levels may become exhausted; this may be reversed by supplementation of tyrosine. Animal studies have shown that while supplementing tyrosine, the release of neurotransmitters is not elevated while the subject is at its normal basal rate; however, while under stress the release of neurotransmitters do increase (Young, 2007).

In a 2012 experiment by Wang et al., 63 healthy mice were divided into three groups: the control, the stressed, and the stressed supplemented with L-tyrosine. They were studied for the

following four weeks, with no incidence of injury or death. When compared, the stressed mice and stressed mice supplemented with L-tyrosine had noticeable differences. Serum levels of TT3 and TT4 in the stressed mice supplemented with tyrosine were higher than of those without (Figure B-2). The levels of the neurotransmitters dopamine and norepinephrine were also measured; higher levels seen with tyrosine supplementation (Figure B-3). Wang et al. (2012) concluded the following:

> Supplementation with tyrosine can increase norepinephrine in the brain and induce thyrotropin-releasing hormone neurons to release more thyrotropin-releasing hormone, which acts on the hypophysis to release more thyroid-stimulation hormone. As a result, the synthesis and release of thyroid hormones increase.

My own ten-week experiment involving ashwagandha and L-tyrosine supplements, along with liquid coconut oil, supplied me with both surprising conclusions and many more questions. Over the course of the watering plan, noticeable changes were seen in the plants (Figures A-1 to A-3). Plant one was watered with only tap water, and was healthy at the end of the ten weeks (Figure A-4 and A-5). Plant four was given Miracle Grow with water, and was dead by the end of the experiment (Figure A-8 to A-10). The amount of Miracle Grow given to the plant may have been higher than it could handle. Two of the plants were given L-tyrosine and water each week, one of them was also given coconut oil, there was a visible difference in the two by the end of the experiment. Although they appeared very similar for the first several weeks, the plant given tyrosine in coconut oil (plant six) was not as full and healthy looking as the plant not given coconut oil (plant three), by the final week. Two of the plants were given ashwagandha and water each week, one of them was also given coconut oil. These two plants looked similar

throughout the experiment, with the plant given coconut oil (plant five) showing more fullness and deeper green leaves than the plant not given coconut oil (plant two), by the end of the ten weeks (Figure A-11).

The original watering plan only included the first four plants, no coconut oil. After considering how healthy fats are so important for humans, and how they allow the absorption of vitamins, such as A, D, E, and K, I decided to include coconut oil and test the influence it would have on the absorption of an herb and an amino acid (Figures A-6 and A-7). I was not surprised to see the plant given ashwagandha in coconut oil (plant five) thriving above all the other plants. I was a little surprised to see that the L-tyrosine powder, given with the coconut oil, was not making it into the soil of plant six after several weeks, and that the plant appeared sparse compared to the plant given only tyrosine and water (Figure A-12). It appeared that the coconut oil may have altered the absorption of the L-tyrosine, leaving the last few weeks of tyrosine powder visibly on top of the soil. I thought that the plants given coconut oil would show the same growth as each other. The pictures taken with the microscope did not appear to show change. Perhaps with greater magnification, a cellular change would be visible.

As a health enthusiast at the Vitamin Shoppe, I speak with many people from many demographics about their supplement wants and needs. Two of the most frequently asked questions are, “how can I lose weight” and “what can I take for stress”. Although a healthy lifestyle, including diet, exercise, and mindfulness, must be at the top of the goal list, there are some supplements that make the top of the shopping list. Ashwagandha is the number one recommendation among myself, and my coworkers, for stress. I have been taking ashwagandha since beginning work at the Vitamin Shoppe last summer, with positive results. I stopped taking the supplement for several weeks after the new year, and felt a noticeable difference in the

amount of stress and anxiety I was feeling, along with a decrease in energy. Since resuming supplementation, I have seen the positive results return. For customers with hypothyroidism, we often recommend one of the many thyroid blends that we offer. All the blends include L-tyrosine, ashwagandha, and kelp, a natural source of iodine. Many customers come back to tell us how the supplements are working for them; I have yet to have a customer tell me that they were unhappy with the results of the ashwaganda. I see customers repeatedly purchasing thyroid blends, but do not know if they see actual results with their thyroid hormone levels.

I will continue taking ashwagandha and making note of my own experience. I would like to continue researching ashwagandha supplementation on a larger scale, for years rather than weeks. The studies that I read were only for short periods of time, making me wonder what long-term effects ashwagandha will have on the body, good or bad. I would be interested to explore whether L-tyrosine along with ashwagandha and iodine have a noticeable effect on people with hypothyroidism. I am curious what effect tyrosine and kelp supplementation may have on people who do not suffer from hypothyroidism. Also, I would like to continue looking at coconut oil, and how it can be used for optimal health.

