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Research Article

Vedic Methodology That Highlights the Benefits of Sunlight between Twilight and Sunrise/Sunset

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Abstract:

Memory destroying diseases such as dementia do not have effective medication. Various approaches including Infrared (IR) and Near-Infrared (NIR) therapies have been partially successful with potential side effects. Laser or LED based Photobiomodulation (PBM) has been relatively better in treating various diseases including Traumatic Brain Injury (TBI). However, finding the appropriate wavelengths and intensities for the therapies continue to create challenges. We have calculated the intensity, energy, and power delivered by Sunrays in the region [IR + Red] during the Twilight to Sunrise and Sunset to Twilight timings (time of interest) to the retinae of closed eyes, opened eyes, and to the skin of humans. Based on the intensity, energy, and power these Sunrays in the region [IR + Red] during the "time of interest", we propose that these Sunrays in the region [IR + Red] can help humans use NIR therapy to mitigate TBI, mitigate wide range of neurological and psychological conditions, improve alpha rhythm, treat visual diseases, be good for skin, reduce aging, eliminate wrinkles on face, promote tissue regeneration, reduce swelling, reduce inflammation, relieve pain, non-thermally induce cytocidal effects in cancer cells, induce cell killing of cancer cells. Our methodology is extracted from Vedic Mantras.

Keywords: Twilight, Infrared (IR), Natural Therapy, Sunrays, Photobiomodulation (PBM)

Introduction

Most disturbing health condition that is faced by Western World today is Alzheimer's Disease (AD) and dementia next to Cancer. Tested drugs failed to prove the clinical trials in reversing and stabilizing the cognitive function. To relieve inflammation and pain, stimulate healing, and prevent tissue from dying, Photobiomodulation (PBM) is used non-invasively by shining light in red or near-infrared regions.

In their investigation Carlo Salvi et al [1] reported that Insight problem solving participants blinked their eyes more frequently than participants who solved by analysis. In case of Traumatic Brain Injury and stroke in animal models, Near-Infrared (NIR) light has shown promise of effective treatments. Theodore et al [2] reported their studies on tissue and reviewed data on the power of the device, wavelength of Infrared (IR), the penetration depth and concluded on low power NIR penetration. For convenience we present table-1 that gives the summary the report of Theodore et al.

Table-1 Theodore et al [2] report

Wavelength	Power	Depth of penetration skin or skull and brain	% Power at that depth
NIR	Low level	No penetration	0
810 nm	10W - 15 W	3 cm	0.45% - 2.90%
980 nm	10W - 15 W	3 cm	1.22%

According to the Theodore et al conclusion, "Extensive research has shown the fluence within the range of 0.9–15.0 J/cm^2 is most effective in activating the biological processes involved in reversing or mitigating the pathophysiological effects of Traumatic Brain Injury (TBI)". In biological tissue the penetration depth of Ultraviolet (UV), Visible, and IR is important for risk assessment. Ash et al [3] reported Monte Carlo simulations and the calculations showed that penetration depth increased with increasing wavelength and the maximum depth of penetration being 0.5378 cm. Salehpour et al [4] reviewed the state-of-the-art preclinical and clinical evidence regarding the efficacy of brain Photobiomodulation (PBM) therapy and suggested therapy using red to near-infrared (NIR) light as an innovative treatment for a wide range of neurological and psychological conditions.

Michael's [5] review discusses the mechanisms of action of transcranial PBM in the brain and summarizes studies that have used transcranial PBM to treat animal models of Alzheimer's Disease (AD).

