Thesis Title

STUDIES ON BEHAVIOURAL EFFECT FOR CHANGE IN AMBIENT LIGHT SOURCES

Thesis submitted in partial fulfilment of the requirement of the degree of

'MASTER OF PHARMACY'

Under the guidance of

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Declaration of originality and compliance of academic ethics

The author thereby declares that this thesis contains original research work as a part of his master of pharmacy curriculum. This indicates that the work was done entirely by the author and the elements in the thesis are not a copy of any similar to any other thesis submitted/published elsewhere.

All works are performed under the supervision of Prof. Sanmoy Karmakar and Prof. Saswati Mazumdar at the Department Of Pharmaceutical Technology and Department Of Electrical Engineering, Jadavpur University.

All information in this document have been obtained and presented in accordance with the academic rules and ethical conduct.

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Certification

This is to certify that Mr Suparno chakraborty has carried out all research studies under my supervision at the Department Of Pharmaceutical Technology , Jadavpur University, Kolkata ,India for the thesis entitled **" STUDIES ON BEHAVIOURAL EFFECT FOR CHANGE IN AMBIENT LIGHT SOURCES "** during the session 2017-2019 for the partial fulfilment of the requirement for the degree of Masters of Pharmacy of Jadavpur University .The ideas put into effect are original and are not a copy of or similar to any other thesis submitted/published elsewhere.

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CONTENTS

CHAPTER 1

INTRODUCTION

Human being is continuously exposed to light. At homes people are exposed to artificial LED light, tube light and other types of light whereas outside people are exposed to sun light in day and at night people are exposed to different artificial light sources. In metro cities most of us are exposed to the lights coming from the streets while people sleep, this hampers our quality of sleep and repeated hampering of our sleep may result in change of our biological clock i.e. circadian rhythm. Effect of exposure to lights of varying types might have a wide range of effect on our health, which is often difficult to evaluate and seldom investigated. During sleep biological rhythms are cyclic changes which correspond to the temporal organization of the environment. The frequencies of these rhythms are believed to be synchronised with daily tidal behaviour and also with the seasonal cycles that serve to adapt organism to rhythms of environmental changes. In the absence of signals such as light/dark cycle they also enable organisms to anticipate cyclic events. Circadian rhythms are deeply rooted in the biology of virtually all organisms. The pervasive use of artificial lighting in modern society disrupts circadian rhythms and can be detrimental to our health.

Studies say that bright light can heighten emotions, blue light can make people feel more energetic, natural light could make happier and light can even affect appetite. Blue was a very calming colour that can make people centred, relaxed and serene. It was known to help low blood pressure, clear the mind and help steady one's breathing. While blue rooms are lovely to lounge and rest in, yellow can catch the sunlight and leave with an uplifting feeling of joy and liveliness. White instils the fear of dirt in even the messiest of people, but painting walls white or off-white was a great way to help make home feel more spacious and open and the people within it more neutral**.** Green was a great colour for home, office as it symbolises prosperity and helps to reduce anxiety. It was one of the most restful colours for eyes and was known to be restorative, mind-clearing and encourage composure. Purple was a rich, dramatic colour that was historically the colour of royalty and luxury. Deep purples give off a very romantic, mysterious and luxurious vibe and are great for sparking creativity. Orange was a very exciting colour that brings a burst of energy and enthusiasm. Red was known to raise blood pressure, heart beat and irritability.

COLOUR PSYCHOLOGY AS THERAPY

Several ancient cultures, including the Egyptians and Chinese, practiced chromotherapy, or the use of colours to heal. Chromotherapy was sometimes referred to as light therapy or colourology and was still used today as a holistic or alternative treatment.

In this treatment:

- Red was used to stimulate the body and mind and to increase circulation.
- Yellow was thought to stimulate the nerves and purify the body.
- Orange was used to heal the lungs and to increase energy levels.

- Blue was believed to soothe illnesses and treat pain.
- Indigo shades were thought to alleviate skin problem.

MODERN RESEARCH ON COLOUR PSYCHOLOGY

Most psychologists view colour therapy with scepticism and point out that the supposed effects of colour are often grossly exaggerated. Colours also have different meanings in different cultures. Research has demonstrated in many cases that the mood-altering effects of colour may only be temporary. A blue room may initially cause feelings of calm, but the effect dissipates after a short period of time.

However, the existing research has found that colour can impact people in a variety of surprising ways:

- One study found that warm-coloured placebo pills were reported as more effective than cool-coloured placebo pills.
- Anecdotal evidence has suggested that installing blue-coloured streetlights can lead to reduced crime in those areas.
- More recently, researchers discovered that the colour red causes people to react with greater speed and force, something that might prove useful during athletic activities.
- A study that looked at historical data found that sports teams dressed in mostly black uniforms are more likely to receive penalties and that players were more likely to associate negative qualities wearing a black uniform.

PHOTOBIOLOGY AND NON-VISUAL EFFECTS

In addition to receiving all of the signals necessary for forming images, the retina also houses a network of sensors that detect optical radiation for biological responses, particularly the human response to light-dark cycles. With light, the body resets its internal circadian clock and synchronizes it to local time.

Because this circadian clock synchronization with the daily light-dark pattern was vital for the body to function effectively, it was essential for lighting designers to understand the direct biological and behavioural influence of optical radiation. These nonvisual effects of light—those that don't involve the visual system—include the following:

- Melatonin secretion
- Body temperature
- Cortisol secretion
- Heart rate
- Alertness
- Cognitive performance
- Psychomotor performance
- Brain blood-flow
- Electroencephalogram (EEG) responses
- Clock gene expression
- Overall circadian regulation

These nonvisual effects demand that design considerations include the interaction between light and endocrine systems, sleep cycles, and mood. [1]

THE CIRCADIAN PACEMAKER

The optic nerve branches from the rear of the eye into two main pathways: one pathway goes directly to the visual cortex, where signals from the cones and rods lead to the interpretation of the light in the environment; the other pathway connects with the nonvisual functions of the eye. This neural pathway was called the retinohypothalamic tract (RHT). The origin of the RHT was a recently discovered class of photoreceptor in the retina: the intrinsically photosensitive retinal ganglion cells (ipRGCs). In contrast to the rods and cones, these photosensitive cells are located near the top layer of the retina in the ganglion cell layer. The RHT serves as a conduit for the neural signals from the ipRGCs to reach the hypothalamic suprachiasmatic nuclei (SCN), which acts as the circadian pacemaker and was primarily responsible for the entrainment of your internal body clock. This function of the eye was what allows people to maintain daily wake-sleep cycles and to adjust to new daylight settings in other parts of the country and other parts of the world when travelling, this effect was shown in Fig-1 and in Fig -2.

After information about light in the environment was transmitted from initial exposure at the retina through the SCN, the SCN then transmit information about lighting cues to the pineal gland, which responds by regulating the secretion of the hormone melatonin. As a result, rhythmic patterns of light entrain the circadian production and the secretion of melatonin. In mammals, this pattern results in higher levels of melatonin during the dark night time hours. In addition, exposure to light of sufficient intensity can suppress high nocturnal melatonin secretion.

The light-sensitive hormone melatonin was produced by the body every evening and during the night. Melatonin promotes sleep and alerts a variety of biological processes to the approximate hour of the day. As light hitting the retina suppresses the production of melatonin, therein lies the rub. In the modern world our eyes are flooded with light ll after dusk, contrary to our evolutionary programming. The disruption of circadian cycles may not just be short changing our sleep, it may also be contributing to a host of diseases.

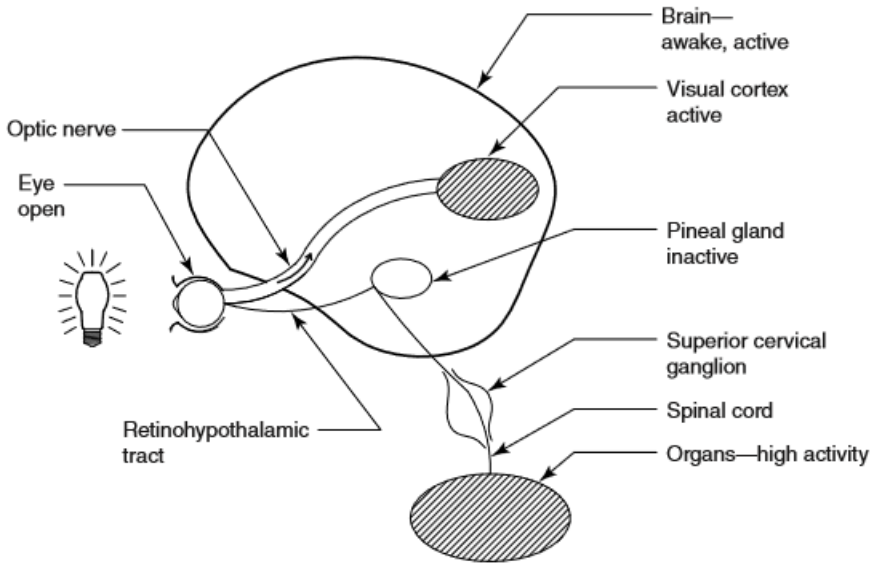


Fig -1: The neural pathway of the circadian pacemaker in light.

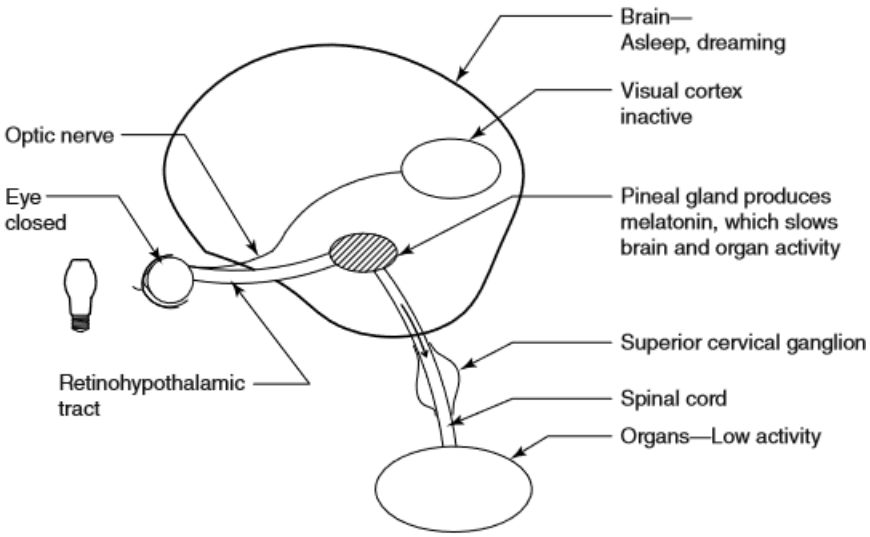


Fig -2: The neural pathway of the circadian pacemaker in dark.