Is a life supply of Synthroid prescriptions the only answer to hypothyroidism? Could L-tyrosine, ashwagandha, and kelp make a noticeable difference in thyroid hormone levels? Is there any truth to the ancient Ayurvedic promises that ashwagandha may halt the speed of aging? Could ashwagandha be an alternative to prescription antidepressants and antianxiety drugs? Is coconut oil the miracle cure it has been labeled? Could the oil, high in saturated fat, be more beneficial than harmful?

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Appendix A

Figure 1. All plants, week 1.

Figure 2. All plants, week 5.

Figure 3. All plants, week 9

Figure 4. Plant 1, week 1.

Figure 5. Plant 1, week 10.

Figure 6. Plant 2 (left) and plant 5 with supplements, week 5.

Figure 7. Plant 3 (left) and plant 6 with supplements, week 5.

Figure 8. Plant 4, week 5.

Figure 9. Plant 4, week 9.

Figure 10. Plant 4, week 10.

Figure 11. Plant 2 (left) and plant 5, week 10.

Figure 12. Plant 3 (left) and plant 6, week 10.

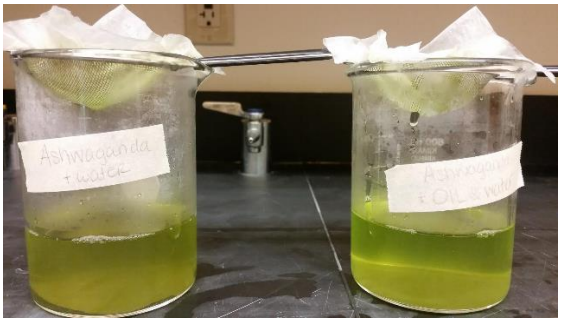

Figure 13. Plant 2 (left) and plant 5 solutions, week 10.

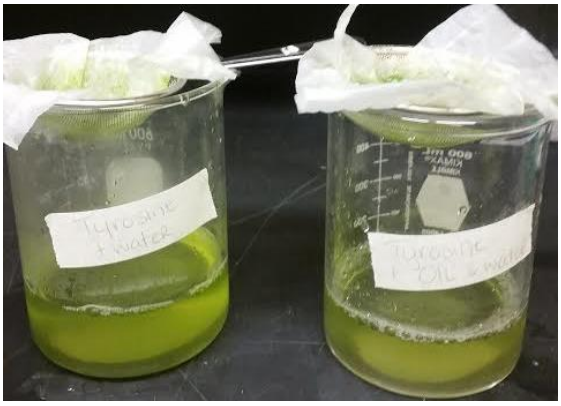

Figure 14. Plant 3 (left) and plant 6 solutions, week 10.

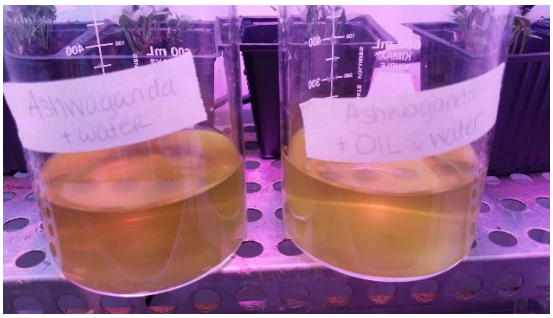

Figure 15. Plant 2 (left) and plant 5 solutions under black light, week 10.

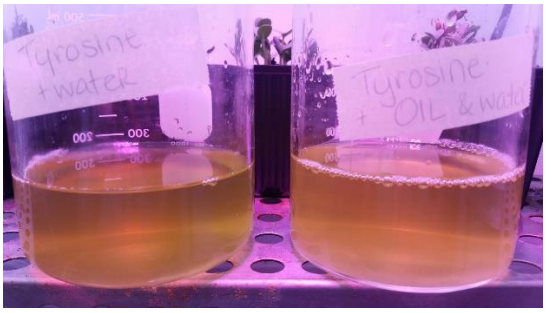

Figure 16. Plant 3 (left) and plant 6 solutions, under the black light, week 10.

Appendix B

	Ashwagandha (*n*=30)		Placebo (*n*=31)		*P*
	Mean	**SD**	**Mean**	**SD**	
Baseline	15.7	3.2	15.6	3.3	0.9011
Day 60	11.3	3.7	14.4	3.2	0.0006
Change from baseline	–4.4	4.3	–1.2	3.9	0.002
% change from baseline	–27.9	–	–7.9	–	–

*Serum cortisol levels are measured in μg/dL

Figure 1. Serum cortisol levels. This figure illustrates the drop of cortisol levels among both the control group and the variable group of the double-blind, placebo-controlled ashwagandha study.

