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METABOLIC AND PHYSIOLOGICAL FUNCTIONS OF MELATONIN'S ACTION

***Maria Gisele dos Santos and Raquel Simone Maccarini Zarpellon**

Department of Physical Education, Federal University of Paraná Raquel Simone Maccarini Zarpellon.

***Corresponding Author: Maria Gisele dos Santos**
Department of Physical Education, Federal University of Paraná Raquel Simone Maccarini Zarpellon.

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ABSTRACT
The objective of this study was to review the metabolic and physiological functions of the Pineal Gland regarding the importance of feeding. The Pineal Gland is part of the neuroendocrine system and secretes the Melatonin hormone, which is responsible for the temporal organization of several physiological and behavioral events, such as the sleep-wake cycle regulation, the immune system regulation, cardiovascular regulation, as well as the genital system's. Additionally, melatonin affects the rhythm of many other physiological processes at night: the digestion process slows down, the body temperature drops, the heart rate and blood pressure decrease, and the immune system is stimulated. Apparently, it increases the mobility and activity of defense cells, stimulates the formation of antibodies, and facilitates the defense against microorganisms. Melatonin is usually quoted as the key molecule in the control of the circadian cycle in animals and humans. It originates from serotonin, which, in turn, has the tryptophan amino acid precursor.

KEYWORDS: The objective of this tryptophan amino acid precursor.

INTRODUCTION
A balanced nutrition is the basis of support for a healthy life. Serotonin, as one of the most important neurotransmitters in the brain, is responsible for our mood. Stressed, dysthymic, and depressed people should avoid certain foods and consuming serotonin, leaving people in a bad mood, depressed, and anxious.

The pineal gland was considered as a mysterious or vestigial gland until recently because most of its functions were unknown. Also, the pineal gland is the first gland of the body that is formed during the embryonic stage, and is easily distinguishable around the third week after conception.

Metabolic and Physiological Functions
In the brain, there are two endocrine glands that command the functions of the entire organism. These glands are: the Pituitary and Pineal Glands. These two endocrine glands have similar functions in the production of nine hormones that regulate several bodily processes and stimulate the production of another series of hormones that affect processes such as digestion, menstruation, and ejaculation of the male semen. That is a complicated process that medical science itself has difficulty to explain. The Pituitary gland, also known as Pituitary, works during the day, while the Pineal gland works at night, when we are sleeping.

In spite of their size—the size of a pea—these endocrine glands command the other glands and the general functions of the body. Since they are invaginated in the brain, they help in the production of a hormone known as "melatonin," which the Traditional Chinese Medicine calls "internal secretion," whose scientific name is: N-acetyl-5-methoxytryptamine. This hormone is synthesized by the pineal gland, beginning with a substance called tryptophan, an amino acid that is produced in the intestines and acts as regulator of the body's vital activities along with twenty-one other organic compounds that constitute the basic parts of human life. Tryptophan is found in several foods and fruits such as in pineapples, as well as in seeds, vegetables, and cereals. Once digested by our body, the tryptophan is converted by the pituitary gland into a neurotransmitter called serotonin as we sleep, which is then transformed by the pineal gland into melatonin by the biomolecular process. In the morning, when artificial light of sunlight reaches our eyes, the pineal gland interrupts its activity, and from this moment on, the pituitary gland, in charge of distributing melatonin to the other endocrine glands, starting with the thyroid gland, followed by the thymus gland, then by the adrenals, and finally reaching the gonads (Le Floc'h ET AL, 2003; Barrenetxe J et al. 2004, Dias, 2010).

Melatonin is not just a hormone; it is also a natural remedy produced by the divine laboratory that exists within our body. Among other things, melatonin prevents and fights insomnia, nervousness, stress, premature aging, depression, heart disease, cancer, cataracts, male impotence, and female frigidity, as well as epilepsy, prostate hypertrophy, and skin diseases, since this hormone generates melanin, which is responsible for the pigmentation of our skin (DIAS, 2010).