MELATONIN SUPPRESSION

Because light serves as a powerful stimulus with both biological and behavioural effects in human beings, it follows that if light can regulate circadian and endocrine cycles, it can also deregulate these cycles and cause disease. Circadian disruption due to electric-light exposure may represent a breast cancer risk. Suppression of the pineal gland's melatonin secretion appears to play a pivotal role in this risk. Any kind of light can suppress melatonin, but recent experiments raise particular concerns about the short (blue) wavelengths produced by electronics and many energy-efficient electric light sources, because light composed of short wavelengths slows the release of melatonin with unusual effectiveness. The problem now was that our world was increasingly illuminated by sources rich in the short-wavelength (blue) region of the spectrum. Sources with short wavelengths cause 40 percent less melatonin to be produced than incandescent and halogen sources, causing people to feel more awake an hour after the lights are turned off. In addition, the quantity of light necessary to affect melatonin was much smaller than once thought: ordinary indoor lighting before bedtime suppresses melatonin in the brain, delaying production of the hormone for 90 minutes after lights are switched off. The use of any kind of light too late into the evening may have broad health effects, independent of any effect on sleep. The effects of blue light are particularly pronounced for shift workers and others who get little natural daylight. In 2007, the World Health Organization declared shift work a probable carcinogen. The agency concluded that body clock disruptions "can alter sleep-activity patterns, suppress melatonin production, and dysregulate genes involved in tumor development." Although, only 20% of the population stays up all night exposed to electric light, most of us have extended our daily light exposure considerably beyond the normal circadian cycle. According to the Centers for Disease Control, this has

resulted in an epidemic of sleep deprivation strongly associated with an assortment of health risks from diabetes to heart disease to obesity. Both directly and indirectly, then, optical radiation incident on the retina regulates physiology and behavior by suppressing pineal melatonin production, enhancing psychomotor performance, changing brain activation patterns to a more alert state, elevating heart rate, increasing core body temperature, activating pupil constriction, and stimulating circadian clock gene expression.

THE AGING EYE

As the visual system ages, several changes in its structure and capabilities occur, including the loss of focusing power, a reduction in lens transparency, yellowing of the lens, and a decrease in maximum pupil size. As the lens of the eye becomes yellow with advancing age, it reduces the amount of short-wavelength radiation that reaches the retina. Advancing age often brings lens clouding (called "cataract"), which was caused by chemical changes within the eye. This decrease in transparency causes a decrease in vision. Advancing age also causes the maximum pupil size that the iris can provide to be reduced. This effect of age was particularly pronounced at low levels of light. With age, the amount of light reaching the retina was reduced, more of the light entering the eye was scattered, and the spectrum of light reaching the retina was altered by an increasingly preferential absorption of the short visible wavelengths. The neurological components of the visual system also deteriorate in later life. Consequently, aging eyes experience reduced visual acuity, reduced contrast sensitivity, reduced colour discrimination, increased adaptation time to large and sudden changes in illumination, and increased sensitivity to glare. Glare and relfection contribute to confusion, agitation, and anger; inhibit activity; and compromise safety. Lighting can help to ameliorate some of these conditions by increasing the amount of light on the task, minimizing glare, providing softer shadows, and improving colour discrimination.

LIGHT THERAPY

Seasonal affective disorder (SAD), also known as seasonal depression, winter depression, or winter blues, was a mood disorder in which people experience a recurrence of depressive symptoms during particular seasons of the year. Seasonal affective disorder was more prevalent in higher latitudes (such as in U.S. north eastern states and in Arctic country regions like Scandinavia). The rate of SAD was almost 10% of the global population. In the United States, approximately 11 million people are affected by SAD and up to 25 million people suffer from a mild form of SAD called Subsyndromal SAD (SSAD). SAD and SSAD can lead to depression, a tendency to oversleep and overeat, and other harmful conditions owing to lack of energy. Phototherapy, or light therapy, has been the prescribed treatment for SAD for almost 30 years. Light therapy inhibits the production of melatonin, aiding circadian phase synchronization, and helps to establish regular sleep patterns The box can be installed upright on a wall or slanted downward toward a Table. Patients with an upright box need to face the light source without looking directly at the light. Slanted boxes are designed to focus on a Table so that the patient can read or do sedentary activities under the light. Light therapy was also used for nonseasonal depression, sleep disorders, menstrual cycle disturbances, eating disorders, jet-lag adjustment, shift-work adaptation, and some of the effects of aging. It was used in eldercare facilities for those who suffer from senile dementia and Alzheimer's disease, which can cause mood and sleep disturbances.

Chapter 2

LITERATURE SURVEY

Our literature survey revealed that very few scientific works in this field have been published in peer review journals. However, from the available literature, initiative has been taken to gather information on the effect of light on laboratory animals so as to design the experiments using laboratory mice with an intent to find out the probable effect of the same on human beings.

According to Lucassen et al, virtually all organisms have measurable circadian rhythms that help them anticipate and adapt to the environmental day-night cycle. In mammals, these circadian rhythms are orchestrated by neurons within the suprachiasmatic nucleus (SCN), which was located in the anterior hypothalamus. The pervasive use of artificial lighting in modern society disrupts circadian rhythms and can be detrimental to our health. To investigate the relationship between disrupting circadian rhythmicity and disease. The SCN conveys temporal information to peripheral tissue oscillators, thus producing synchronized circadian rhythms in many bodily processes, including muscle function, bone metabolism, and immune system function. Under evolutionary pressure, the circadian system evolved as a robust mechanism for adapting to life in a cyclic environment. Thus, hypothesized that organisms require clear external cycles in order to maintain a healthy state and that absence of external rhythmicity was detrimental for health. The use of artificial lighting in modern society—particularly during the night—disrupts the natural robust environmental cycle and was a risk factor for frailty. Nowadays, 75% of the world's population was exposed to light during the night. Moreover, the prevalence of shift work was relatively high around the globe; approximately 20% of workers in Europe, 29% of Americans, and 36% of Chinese and Koreans are engaged in shift work. Importantly, epidemiological studies of shift workers revealed increased prevalence of breast cancer, metabolic syndrome, osteoporosis, and bone fractures in this population. In addition, individuals who are exposed to more light at night tend to have decreased sleep quality, increased body weight, and a higher prevalence of cardiovascular disease. Although these studies suggest a correlation between artificial light exposure and health, they cannot determine whether this relationship was causal. Animal studies have shown that aberrant light exposure can affect both the immune system and metabolic function. However, in these studies, the exposure to light was relatively brief; therefore, the results cannot be translated directly to humans, who are often chronically exposed to disruptions in circadian rhythm.

At Arctic and Antarctic latitudes, personnel are deprived of natural sunlight in winter and have continuous daylight in summer: light of sufficient intensity and suiTable spectral composition was the main factor that maintains the 24-h period of human circadian rhythms. Thus, the status of the circadian system was of interest. Moreover, the relatively controlled artificial light conditions in winter are conducive to experimentation with different types of light treatment. The hormone melatonin and/or its metabolite 6-sulfatoxymelatonin (aMT6s) provide probably the best index of circadian (and seasonal) timing. A frequent observation has been a delay of the circadian system in winter. A skeleton photoperiod (2 × 1-h, bright white light, morning

and evening) can restore summer timing. A single 1-h pulse of light in the morning may be sufficient. A few people desynchronize from the 24-h day (free-run) and show their intrinsic circadian period, usually >24 h. With regard to general health in polar regions, intermittent reports describe abnormalities in various physiological processes from the point of view of daily and seasonal rhythms, but positive health outcomes are also published. True winter depression (SAD) appears to be rare, although subsyndromal SAD was reported. Probably of most concern are the numerous reports of sleep problems. These have prompted investigations of the underlying mechanisms and treatment interventions. A delay of the circadian system with "normal" working hours implies sleep was attempted at a sub-optimal phase. Decrements in sleep efficiency, latency, duration, and quality are also seen in winter. Increasing the intensity of ambient light exposure throughout the day advanced circadian phase and was associated with benefits for sleep: blue-enriched light was slightly more effective than standard white light. Effects on performance remain to be fully investigated. At 75°S, base personnel adapt the circadian system to night work within a week, in contrast to temperate zones where complete adaptation rarely occurs. A similar situation occurs on high-latitude North Sea oil installations, especially when working 18:00–06:00 h. Lack of conflicting light exposure (and "social obligations") was the probable explanation. Many have problems returning to day work, showing circadian desynchrony. Timed light treatment again has helped to restore normal phase/sleep in a small number of people. Postprandial response to meals was compromised during periods of desynchrony with evidence of insulin resistance and elevated triglycerides, risk factors for heart disease. Only small numbers of subjects have been studied intensively in polar regions. However, these observations suggest that suboptimal light conditions are deleterious to health. They apply equally to people living in temperate zones with insufficient light exposure.[2]

ELECTRICAL AND PHOTOMETRIC PARAMETERS THAT HAVE BEEN USED IN THE STUDY:

CIE Chromaticity

The international commission on illumination has chosen a basis for standardization the response of three sets of colour receptors in the eye. The CIE system (Fig-3) uses a tristimulus method of the three sets of colour receptors of the light on a surface in terms of the amounts of the primary colour of light required to match the unknown colur in question. The system employs a chromaticity diagram that contains the seven colour of the visible spectrum .thw spectral colours are located on the locus (edge) of the chromaticity diagram. A straight line joins the red and violet ends of the spectral locus to form a closed diagram.