According to the author, to stimulate alpha rhythms, pulsing of the light at 10 Hz and to stimulate gamma rhythms 40 Hz pulsing is used. A study [6] explored the outcome of applying red/near-infrared light therapy using light-emitting diodes (LEDs) pulsed with three different frequencies transcranially to treat traumatic brain injury (TBI) in Veterans and concluded that Pulsed transcranial PBM using LEDs shows promise in improving cognitive function and regional cerebral blood flow (rCBF) several years after TBI indicating larger controlled studies. Irene et al [7] hypothesized the possibility of Electro-Magnetic (EM) energy transfer in molecular interactions instead of the vibrational one because EM energy transfer is much faster in molecular interactions (higher resonant frequencies). The speed of the process was estimated to be approximately of 0.1 picosecond, order of value faster than the vibrational relaxations in the molecule. Horváth et al [8] used continuous wave infrared light ($\lambda = 1550$ nm) to increase or suppress firing rate of stimulated neurons in a reversible manner. Julio et al [9] described the mechanisms action of low-level light therapy (LLLT) at the molecular, cellular, and nervous tissue levels and reported that Photoneuromodulation of cytochrome oxidase activity is the most important primary mechanism of action of LLLT. The authors believed LLLT as a novel paradigm to treat visual, neurological, and psychological conditions, and supports that neuronal energy metabolism could constitute a major target for neurotherapeutics of the eye and brain.

Qin et al [10] reported in their review highlighted the value of NIR therapy as a novel paradigm for treatment of visual and neurological conditions and provide scientific evidence to support the use of NIR therapy with emphasis on molecular and cellular mechanisms in eye diseases. Xiaofeng et al [11] affirmed that EMFs or Electric Fields (EF) can influence the features of energy transport in living systems and thus have certain biological effects. Daniel Barolet et al [12] reported that Red or Near infrared (NIR or IR-A) is good for skin. Consequently IR-A is the solution, not the problem. It does good than bad for the skin. It is a question of intensity and how we can learn from the sun. According to the authors, this NIR range is 760nm-1400nm and early morning and evening red and IR-A wavelengths in sunlight may ready the skin for the coming mid-day deleterious UV radiation. Lee et al [13] reported that NIR Induced Photo-rejuvenation reduces aging, eliminates wrinkles on face. Inoue et al [14] observed that LLLT is typically used to promote tissue regeneration, reduce swelling and inflammation, relieve pain, and is often applied to the injury for 30 seconds to a few minutes or so, a few times a week for several weeks. Tanaka et al [15] reported that near-infrared irradiation can non-thermally induce cytocidal effects in cancer cells because of activation of the DNA damage response pathway. Tanaka et al [16] observed that infrared, independent of thermal energy, can induce cell killing of cancer cells. Ando et al [17] evaluated eyelid transmission with a visual threshold response. Estimated light transmission through the eyelids was 0.3% for blue, 0.3% for green, and 5.6% for red light. The authors further stated that "the eyelid was an effective attenuator and functioned as a red-pass filter. Illumination intensity and color balance after passing through the eyelid should be considered in evaluating the effects of light treatments during sleep." Stone [18] reported that "measurements have been made of Rayleigh scattering in CCl_4 and C_2Cl_4 as a function of wavelength between 6,000 Å and 10,600 Å. The scattering loss rate is 25 dB/km for CCl_4 and 68 dB/km for C_2Cl_4 at 6328 A. The scattering loss rate follows a $(\text{wavelength})^{-4}$ dependence over the entire spectrum observed".

Yusuf et al [19] presented a device capable of measuring pupil diameter and light reactivity through closed eyelids and found that the special resolution of the pupil diameter measurement is estimated to be 0.4 mm while the eyelids were closed. The range of wavelengths of Solar Radiation [20] reaching the Earth may be between one million nanometers to 290 nm with 38.9% visible, 54.3% NIR, and about 6.8% UV. Most experts will agree that **red light therapy depends on two main parameters, wavelength, and intensity**. As long as the wavelengths are generally between 600nm to 900nm, it shouldn't matter what kind of light source it is – LED, Laser, Incandescent, or Sun.

In this paper we examine the following for efficient and cost-effective IR + Red therapy with the help of Veda Mantras. We extracted the meanings of few Mantras that describe the benefits of Pusha (Sunrays in Red and IR region) and put forward the following questions.

1. Is Moring and Evening Sunrays during the time interval between twilight-Sunrise and Sunset-twilight efficient for IR + Red therapy?
2. Does meditating with closed eyes during twilight-Sunrise and Sunset-twilight benefit more?