Balanced Diet

A balanced nutrition is the basis of support for a healthy life. Serotonin, as one of the most important neurotransmitters in the brain, is responsible for mood. Stressed, dysthymic, and depressed people should avoid certain foods by consuming serotonin, leaving people in a bad mood, depressed, and anxious. Therefore, we will indicate what should be avoided and what should be consumed to increase the level of serotonin and energy, and the joy of living, considerably improving or, in many cases, definitively solving these problems. These foods act in the body in much the same way as antidepressants (Le Floc'h et al, 2003).

You should avoid foods that contain caffeine such as coffee, maté tea, black tea, chocolate, and soft drinks. Also barbecue, pork, fried foods, beer, avocado, figs, beans, curds, soy sauce, fish roe, cured cheeses, organ meats—such as liver—, ginseng, white sugar, aspartame sweetener, dietary protein supplements, preservatives, sauces, peppers, salami, certain wines, yeasts, and fava beans.

You should consume foods, vitamins, and minerals that contain

Folic Acid: Found in brewer's yeast, orange, apple, asparagus, Brussels sprouts, white beans, and soybeans.

Vitamin B6: Sesame seeds, whole grains, garlic, brown rice, bean, beer yeast, chicken, banana, and tuna, which are rich in vitamin B6 and participate in the production of norepinephrine and serotonin.

Calcium: It is found in dolomite, cumin, and dark green colored vegetables, such as cabbage, spinach, and cress. Calcium reduces irritability and nervousness, and regulates the body's blood pressure and heart rate.

Magnesium: It contributes in energy production and for cardiac functions; it is found in brown rice, spinach, oats, tomatoes, tofu, cashew, salmon, and soya.

Selenium: Fish, Pará nuts, almonds, nuts, sunflower seeds, whole wheat, and tuna are indicated for depressed, irritated, and anxious people since it contributes to improve our mood.

Omega 3: Besides helping to reduce cholesterol, it maintains the blood pressure stable, strengthens the immune system, and helps to fight depression; it is found in linseed, cod, mackerel, herring, sardines, tuna, salmon, trout, and fish oils.

Soy Lecithin: Activates the vitality of the entire body, reduces fatigue, it is an excellent tonic for the brain, and increases concentration and memory capacity.

Honey: Besides its several health benefits in general, it boosts the serotonin production.

Banana: Helps to reduce anxiety and ensures a peaceful sleep. It is rich in carbohydrates, potassium, magnesium, and biotin. Bananas also has the B6 vitamin, which produces energy.

Spinach: This vegetable contains potassium and folic acid, which prevent depression. Additionally, spinach has magnesium, phosphate, and vitamins A and C of the B complex, which help to stabilize pressure and ensure the nervous system's functioning.

Lettuce: Great to reduce irritation; its stalk has lactucine, a substance that works as a sedative. Additionally, it is rich in phosphate. The lack of this element in the body causes depression, confusion, and tiredness.

Jabuticaba: Rich in carbohydrates, provides energy; since it contains iron, it fights anemia; its B vitamins are antidepressants and its C vitamin strengthen the body.

The pineal gland produces the hormone called melatonin, which dictates the rhythm of several neuroendocrine activities, regulating, among other functions, the sleep and wake cycle, the reproductive activity, as well as the metabolism of several species. Its secretion is linked to the circadian cycle and requires the absence of light to function properly. The seasons also affect the production of melatonin. This gland is stimulated by meditation (SERAPHIM, et al, 2000).

In studies developed with rats that underwent pinealectomy, it was evident that there was a reduction in the hepatic and muscular glycogenogenesis, as well as an increase in the plasma pyruvate levels. They also showed elevated plasma corticosterone levels at day. At the same time, it was reported that the ingestion of pineal extract led to the reduction of glycemia, increased glucose tolerance, and hepatic and muscle glycogenogenesis when exposed to a glucose overload. The role of the pineal gland was evident in the carbohydrate metabolism regulation with the elevation of glycemia, insulin, and glucagon in pinealectomized rats.