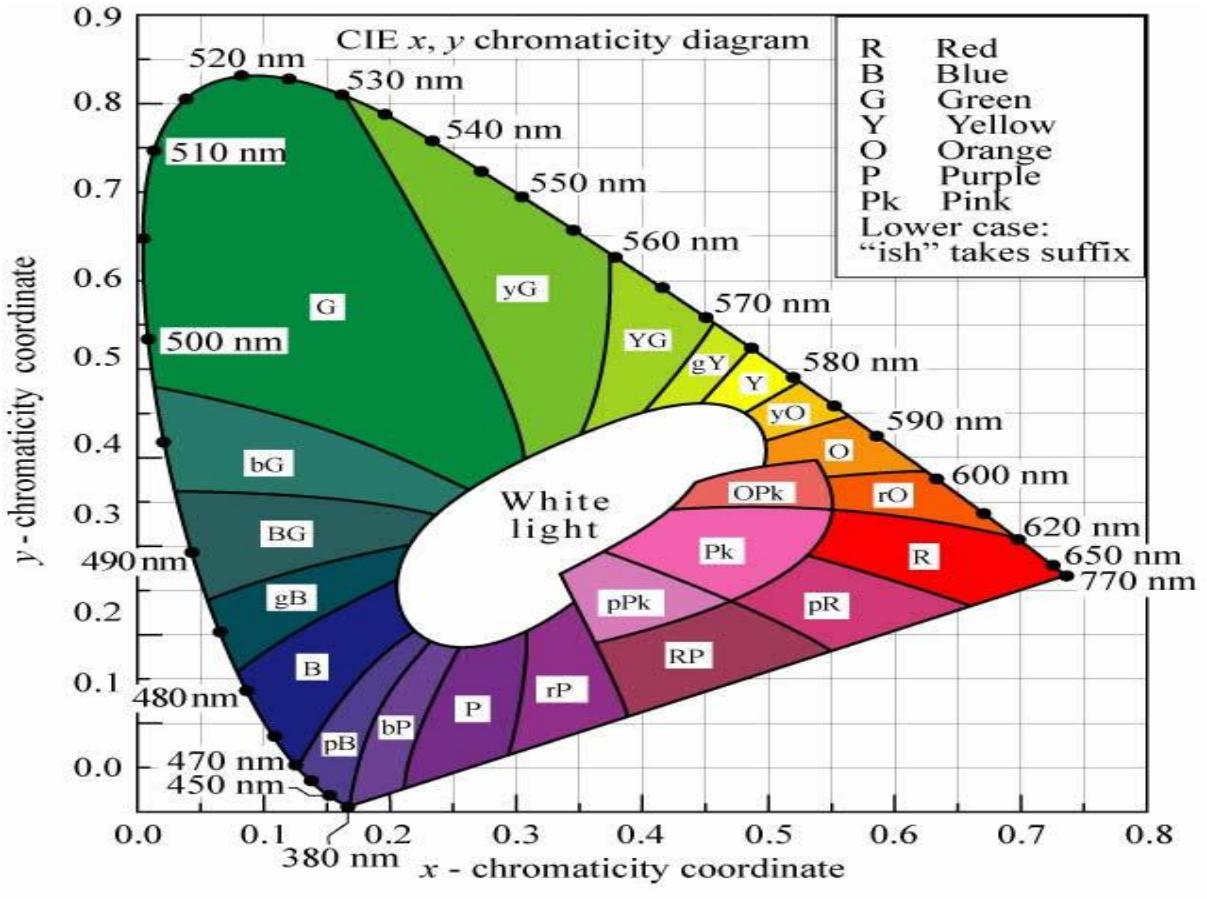


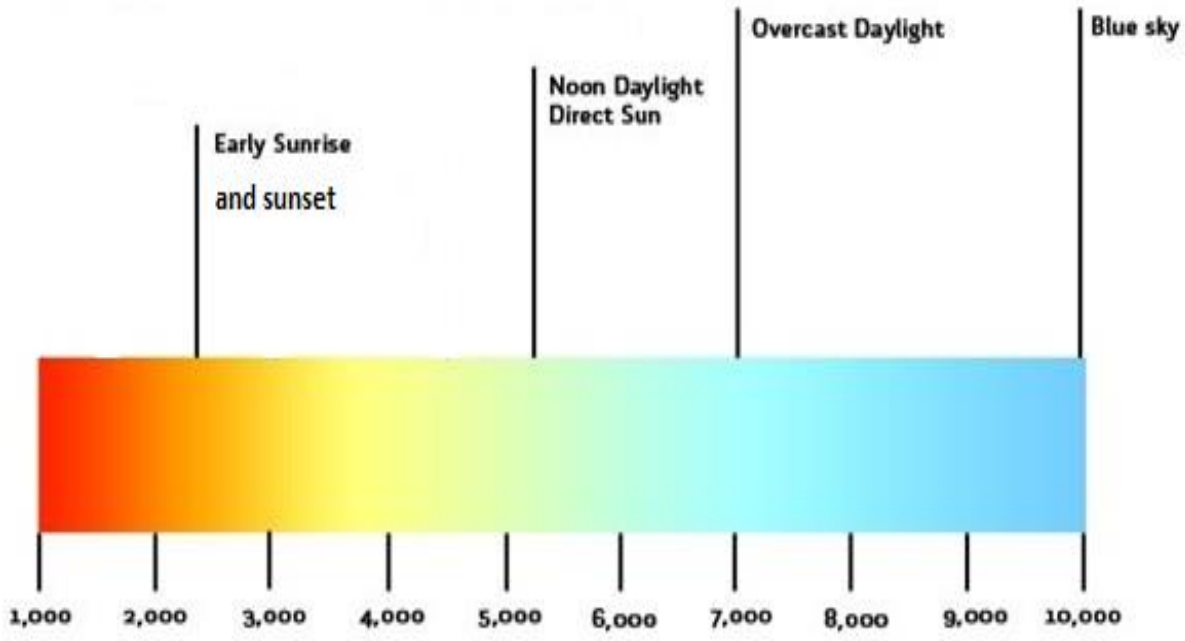
FIG -3: CIE CHROMATICITY DIAGRAM

COLOUR TEMPERATURE

Colour temperature was a method for describing certain colour characteristic of light sources. In order to define colour temperature people must first understand the term blackbody radiator. A blackbody was a theoretical object which was a perfect radiator. As the temperature of a blackbody was raised, it radiates energy in the visible range, first red, changing to orange,

yellow, bluish white and finally white. these colours re plotted as a curved line on the cie chromaticity diagram .the curve was known as black body locus. Colour temperature then was used to describe the colour of a light source by comparing it to the colour of a blackbody radiator, eg the colour appearance of a led light was similar to a black body radiator heated to about 3000 degrees kelvin therefore it was said that the led lamp has a colour temperature of 3000K. Colour temperature, expressed in degrees Kelvin, can be measured with a colour temperature meter. At room temperature, an object such as a bar of steel does not emit light, but if it was heated to a certain point it glows dull red. Instead of a bar of steel, physicists used an imaginary object called a blackbody radiator. Similar to a steel bar, the blackbody radiator emits red light when heated to 800 K; a warm, yellowish "white" at 2800 K; daylight like white colour at 5000 K (Fig-4); a bluish, daylight white at 8000 K (Fig-5); and a brilliant blue at 60,000 K. The theoretical blackbody was necessary because the bar of steel would melt at these higher temperatures. The available light sources and the corresponding Correlated Colour Temperatures (CCT) are given in Table 2.1.

FIG 4: CORRELATED COLOUR TEMPERATURE OF CORRESPONDING DAYLIGHT



Temperature	Source
1,700 K	Match flame
1,850 K	Candle flame, sunset/sunrise
2,700–3,300 K	Incandescent lamps
3,000 K	Warm White fluorescent lamps
3,200 K	Studio lamps, photofloods, etc.
3,350 K	Studio "CP" light
4,000 K	Cool White fluorescent lamps
5,000 K	Horizon daylight
5,000 - 5,500 K	Daylight fluorescent lamps
5,500–6,000 K	Vertical daylight, electronic flash
6,200 K	Xenon short-arc lamp
6,500 K	Daylight, overcast
6,500–10,500 K	LCD or CRT screen
15,000–27,000 K	Clear blue poleward sky

Fig-5: FEW EXAMPLES OF LIGHT SOURCES AND CORRESPONDING CORRELATED COLOUR TEMPERATURE

COLOUR RENDERING INDEX (CRI)

Colour Rendering Index (CRI) is a quantitative measure of the ability of a light source to reveal the colours of various objects faithfully in comparison with an ideal or natural light source. Like colour temperature CRI compares the light source in question to a reference source. Unlike colour temperature, which was concerned with the colour appearance of light produced. CRI deals with the appearance of coloured objects illuminated by a light source and how that appearance compares with the colour appearance of objects illuminated by a reference source. Colour rendering index expresses how colours appear under a given light source. For example, a shade of red will be rendered lighter or darker, more crimson or more orange, depending on the spectral-distribution properties of the light falling on it. The most accepted method to determine the colour-rendering ability of a light source was a rating system called the colour rendering index (CRI).

The CRI establishes the real or apparent colour temperature of a given light source. Then, it establishes a comparison between the colour rendition of the given light source and of a

reference light source. If the colour temperature of a given source was 5000 K or less, the reference source was the blackbody radiator at the same colour temperature. If the given colour temperature was above 5000 K, the reference source was a simulated phase of daylight of the same colour temperature. The comparison was expressed as an Ra factor on a scale with a maximum of 100, which indicates how closely the given light source matches the colour-rendering ability of the reference light source. Since the reference for CRI changes with colour temperature, the CRIs of different light sources should only be compared if they have similar SPD composition. Therefore, it was inappropriate to compare two light sources unless their colour temperature was similar—within 100 K to 300 K.For example, a 3000 K RE-70 fluorescent lamp and a 6500 K "daylight" fluorescent lamp render objects differently, despite the fact that they both have a CRI of 75. This occurs because the CRI for the 3000 K lamp was compared to a blackbody radiator, and the CRI for the 6500 K lamp was based on comparison to actual daylight. R_a was an average of the colour-rendering ability of eight test colours; better performance at some wavelengths was concealed when averaged with poorer performance at other wavelengths. As a consequence, two lamps that have the same colour temperature and CRI may have different spectral distributions and may render coloured materials differently.