We considered the time interval starting between Sun's position 6^0 below the horizon (twilight) and ending 10 minutest after Sunrise as "time of interest". Similarly, the time interval starting between 10 minutes before Sunset and ending when Sun's position reaches 6^0 below the horizon (twilight) as the "time of interest". This time period is referred in this paper as "time of interest".

Methods and Materials

(a) (b) (c)

Figure – 1 (a) Light Meter MT-912, (b) Light Meter on a stand, (c) Light Meter on stand facing Sun during the "time of interest"

We have used Light Meter MT-912 device as shown in Figure-1(a) to monitor the intensity of Sunlight during the "time of interest" as explained above and collected data given in Table-2. Location is Irving, TX, USA. We have kept the device in a cup and the cup on a stand as shown in Figure – 1(b) and facing Sun during the "time of interest" as shown in Figure – 1(c).

Table-2: Measurement of Sunlight intensity in the time interval of interest.

Date	**Twilight**	**Start or End of Twilight Watt/sq. cm**	**10 min. before start of Sunset or 10 min. after the end of Sunrise Watt/sq. cm**	**Weather**
12-Apr-2023	Evening	7.32E-8	0.0001076135	Clear and Nice
13-Apr-2023	Morning	3.07E-7	0.000143631	Clear and Nice
13-Apr-2023	Evening	4.50E-7	0.000143631	Clear and Nice
14-Apr-2023	Morning	7.40E-7	0.0002535871	Clear and Nice
14-Apr-2023	Evening	3.60E-7	0.0000614202	Partially Cloudy
15-Apr-2023	Morning	3.90E-7	0.0000195754	Partially Cloudy
15-Apr-2023	Evening	1.03E-7	0.000110981	Partially Cloudy
16-Apr-2023	Morning	4.00E-7	0.0001672035	Clear and Nice
16-Apr-2023	Evening	7.32E-8	0.0001437775	Clear and Nice
17-Apr-2023	Morning	1.80E-7	0.0001600293	Clear and Nice
18-Apr-2023	Evening	1.02E-7	0.0001124451	Clear and Nice
18-Apr-2023	Morning	1.32E-7	0.0001308931	Clear and Nice

Our research is scoped for the Twilight to Sunrise and Sunset to Twilight timings as guided by the Vedic Text. We did not test the benefits outside of these "times of interest".
Following are the five Vedic Mantras taken from Rigveda. We have developed the described therapeutic methodology of consuming [IR + Red] from Sunrays during the "time of interest" based on the inner meanings of these mantras.

Rigveda: 6.58.1

śukraṃ te anyad yajataṃ te anyad viṣurūpe ahanī dyaur ivāsi |
viśvā hi māyā avasi svadhāvo bhadrā te pūṣann iha rātir astu ||

Meaning: In Rigveda (6-58-1), Rishi Yaska in his Niruktam (Dictionary for important Vedic Words) explains about "Pusha" as Sunrays that are Red and Infrared (IR).

Rigveda: 1.23.13

ā pūṣañ citrabarhiṣam āghṛṇe dharuṇaṃ divaḥ | ājā naṣṭaṃ yathā paśum ||

Rigveda (1-23-13) Mantra explains that "Pusha [IR + Red]" is capable of showing the properties of materials.

Rigveda: 1.23.14

pūṣā rājānam āghṛṇir apagūḻhaṃ guhā hitam | avindac citrabarhiṣam ||

Rigveda (1-23-14) Mantra mentions that "Pusha" can enter into the depths of the brain and make the person do good deeds. Indicating the brain to be in calm state and think properly.

Rigveda: 1.42.2

yo naḥ pūṣann agho vṛko duḥśeva ādideśati | apa sma tam patho jahi ||

Rigveda (1-42-2) Mantra mentions that "Pusha" can eliminate three types of diseases that cause pain internally, mentally, and physically.

Rigveda: 1.42.3

apa tyam paripanthinam muṣīvāṇaṃ huraścitam | dūram adhi sruter aja ||

Rigveda (1-42-3) Mantra mentions that "Pusha [IR + Red]" eliminates those disease-causing enemies (bacteria, viruses, etc.) responsible for visible and invisible harm to humans.