Despite the relevance of endogenous factors, several metabolic markers changed in their diurnal rhythm regardless of the dietary behavior and environmental factors to which the rats were exposed. These diurnal changes in response to the glucose tolerance test prevail, as well as the variations resulting from the presence of light in insulin sensitivity.

Studies have sought to respond to the existing link between the influence that the pineal gland exerts on both the quality and quantity of the dietary behavior and carbohydrate metabolism, which may lead to increased body weight, obesity, and fat mass and lean mass ratio change (SERAPHIM, et al, 2000).

Removing the pineal gland decreased the capacity of the pancreas to secrete insulin, decreasing the peripheral sensitivity to this hormone. Studies have shown that pancreatic b cells are susceptible to melatonin. This influence apparently occurs due to the action of melatonin on target cells that bind to the receptors located on the cell's plasma membrane, activating intracellular signaling proteins, such as kinase and the GLUT4 glucose transporter. (SERAPHIM et al., 2000).

Diabetes Mellitus and Insulin Resistance

Diabetes mellitus is considered a public health problem due to its high morbidity and mortality rate, with a significant patient life quality decrease, with a projection of 11.3 million diabetics in Brazil by 2030. Among the causes for this increase are the population's demographic aging, as well as changes related to the modern lifestyle that are directly related as risk factors, such as diets rich in simple carbohydrates and fats and poor in vitamins, minerals, and fibers, smoking, sedentary lifestyle, obesity, and exaggerated alcohol consumption. The association between an altered glucose metabolism and sleep hour reduction has been a reason for research into diabetes mellitus. During sleep, several things change in our cognitive and systemic functions, for example, there is a reduction in our cardiac output and peripheral vascular resistance; consequently, our blood pressure drops due to a decreased sympathetic activity, there is hypo and hyperventilation, hypothermia and hormone secretion.

As we have seen before, among the hormones produced during sleep, melatonin stands out. At the same time, we know that sleep deprivation also inhibits the production of insulin due to the cortisol level elevation at long term, which can lead to the diagnosis of diabetes.

According to Cunha in 2008, normal subjects have a balance between insulin secretion and glucose, without the presence of hypoglycemia and hyperglycemia. In diabetics, this balance is compromised due to hypoglycemia attacks. During sleep deprivation, increased glucose levels were evidenced due to this metabolism's decrease and elevated cortisol levels.

Therefore, the difficulty in maintaining a sleep pattern for diabetics can mean more than fatigue on the following day, since it interferes with the metabolic control, glucocorticoid production, glycemia, and the onset of insulin resistance. The intrinsic—sleep apnea, insomnia, periodic leg movements—and extrinsic—circadian rhythm, sleep hygiene, and psychoactive substance use— sleep disturbances have been reported in studies with diabetic patients.

Among the main intrinsic causes of sleep disorders, we can highlight: apnea, retinopathy, nocturia, nocturnal hypoglycemia (29% to 56% of patients with type 1 or type 2 diabetes on insulin), psychophysiological insomnia, restless legs syndrome. As for the extrinsic disorders, we highlight: noise, practice of activities such as listening to music, reading, watching television, doing manual work, etc., as well as excessive food and fluid intake before sleeping. Intrinsic and extrinsic sleep disturbances, to a certain point, change the diabetic patient's life quality and play an important role in the sleep quality. Studies show that approximately 50% of diabetics have poor sleep quality. In particular for Type 2 diabetics, these difficulties can compromise their metabolic control since the hormones that play vital roles in the functioning of our body are produced during the sleep cycle. The bad news is that the use of medications to improve sleep patterns in diabetics can cause more problems than benefits. It is worth remembering that elderly diabetics usually take several medicines to control diabetes, dyslipidemias, hypertension, etc., and the combined effects of several medications can compromise their sleep pattern. Another problem that occurs with this population is the excessive daytime sleepiness, which can be confused with laziness, lack of interest in activities, or drunkenness (CUNHA, 2008).