Group	TT3	TT4
Control	0.74±0.22	48.20±3.41
CUS	0.55±0.27[a]	29.91±12.8[a]
CUS-L	0.64±0.13[b]	35.62±7.1[b]

Data are presented as mean ± SD. Differences were tested using analysis of variance and paired sample *t*-test. [a]$P < 0.05$, *vs*. control group; [b]$P < 0.05$, *vs*. CUS group. TT3: Total thyrotropin; TT4: total triiodothyronine; CUS: chronic and unpredictable stress; CUS-L: CUS plus L-tyrosine interference.

Figure 2. Effect of chronic stress on serum levels of TT3 and TT4 (ng/mL). This figure illustrates the serum levels of TT3 and TT4 in three groups of mice: the control, the chronic and unpredictable stress (CUS), and the chronic and unpredictable stress plus L-tyrosine interference group (CUS-L).

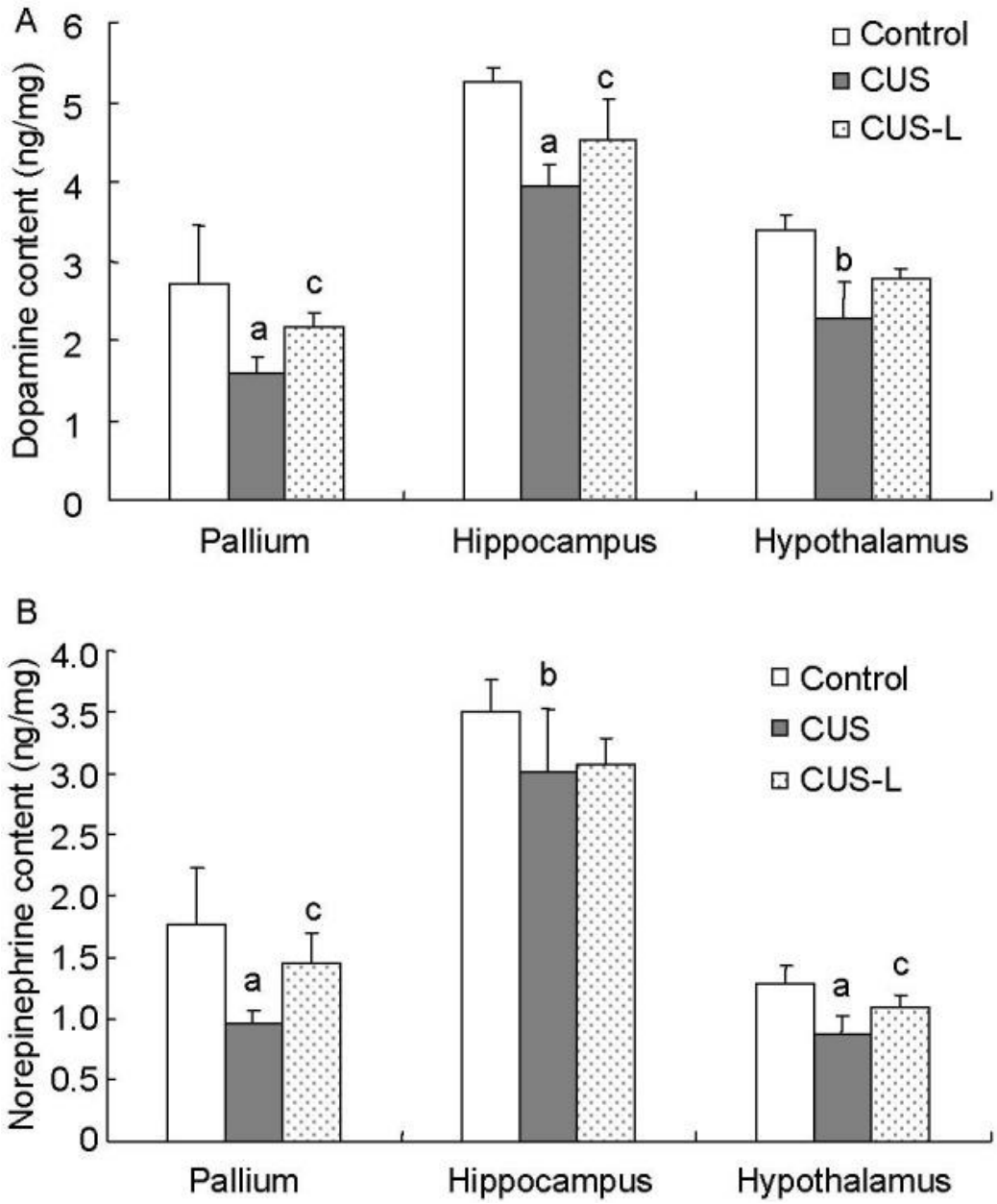

Figure 3. Dopamine (A) and norepinephrine (B) content in the pallium, hippocampus, and hypothalamus (ng/mg). This figure illustrates the levels of dopamine and norepinephrine in the three groups of mice. The three groups are: the control, the chronic and unpredictable stress (CUS), and the chronic and unpredictable stress plus L-tyrosine interference group (CUS-L).