Finding the intensity, energy, and power of "Pusha [IR + Red]": Experiment Method

During the experiment the person or subject is kept his/her eyes either closed or open and facing Sunrise or Sunset. The diameter [19] of the pupil is about d = 0.4 mm (closed eyelids) and about d = 4 mm (open eyelids).
Average area of the pupil through which the light can pass when the eyelids are closed is:

$A_1 = \frac{\pi d^2}{4} = \frac{3.14*(0.4*10^{-1})^2}{4} = 12.56 * 10^{-4}\ cm^2$ ---------- (1)

Average area of the pupil through which light can pass when eyelids are opened is:

$A_2 = \frac{\pi d^2}{4} = \frac{3.14*(4 * 10^{-1})^2}{4} = 12.56 * 10^{-2}\ cm^2$ ---------- (2)

Calculation of intensity, energy, and power of [IR + Red] rays with Eyelids Closed

Light transmission [17] through the eyelids was 0.3% for blue, 0.3% for green, and 5.6% for red light.

After twilight and before Sunrise, and after Sunset and before twilight most of the light is the range [Red + IR], then the intensity of [Red + IR] light crossing the pupil and falling on one of the retinas while the eyelids are closed is:

$I_{R1} = I_0 * (0.056) = 0.056\ I_0$ (watt / sq. cm) ---------- (3)

$I_0 = 3.07 * 10^{-7}$ watt / sq. cm is taken as the average minimum from Table – 2 and
$I_0 = 25 * 10^{-5}$ watt / sq. cm as the maximum from Table – 2

I_{R1} (Minimum) $= 0.056 * 3.07 * 10^{-7} = 0.17192 * 10^{-7}$ watt / sq. cm ---------- (4)

I_{R1} (Maximum) $= 0.056 * 25 * 10^{-5} = 140 * 10^{-7}$ watt / sq. cm ---------- (5)

Where, I_0 [W/sq. cm] is the intensity of the light falling on the eyelids, and about 0.056 fraction of that light crosses the eyelids in the [Red + IR] range.

The power received in the [Red + IR] region by the retina of each eye when the eyelids are closed is given by:

P_{R1} (Minimum) $= 0.17192 * 10^{-7} * 12.56 * 10^{-4}$ watt $= 2.16 * 10^{-11}$ watt ---------- (6)

P_{R1} (Maximum) = 140 * 10^{-7} * 12.56 * 10^{-4} watt = 1,758 * 10^{-11} watt ---------- (7)

Minimum Energy delivered to the retina in 30 minutes by [Red + IR] while the eyes are closed:

E_1 (Minimum) = 0.17192 * 10^{-7} * 30 * 60 = 31 μJ / sq. cm ---------- (8)

Maximum Energy delivered in 30 minutes by [Red + IR] while the eyes are closed:

E_1 (Maximum) = 140 * 10^{-7} * 30 * 60 = 0.025 J / sq. cm ---------- (9)

Calculation of intensity, energy, and power of [IR + Red] rays with Eyelids Opened

Intensity of [Red + IR] light crossing the pupil and falling on one of the retinas while the eyelids are open is given by:

I_0 = 3.07 * 10^{-7} watt / sq. cm is taken as the average minimum from Table – 2 and
I_0 = 25 * 10^{-5} watt / sq. cm as the maximum from Table – 2

$I_{R2} = I_0 = I_0$ (watt / sq. cm) ---------- (10)

I_{R2} (Minimum) = 3.07 * 10^{-7} watt / sq. cm ---------- (11)

I_{R2} (Maximum) = 25 * 10^{-5} = 2500 * 10^{-7} watt / sq. cm ---------- (12)

The power received in the [Red + IR] region by the retina of each eye when the eyelids are opened is given by

P_{R2} (Minimum) = 3.07 * 10^{-7} * 12.56 * 10^{-2} watt = 38.5 * 10^{-9} watt ---------- (13)

P_{R1} (Maximum) = 2500 * 10^{-7} * 12.56 * 10^{-2} watt = 31,400 * 10^{-9} watt ---------- (14)