Studies show that melatonin is still an important pharmacological agent that sensitizes peripheral tissues and interferes in the states of insulin resistance, in which small pharmacological doses of this hormone lead to the increase of insulin secretion, directly affecting pancreatic cells and indirectly sensitizing the peripheral tissue. This process occurs through the energy homeostasis of muscle fibers, which is maintained by the action of insulin, which exerts a facilitating action on the uptake process and the glucose metabolism, and regulates several metabolic pathways. (FUSATTO, 2011).

Another factor to consider is melatonin's implication in the function of adipose tissues. Studies show that this hormone increases the sensitivity to insulin measured through glucose uptake tests and that pinealectomy leads to the development of insulin resistance. The pineal gland can act as an energy metabolism internal synchronizer and as a link between the environment and animal organism, working with adipose tissues as a major system of metabolic adaptation to environmental challenges and stress (FONSECA-ALANIZ, et al 2006).

Melatonin's Action in the Treatment of Emotional Diseases

In studies made to find a link between the greater volume of the hippocampus and frontal gray matter with meditation, the researchers realized that meditation practice promotes increased attention, emotional self-control, and greater behavioral flexibility, resulting in the promotion of the practitioner's well-being.

Clinical studies prove that meditation leads to a reduction of physical and psychological symptoms, as well as to progression biological markers of several psychological illnesses. Exams have confirmed physiological and biochemical parameter changes in these patients due to the practice of meditation (LUDERS, et al., 2009).

Greater brain measurements were found in meditators in comparison to controls, but this effect on the brain's macro-structure requires a long-term commitment to the daily practice of meditation.

Newberg et al. (2001), using the single photon emission tomography (SPECT), detected an increase in blood flow in the lower frontal and orbital cortex regions during meditation. This brain region is linked to emotion, and its activation suppresses negative emotional stimulus influences on the subsequent behavior.

Studies developed by Tversky and Kahneman in 1981 found that subjects that meditated were more consistent in their decisions, regardless of how the available choices were presented. These studies prove that people who have the habit of meditating can detach themselves from automatic thoughts and habits more easily than those who do not have this practice.

The study made by Holzel et al in 2008 emphasized that meditation possibly leads to feelings of "deep pleasure and insight into the unity of all reality" (LUDERS, et al., 2009). This researcher observed an increased volume of the right hemisphere hippocampus in meditators. Functional studies done by tomography examination showed increased brain activation during meditation exercises focused on breathing. The hippocampus plays an active role in emotional responses, which raises the hypothesis that people who have difficulty to sensitively regulate their affective responses to events may have a functional impairment of the hippocampus. The researchers conclude that increased hippocampus volumes allow regular meditators to present greater emotional stability and ability to engage in conscious behavior. Increased hippocampal volume was observed more consistently in subjects that pay attention to external and internal visual stimuli.

The hippocampus is a region of the brain responsible for short- and long-term learning and memory processes, and it is involved in emotional control. Structural changes in this area can improve the regulation of emotional responses. Depressed patients or even with post-traumatic stress reflect a decrease in hippocampal density or volume. Several factors may be responsible for this loss of hippocampal volume, such as neuronal loss due to chronic hypercotisolemia, loss of glia cells, reduction caused by stress due to neurotrophic factors, and also a stress-induced reduction in neurogenesis. However, the hippocampus has the ability to remodel synapses and create neurons; therefore this region's volume loss can be reversible (Holzel, 2010).

The insular cortex plays a fundamental role in sensitization, and is important for the formation of consciousness (HOLZEL, 2010).

There is evidence that this brain area's neurons are important for several cognitive, affective, and other behavioral functions, and are linked to clinical dysfunctions (e.g., depression, anxiety, sleep, and circadian disorders, stress) and is where antidepressant drugs act. Baer, in 2003; Kuyken et al., in 2008; and Roemer et al., in 2008, described the importance of meditation as a positive factor on anxiety and depression symptoms, as well as in the improvement of sleep standards and attention (Holzel, 2010).