BLACK BODY ILLUMINANTS

These are materials that produce light when they are heated. The sun was a Black Body Illuminant, as was a candle flame. The colour of light of these types of sources can be characterized by their Kelvin temperature. Note that this temperature has nothing to do with how "hot" a light source was - just with the colour of its light. A light source with a low Kelvin temperature was very red. One with a high Kelvin temperature was very blue. More accurately, when people see two light sources side by side in a scene, the higher Kelvin light appears more bluish, and the lower Kelvin appears more redish. Black Body Illuminants produce a fairly even, continuous spectrum of colours, and so are perceived as "white" by our visual sense.

Therefore, in the absence of comparative light sources in our scene, these should be rendered with available white LED sources having different CCTs (warm, natural white cool). In Fig-6, the Spectral Power Distribution Curves of 3 types of white LED sources are shown and Table-2.2 shows some common Light Sources (other than LEDs) their CCTs values , the RGB values and their respective colour which people perceive.[3]

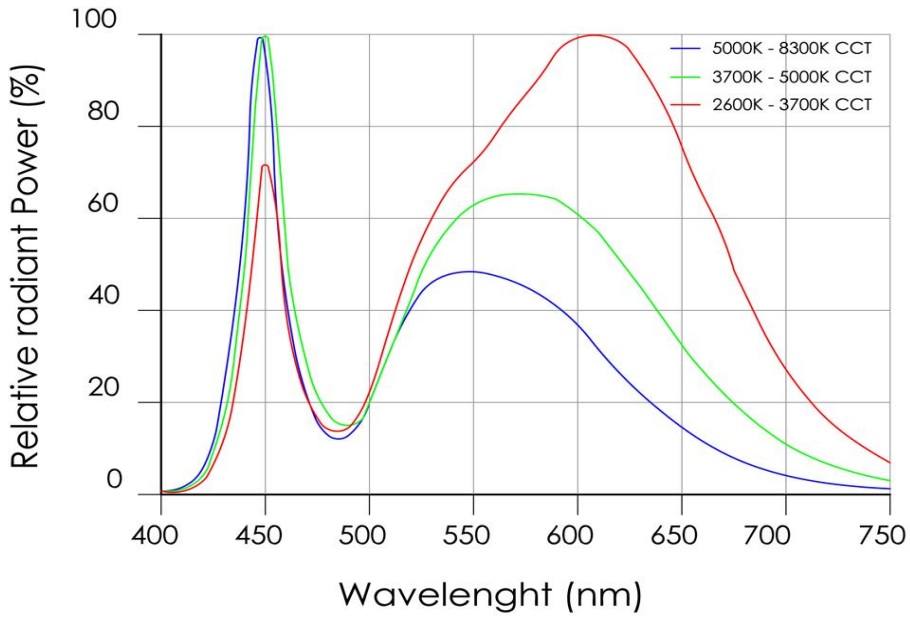


FIG 6: THE FIGURE SHOWS THE RELATION BETWEEN RELATIVE RADIANT POWER (%) AND WAVELENGTH (nm) WITH CCT COMPONENT

Light Source	Kelvin temperature	R G B Values	Color
Candle	1900	255, 147, 41	
40W Tungsten	2600	255, 197, 143	
100W Tungsten	2850	255, 214, 170	
Halogen	3200	255, 241, 224	
Carbon Arc	5200	255, 250, 244	
High Noon Sun	5400	255, 255, 251	
Direct Sunlight	6000	255, 255, 255	
Overcast Sky	7000	201, 226, 255	
Clear Blue Sky	20000	64, 156, 255	

TABLE 2.1 - SHOWING LIGHT SOURCES , CORRELATED COLOUR TEMPERATURE (CCT) AND EQUIVALENT R G B VALUES.

Chapter 3

Methods and materials

ANIMAL HUSBANDRY AND MAINTENANCE

Healthy adult male and female Swiss albino mice weighing 25-30gm were procured from M/S Chakraborty Enterprise, 3/1D Girish Vidyaratna Lane, Narkeldanga, Kolkata-700011, and used for the study. The animals were grouped and housed in cages, 6 animals per cage separate arrangement for male and female in a controlled environment . Five groups were made and each group had two sets- one for male and one for female.

EXPERIMENTAL SETUP

The set up of the experiment consist of eight boxes for eight light. The boxes were made with the help of a long Table and the Table was partitioned into eight part. The eight light were hung from a distance of 2.5ft from the cage

PHARMACOLOGICAL LABORATORY EQUIPMENT USED

- Elevated Plus Maze (Fig-7)
- Actophotometer (Fig-8)
- Rotarod (Fig-9)
- Weight machine

ELECTRONIC AND PHOTOMETRIC EQUIPMENT/METERS USED

- Multi Meter for voltage and current measurement: Fluke 107 and Fluke 115 (Fig-10)
- LUX / Fc Meter 1332 for measuring the luminous intensity (Fig-11)
- Integrated Test Instrument – ACP9000C (Fig-12)
- CRI meter : XY value & CCT value Konica Minolta CL70F (Fig-13)