Minimum energy delivered to the retina in 30 minutes by [Red + IR] while the eyes are kept open:

E_2 (Minimum) = 3.07 * 10^{-7} * 30 * 60 = 552.6 μJ / sq. cm ---------- (15)

Maximum Energy delivered to the retina in 30 minutes by [Red + IR] while the eyes are kept open:

E_2 (Maximum) = 2500 * 10^{-7} * 30 * 60 = 0.45 J / sq. cm ---------- (16)

The intensity [21] of Full Moon at the Zenith = 3.15 * 10^{-7} watt / sq. cm ---------- (17)

The ratio of intensities of Maximum [Red + IR] to Full Moon at Zenith

= I_0 (Max) / (3.15 * 10^{-7})

= 793.65 ---------- (18)

Calculation of intensity, energy, and power of [IR + Red] rays on the skin

The surface area [22] of adults is about 18,000 cm^2 (men) or 16,000 cm^2 (women). The body surface area that will be facing the Sunrise or Sunset will be about 50% of the area indicated.

Taking the smaller area between the men and women, the Energy received by average woman's human body skin in the experiment during the 30-minute period will be around

E_3 (Minimum) = 3.07 * 10^{-7} * 30 * 60 = 552.6 μJ / sq. cm ---------- (19)

E_3 (Maximum) = 2500 * 10^{-7} * 30 * 60 = 0.45 J / sq. cm ---------- (20)

Power of the Sunrays during the interval of interest that effects the subject's skin is given by:

P_3 (Minimum) = 0.00122 watt ---------- (21)

P_3 (Maximum) = 1.0 watt ---------- (22)

Discussion

Reference [1] indicates that blinking the eye is an indication of insight problem solving and does not require outside light but should be in awaken state without the image formation due to the opened eyes despite light entering the eyes. From our experiment it is shown that the during the "time of interest", even though the eyes are closed, we receive light from the [Red + IR] region [Equations 3 to 9]. So, during the "time of interest", based on the reference [1], if the subject is focused on something or is in thought process, it helps the subject to enhance the brain capacity, and there is a possibility for effective treatment for Traumatic Brain Injury.

Extensive research [2] has shown the fluence within the range of 0.9–15.0 J/cm^2 is most effective in activating the biological processes involved in reversing or mitigating the pathophysiological effects of TBI (Traumatic Brain Injury). During the "time of interest", the values of the maximum energy / (sq. cm) received by the human body, and the eyes with eyelids closed [Equations 2 to 8], and with eyelids opened [Equations 10 to 16] is given in Table - 3.

Table - 3: Energy received from Sunlight by individual parts during the time of interest

Part of the body	Maximum Energy received in Joule / sq. cm	Reference
Skin	0.45	Equation - 20
Retina of Closed Eye	0.025 for each eye = 0.05 for both eyes	Equation - 9
Retina of Opened Eye	0.45 for each eye = 0.9 for both eyes	Equation - 16

From table – 3 we can clearly see that the maximum energy received by the both the retinae when the eyes are opened during the "time of interest" is 0.9 J/cm^2. This indicates that Sunrays during the "time of interest" can possibly mitigate the pathophysiological effects of TBI.

From reference [3] penetration depth increased with increasing wavelength and the maximum depth of penetration being 0.5378 cm. In our experiment we selected the "time of interest" at which the Sunrays are in [IR + Red] region having possibly maximum wavelengths in the Solar spectrum. Therefore, the chance of penetration depth increases during the "time of interest" and benefit the subject with [IR + Red] rays.

From reference [4] efficacy of brain Photobiomodulation (PBM) therapy suggested using red to near-infrared (NIR) light is an innovative treatment for a wide range of neurological and psychological conditions. Therefore, the chance of treatment for a wide range of neurological and psychological conditions increases during the "time of interest" and benefit the subject with [IR + Red] rays.