CONCLUSION

Studies show that discrepancies may occur between researches according to their different mental exercises, which may stimulate the creation of neural networks, and in which the continuous practice of meditation may stimulate adult neurogenesis and preserve newly formed neurons (GAGE, 2002).

According to HOLZEL, in 2010, meditation produces continuous psychological well-being effects after the practice period. The study was proven effective to reduce the symptoms of various disorders, such as depression, anxiety, substance abuse, eating disorders, chronic pain, as well as improving life quality and well-being.

REFERENCES

1. Angers K, Haddad N, Selmaoui B, Thibault L. Effect of melatonin on total food intake and macronutrient choice in rats. Physiol Behav. 2003 Oct; 80(1): 9-18.
2. Barrenetxe J, Delagrange P, Martínez JA. Physiological and metabolic functions of melatonin. J Physiol Biochem. 2004 Mar; 60(1): 61-72.
3. Cunha, M. C. B., Zanetti, M. L., Hass, V. J. Qualidade do sono em diabéticos do tipo 2. Rev Latino-am Enfermagem. Set/Out 2008.
4. Fonseca-Alaniz et al. O Tecido Adiposo Como Centro Regulador do Metabolismo. Arq Bras Endocrinol Metab. vol 50 nº 2 Abril 2006.
5. Fusatto, E. L. Provas Funcionais De Responsividade Insulínica Em Ratos Tratados Com Melatonina. Anais do 9º Congresso de Pós-Graduação da UNIMEP. 2011.
6. Hölzel BK, Carmody J, Vangel M, Congleton C, Yerramsetti SM, Gard T, Lazar SW. Mindfulness practice leads to increases in regional brain gray matter density. Psychiatry Research: Neuroimaging. Ago/2010.
7. Ho¨lzel, BK, et al. Investigation of mindfulness meditation practitioners with voxel-based morphometry . Oxford University Press. 2007.

8. Lazar, S. W. et al. Meditation experience is associated with increased cortical thickness. Lippincott Williams & Wilkins, November 2005; 16, 17. 28.
9. Le Floc'h N, Otten W, Merlot E.. Tryptophan metabolism, from nutrition to potential therapeutic applications. Amino Acids. 2010 Sep 25. [Epub ahead of print].
10. Luders, E., Toga, A. W., Lepore, N., Gaser, C. The underlying anatomical correlates of long-term me ditation: Larger hippocampal and frontal volumes of gray matter. Neuroimage. Jan/ 2009.
11. MAGANHIN, C. C., et al. Efeitos da melatonina no sistema genital feminino: breve revisão. Rev Assoc Med Bras. 2008.
12. Newberg, A B, et al. The measurement of regional cerebral blood flow during the complex cognitive task of meditation: a preliminary SPECT study. Psychiatry Research: Neuroimaging. Volume 106, Issue 2, April 2001.
13. Posner, M I, et al. Mechanisms of white matter change induced by meditation training. Hypothesis and theory article. Oct. 2014.
14. Seraphim, PM., Sumid, D.H, Nishide, F.T, Lima, F.B., Cipolla Neto, J., Machado, U.M. A Glândula Pineal e o Metabolismo de Carboidratos. Arq Bras Endocrinol Metab vol.44 no.4 São Paulo Aug. 2000.
15. Tanga, Y Y, et al. Mechanisms of white matter changes induced by meditation. PNAS. Jun / 012, vol. 109, no. 26.
16. Tversky, A, Kahneman, D. The Framing of Decisions and the Psychology of Choic. American Association for the Advancement of Science. SCIENCE, VOL. 211. 2007.
17. Vestergaard-Poulsen, P, et al. Long-term meditation is associated with increased gray matter density in the brain stem. Wolters Kluwer Health. Lippincott Williams & Wilkins. V 20, 2009.
18. Wilson Dias, é terapeuta holístico em iridologia, com especialização em Nutrição Natural. Texto na internet. 2010.