THE PICTURES OF SOME OF THE INSTRUMENTS ARE GIVEN BELOW

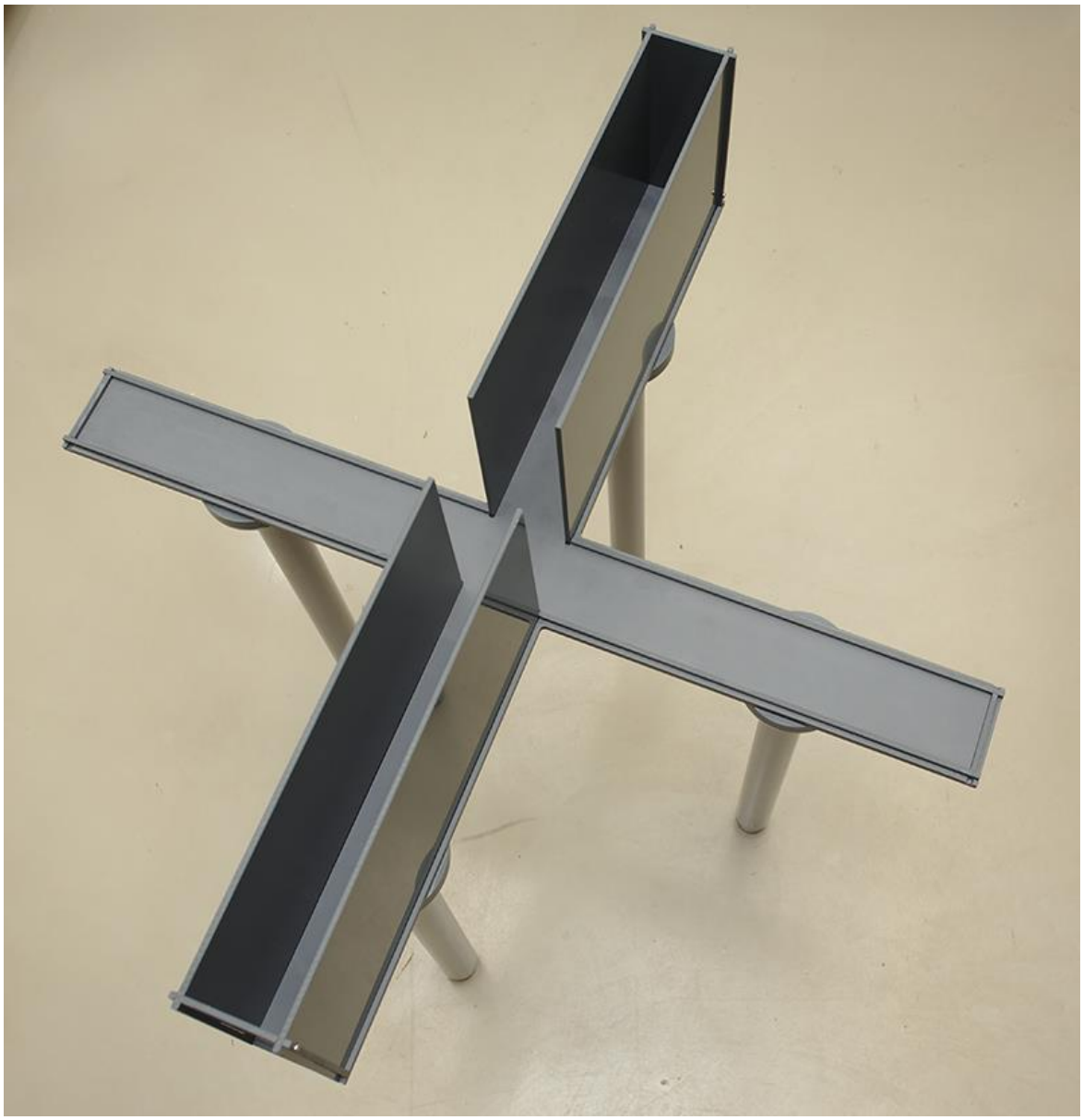


FIG -7: ELEVATED PLUS MAZE

FIG -8: ACTOPHOTOMETER

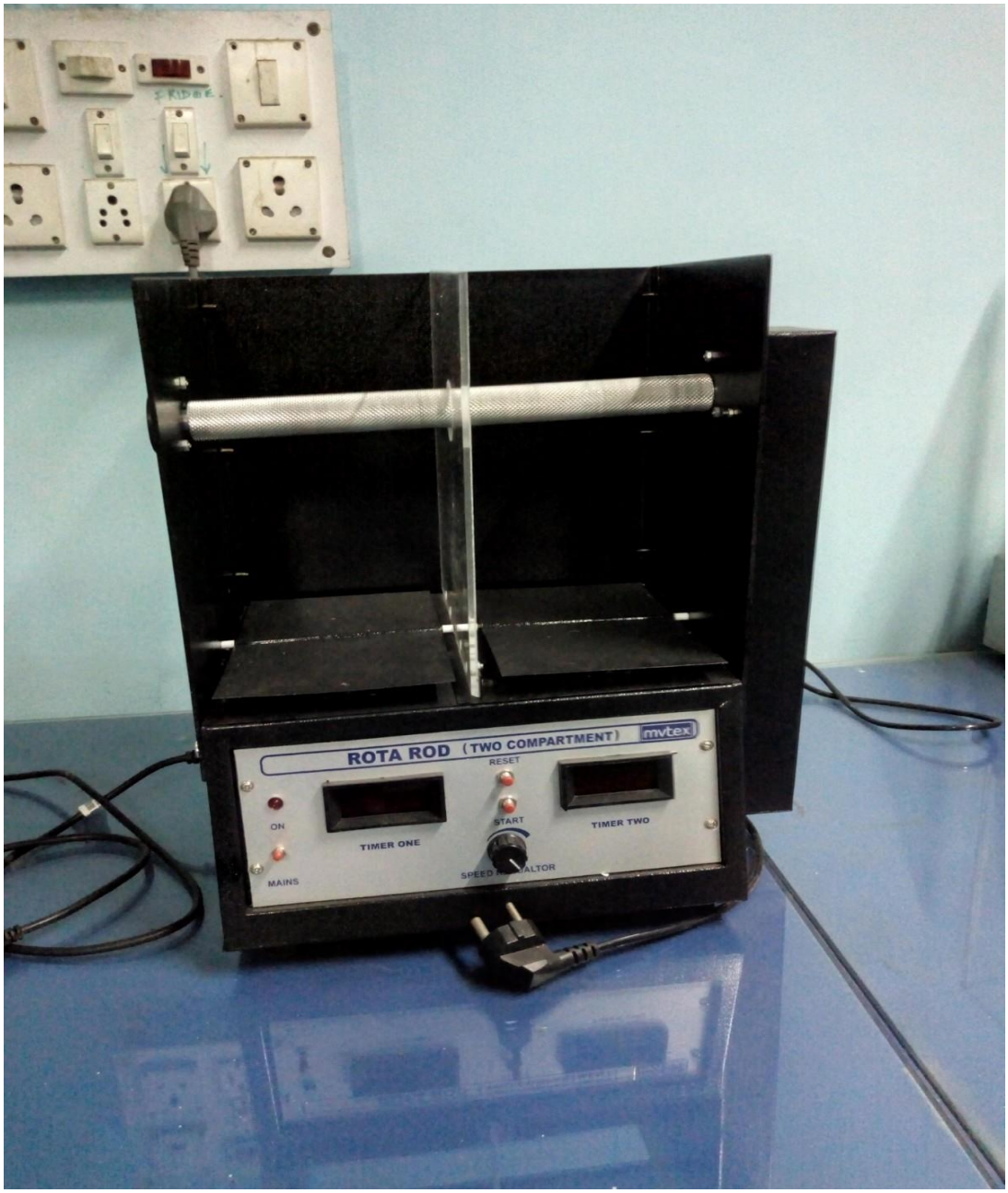


FIG-9 : ROTAROD

FIG 10: FLUKE 115

FIG-11: LUX/FC LIGHT METER 1332

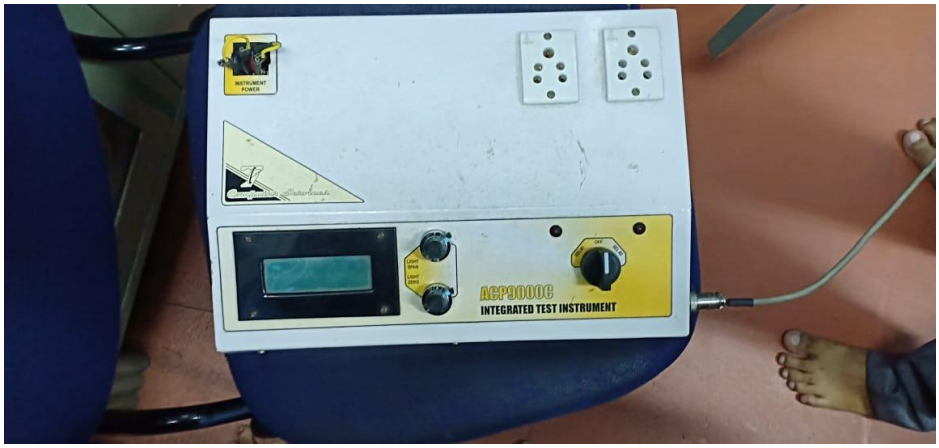


FIG -12: INTEGRATED TEST INSTRUMENT

FIG-13: CRI METER

THE USED LED LIGHT SOURCES

Red Light, Cool Light of 6500K, Warm White Light of 3000K, and White Light of 4000K (Table 3.1) were collected from Kolkata market, each of them two in quantities.

TABLE 3.1: ELECTRICAL AND PHOTOMETRIC CHARACTERISTICS OF LIGHT SOURCES USED

LIGHT	VOLTAGE(V)	CURRENT (mA)	WATTAGE (W)
RED	250	81	18.6
RED	249	82	19.2
COOL	245	106	25.3
COOL LIGHT	252	106	24.7
WARM LIGHT	247	110	26.2
WARM LIGHT	241	110	25.2
WARM LIGHT	244	108	24.9
WARM LIGHT	245	100	25

The significance of choosing artificial light from the range of reddish light to white colour having colour temperature of 6500K is for the colour temperature variation of the daylight as given in Table-3.2 below.[4] From dawn to dusk people are exposed to sunlight which have different colour temperature at different time periods of the day. At night when people are exposed to the artificial light, the artificial lights also mimic the colour temperature of the sunlight which people are exposed during the day. The following chart will be helpful for understanding the fact.

TABLE 3. 2-TIME OF THE DAY AND CORRESPONDING CORRELATED COLOUR TEMPERATURE (CCT) OF DAYLIGHT

Serial No	Time	CCT of daylight (K)
1	06:00 am	2300
2	06:30am	2700
3	07:00am	3100
4	07:30am	3500
5	08:00am	3900
6	08:30am	4100
7	09:00am	4300
8	09:30am	4500
9	10:00am	4900
10	10:30am	5100
11	11:00 am	5115
12	11:30 am	5223
13	12:00 pm	5107
14	12:30 pm	5070
15	1:00 pm	5074
16	1:30 pm	5090
17	2:00 pm	4990
18	2:30 pm	4972

19	3:00 pm	4907
20	3:30 pm	4854
21	4:00 pm	4760
22	4:30 pm	4674
23	5:00 pm	4568

Table-3.2 helps to relate the reason behind the lights chosen for this experiment .The CCT of the natural light with which people are exposed, changes thorough out the day. In this experiment the artificial LED lights mimic few particular daylight CCTs. [5]

]

Lights Used And Their Significance

Fig-13 : RED LIGHT USED IN OUR SET UP

Fig-14 : WARM WHITE COLOUR 3000K USED IN OUR SET UP

Fig-15 : WARM WHITE COLOUR 4000K USED IN OUR SET UP

Fig-16 : WARM WHITE COLOUR 6500K USED IN OUR SET UP

OBJECTIVE OF USING DIFFERENT LED

Red light, Warm white colour 3000K, Cool White colour 6500K were switched on for 108 days 24x7. This condition was done with the objective of breaking the normal circadian rhythm or biological clock of the mice. This conditions mimic the people staying in the countries in and around Arctic and Antarctic circles where there is 6 months of day and 6 months of night. White colour 4000K was set with a timer to be switched on for 16 hours and switched off for the remaining 8 hours, this condition mimics the people living in tropical country like India where people are exposed to different kind of light for approximately 16 hours and the rest 8 hours in darkness during sleep.

Chapter 4

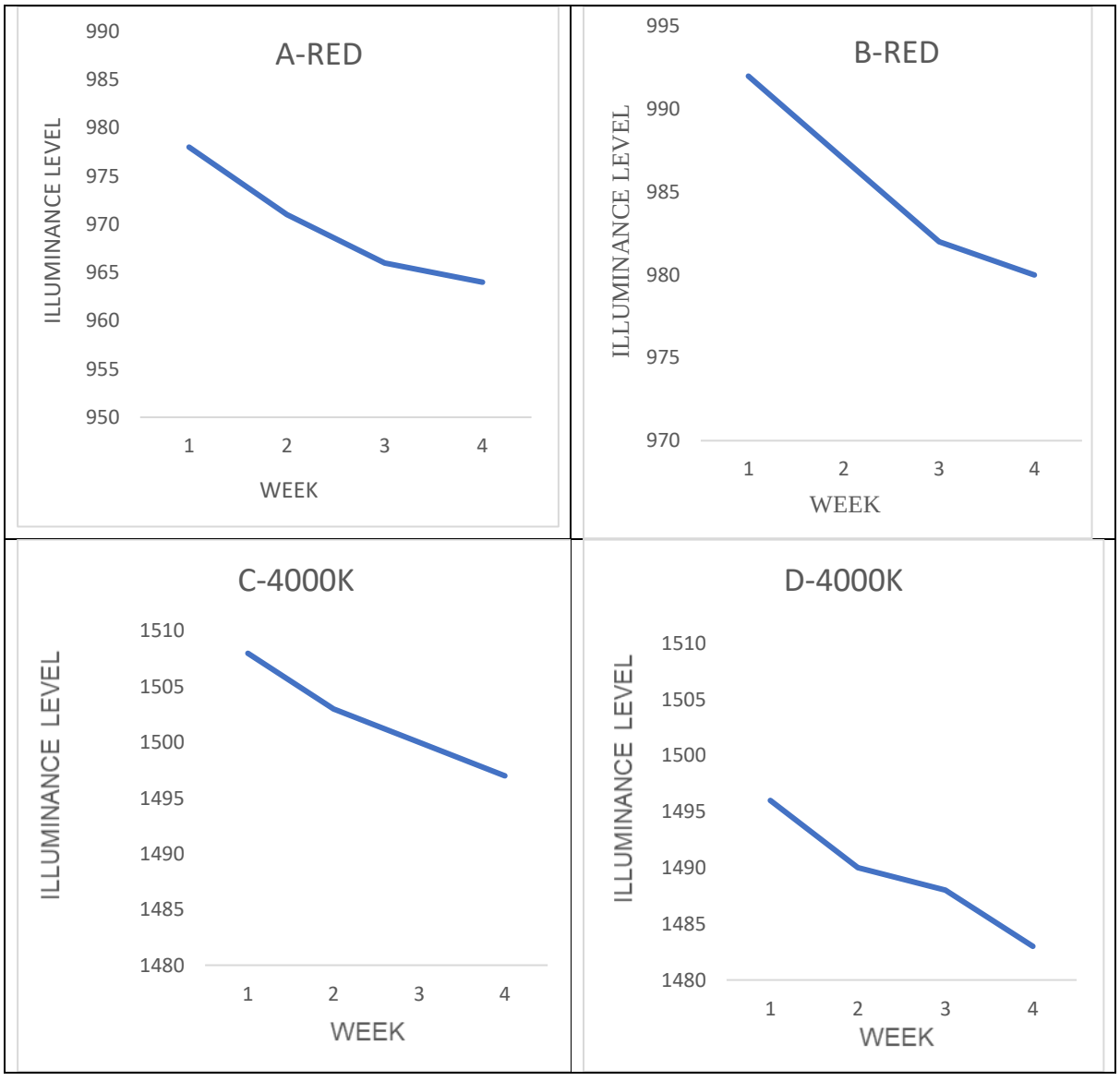
SEQUENCE OF EVENTS FOR THE PRESENT INVESTIGATION