From reference [5], it is evident that to stimulate alpha rhythms, pulsing of the light at 10 Hz and to stimulate gamma rhythms 40 Hz pulsing is used. Brain produces alpha waves [measured between 8 and 12 Hz] when a person is in calm state. In our experiment if the subject can induce pulsing by rapidly closing and opening the eyelids during the "time of interest", the subject can stimulate alpha rhythms to make himself / herself calm. Even reference [6] indicates pulsing is beneficial in the treatment of TBI.

According to the authors of reference [9], they believed LLLT as a novel paradigm to treat visual, neurological, and psychological conditions, and supports that neuronal energy metabolism could constitute a major target for neurotherapeutics of the eye and brain. Our experiment is based on the fact that the eye plays a major role in delivering [IR + Red] during the "time of interest" at low levels of light and fits in the LLLT model.

Reference [10] highlighted the value of NIR therapy as a novel paradigm for treatment of visual and neurological conditions and provide scientific evidence to support the use of NIR therapy with emphasis on molecular and cellular mechanisms in eye diseases. Since, our experiment and methodology are based on receiving [IR + Red] light from natural Sunlight (harmless due to low-level light) during the "time of interest", there is high possibility of treatment of visual and neurological conditions.

Reference [12] indicates [NIR + Red] is good for skin and consequently IR-A appears to be the solution, not the problem. It does more good than bad for the skin. It is essentially a question of intensity and how we can learn from the sun. Our experiment is based on the natural Sunlight during the "time of interest" that is best suitable for low-level light in the [IR + Red] region. From equation (22), we learn that the maximum power received by the skin of the subject is low (1 watt) and harmless during the time of interest. Therefore, there is high possibility that the Sunlight during the "time of interest" does good to the subject's skin.

From reference [13] it is evident that NIR Induced Photo-rejuvenation reduces aging, eliminates wrinkles on face. So, during the "time of interest", if the subject's body is exposed to low-level light in the [IR + Red] region, then it may cause Photo-rejuvenation and increases the chances of reducing aging and eliminating wrinkles on face.

Reference [14] indicates LLLT is used to promote tissue regeneration, reduce swelling, inflammation, and relieve pain. So, during the "time of interest" if the subject's body is immersed in the low-level light in the [IR + Red] region, then there are high chances of promoting tissue regeneration, reduce swelling, inflammation, and relieve pain. An added suggestion is "the subject should practice it on a daily basis".

Reference [15] indicates, near-infrared irradiation can non-thermally induce cytocidal effects in cancer cells because of activation of the DNA damage response pathway. During the "time of interest" where there is a high chance of NIR to be present, and if the subject is immersed in Sunrays, then he/she may be benefited due to the chances of having the NIR activating the DNA damage response pathway.

Tanaka et al [16] observed that infrared, independent of thermal energy, can induce cell killing of cancer cells. During the "time of interest" where there is high chance of [IR + Red] region to be present in the Sunrays and if the subject is immersed in Sunrays during that time, the subject is likely to be cured of cancer.

Equation-18 indicates that the intensity of Sunrays during the "time of interest" is about 793.65 that of Full Moon at Zenith. Therefore, we can safely assume that the light is of good intensity though low.

Conclusion

We have calculated the intensity, energy, and power delivered by Sunrays in the region [IR + Red] during the "time of interest" to the retinae of closed eyes, opened eyes, and to the skin of humans. We collected data from light meter MT-912 during the "time of interest". Based on the intensity, energy, and power these Sunrays in the region [IR + Red] during the "time of interest", we propose that these Sunrays in the region [IR + Red] helps humans use NIR therapy to mitigate TBI, mitigate wide range of neurological and psychological conditions, improve alpha rhythm, treat visual, neurological, with emphasis on molecular and cellular mechanisms in eye diseases, is good for skin, reduces aging, eliminates wrinkles on face, promotes tissue regeneration, reduces swelling, inflammation, relieve pain, non-thermally induce cytocidal effects in cancer cells as a result of activation of the DNA damage response pathway, can induce cell killing of cancer cells. This Vedic methodology is extracted from Vedic Mantras after rigorous research and thought process. Since the process is natural, it is side-effect free. More research on this natural therapeutic Vedic methodology would greatly help taking the therapeutic science to next levels in addressing trivial to advanced diseases.

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