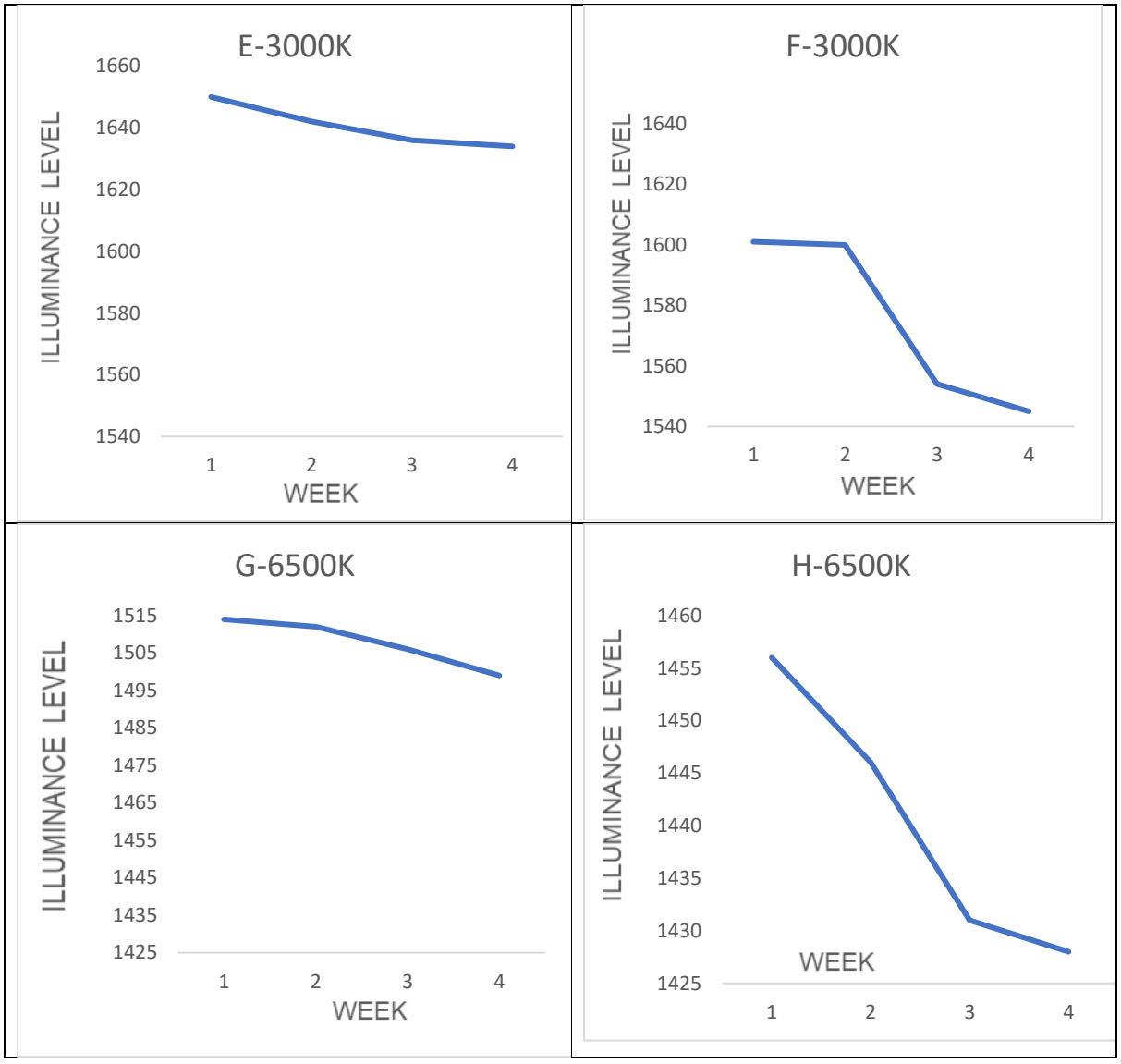
At the onset of the experiment some preliminary work was done for smooth running of the experiment. It includes the design of the set-up where the mice would be kept for next 108 days.

Fig 17 - Timer used in the experiment aligned with warm white light 4000K switched on from 12:00am to 8:00am

The maximum decrease of 3.5% is visible in graph D; on an average light depreciation is negligible for all other types.

GRAPH


A-RED
ILLUMINANCE LEVEL
990
985
980
975
970
965
960
955
950
1
2
3
4
WEEK
B-RED
ILLUMINANCE LEVEL
995
990
985
980
975
970
1
2
3
4
WEEK
C-4000K
ILLUMINANCE LEVEL
1510
1505
1500
1495
1490
1485
1480
1
2
3
4
WEEK
D-4000K
ILLUMINANCE LEVEL
1510
1505
1500
1495
1490
1485
1480
1
2
3
4
WEEK



So within first 45 days, all the above work along with the acclimatization of the mice was accomplished.

Along with the acclimatization, the food and water intake of the mice were noted in the first 45 days so as to give them food as per the observational trend and this amount of food and water was continued for the next three months i.e throughout the experiment. From the 46th day , all the readings for the pharmacological parameters were recorded on weekly basis.

PHARMACOLOGICAL PARAMETERS

1. Change in body weight.
2. Change in Spontaneous motility.
3. Time spent in open and closed side of elevated plus maze.
4. Change in the amount of faeces each day.
5. Change in the amount of left over food .
6. Change in the amount of water intake.

A routine was followed for three months (1 month for getting the data before subjecting to different light condition and 2 months while exposing to artificial and natural lights) so that a diurnal variation can be minimised. The routine was per the given Table-4.2. From 76th day the mice were subjected to different light condition.[6]

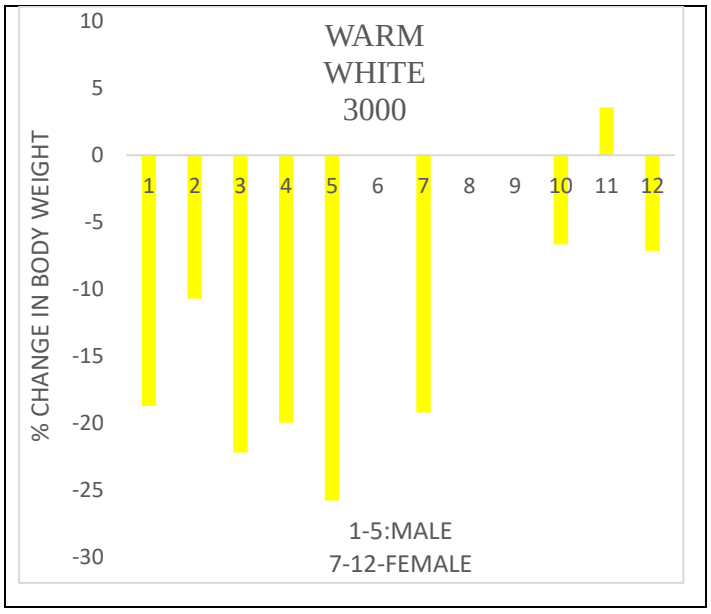
CHAPTER 5:

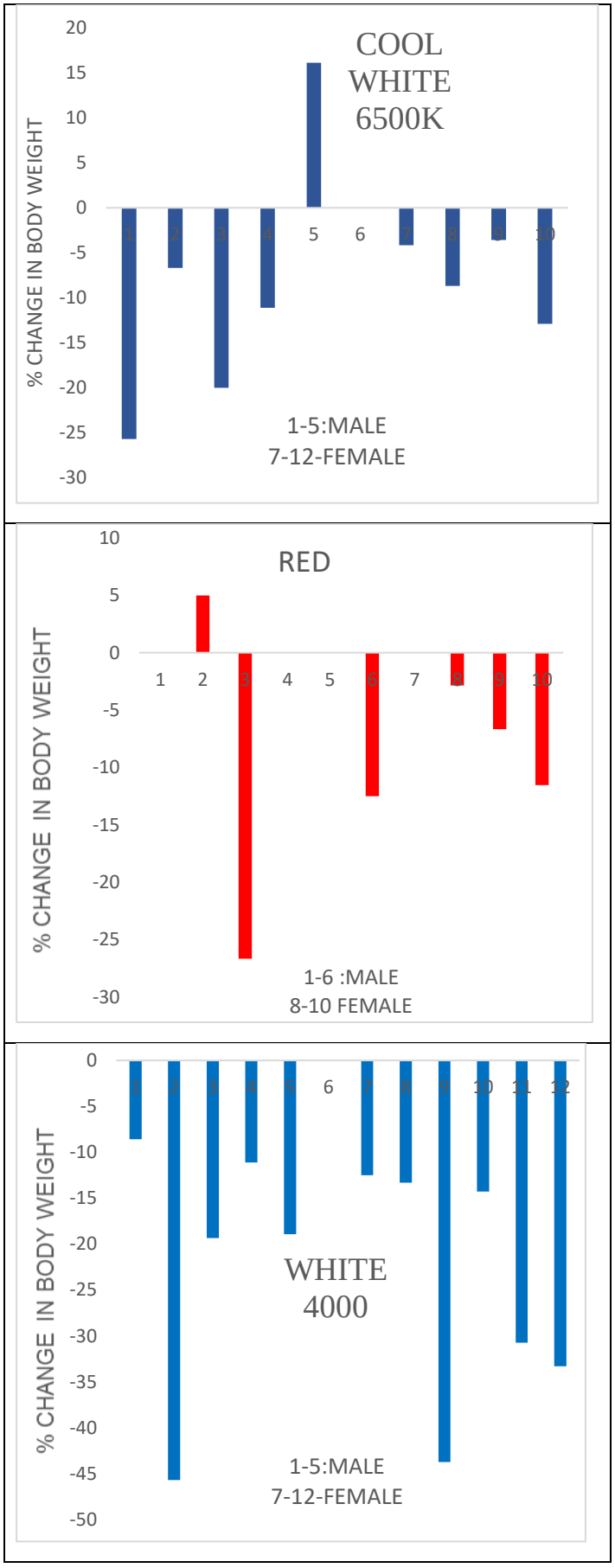
RESULTS & DISCUSSION

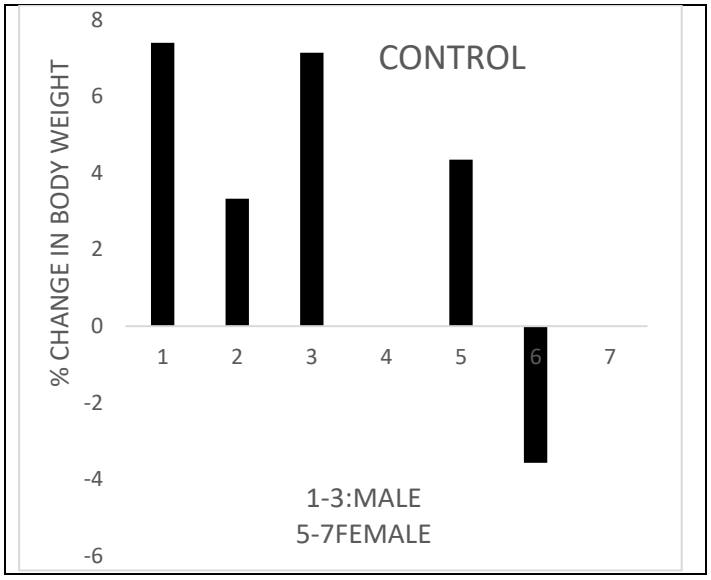
The result of all the light condition and the control group are given in the form of a chart in which the x -axis represent the male and female mice and the y-axis represent, % change of the parameters. The discussion is given by the help of short explanation beside the corresponding chart.

PARAMETER- BODY WEIGHT (chart-1)

CHART-1

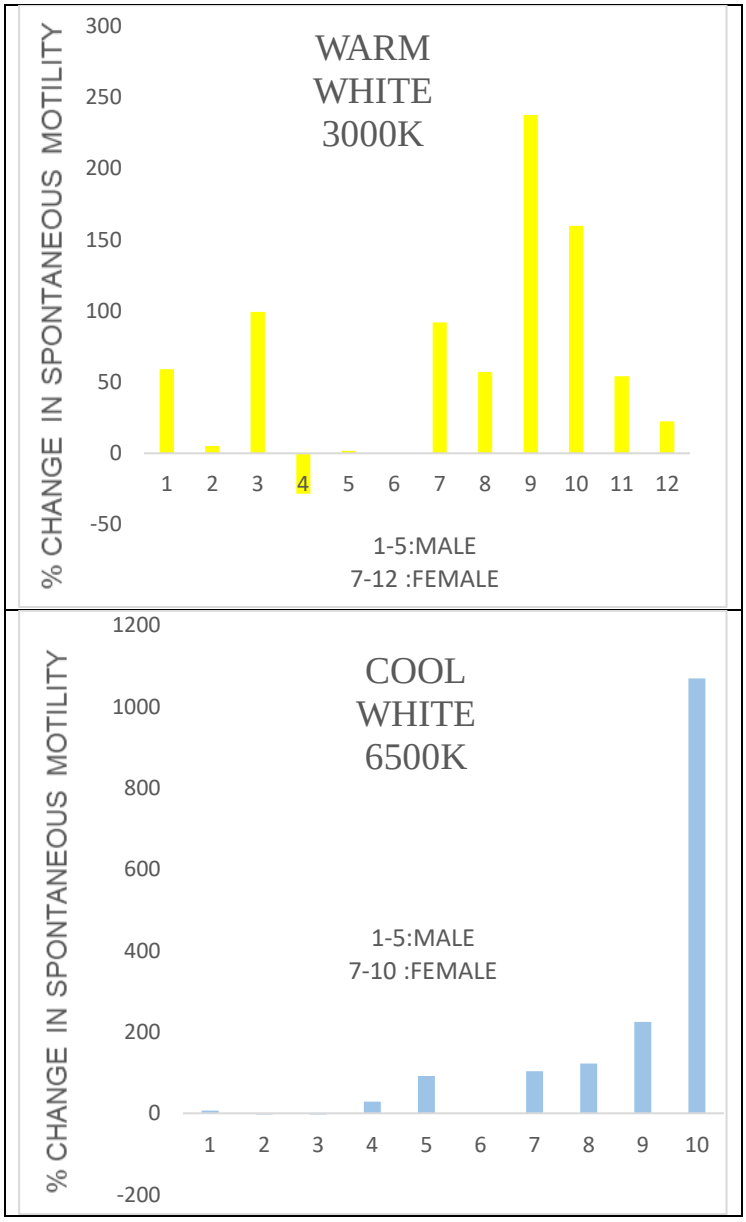


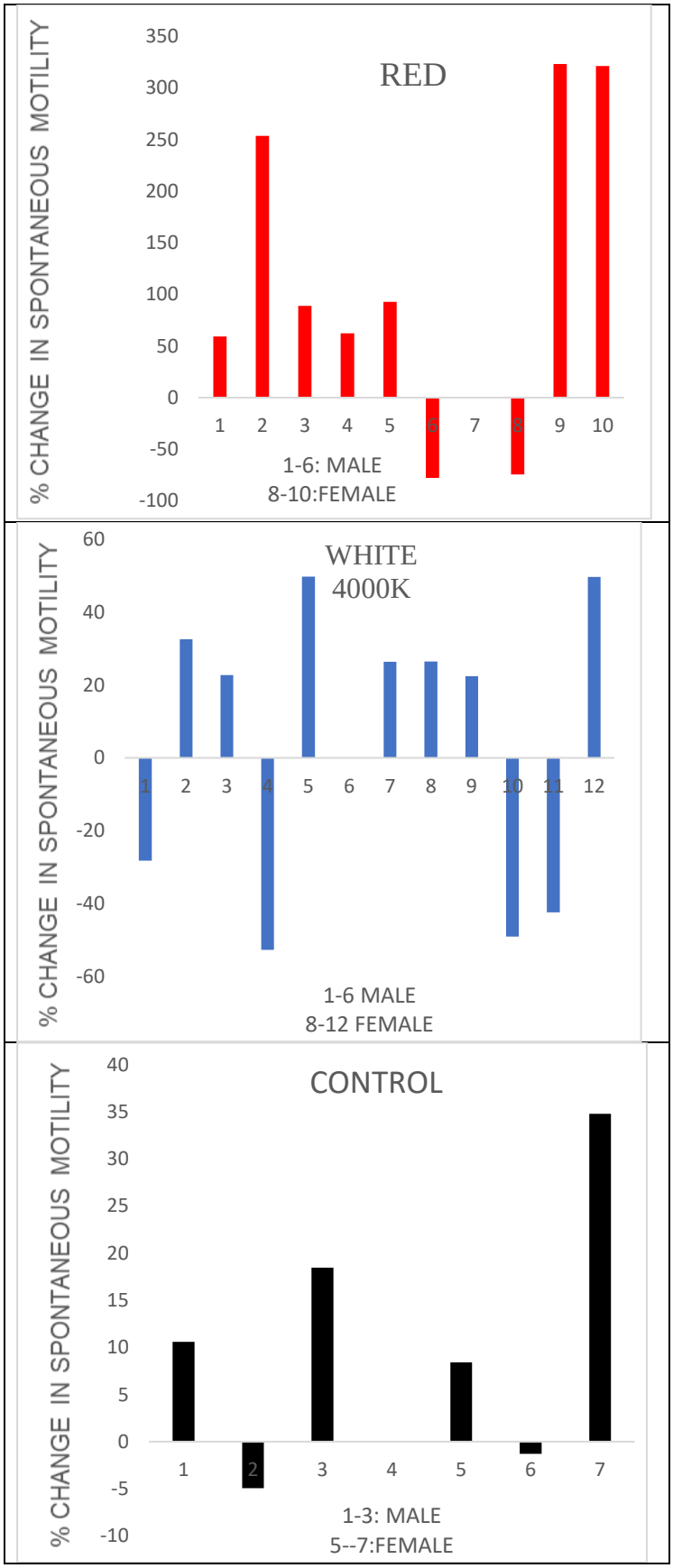

COOL
WHITE
6500K
% CHANGE IN BODY WEIGHT
20
15
10
5
0
-5
-10
-15
-20
-25
-30
1
2
3
4
5
6
7
8
9
10
1-5:MALE
7-12-FEMALE
RED
% CHANGE IN BODY WEIGHT
10
5
0
-5
-10
-15
-20
-25
-30
1
2
3
4
5
6
7
8
9
10
1-6 :MALE
8-10 FEMALE
WHITE
4000
% CHANGE IN BODY WEIGHT
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1
2
3
4
5
6
7
8
9
10
11
12
1-5:MALE
7-12-FEMALE


CONTROL
% CHANGE IN BODY WEIGHT
8
6
4
2
0
-2
-4
-6
1
2
3
4
5
6
7
1-3:MALE
5-7FEMALE

PARAMETER-% CHANGE IN SPONTANEOUS MOTILITY (chart -2)

CHART-2 :

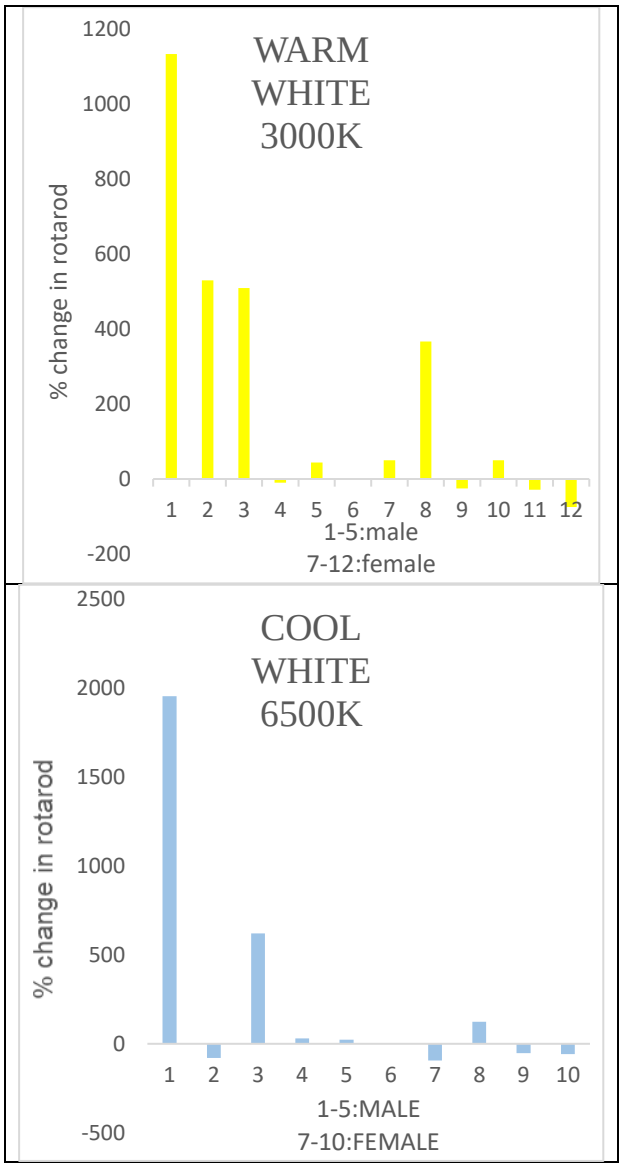


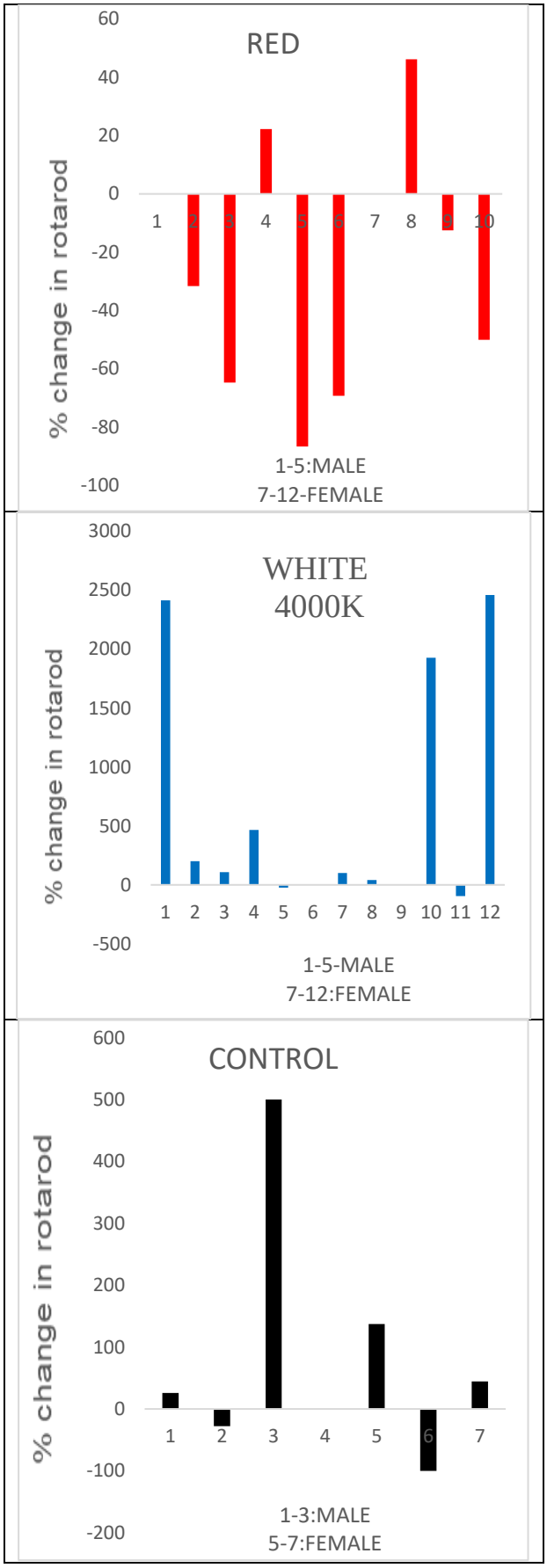

RED
% CHANGE IN SPONTANEOUS MOTILITY
350
300
250
200
150
100
50
0
-50
-100
1 2 3 4 5 6 7 8 9 10
1-6: MALE
8-10:FEMALE
WHITE
4000K
% CHANGE IN SPONTANEOUS MOTILITY
60
40
20
0
-20
-40
-60
1 2 3 4 5 6 7 8 9 10 11 12
1-6 MALE
8-12 FEMALE
CONTROL
% CHANGE IN SPONTANEOUS MOTILITY
40
35
30
25
20
15
10
5
0
-5
-10
1 2 3 4 5 6 7
1-3: MALE
5--7:FEMALE

++

PARAMETER- % CHANGE IN TIME SPENT IN BALANCING ROTAROD (chart-3)

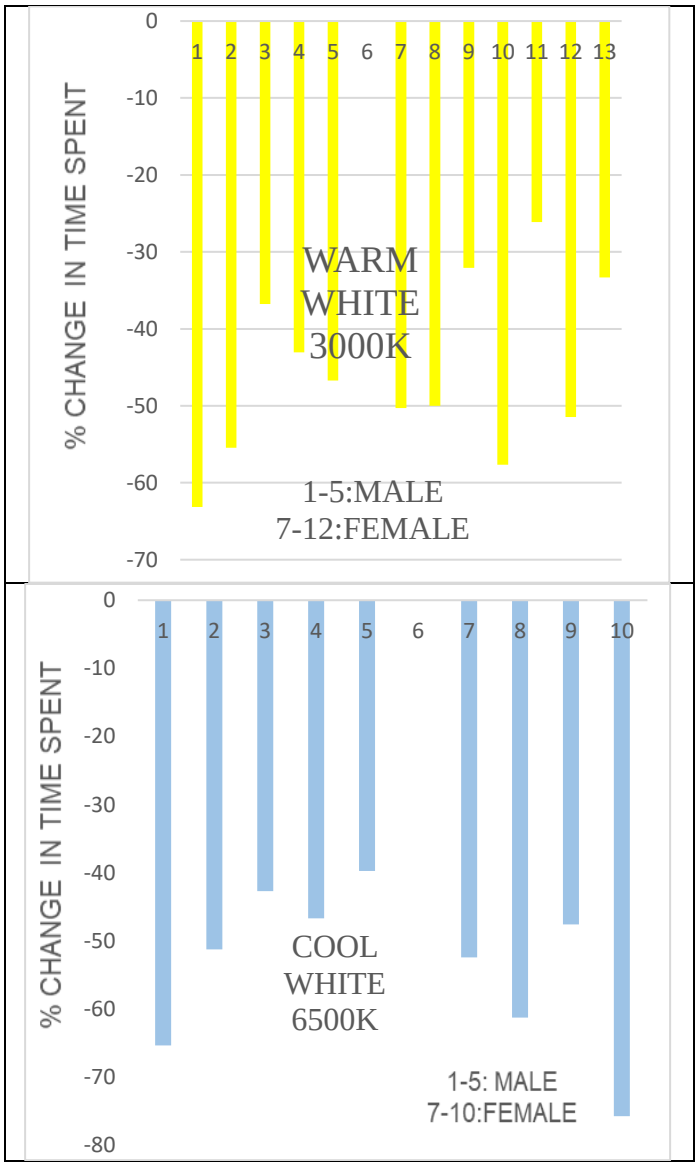
CHART-3:

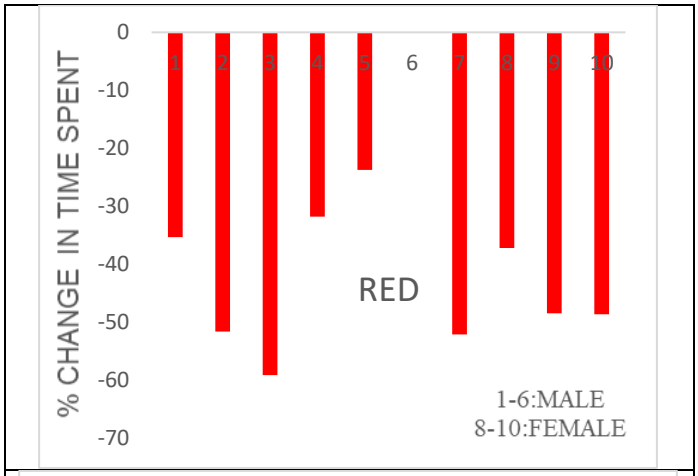


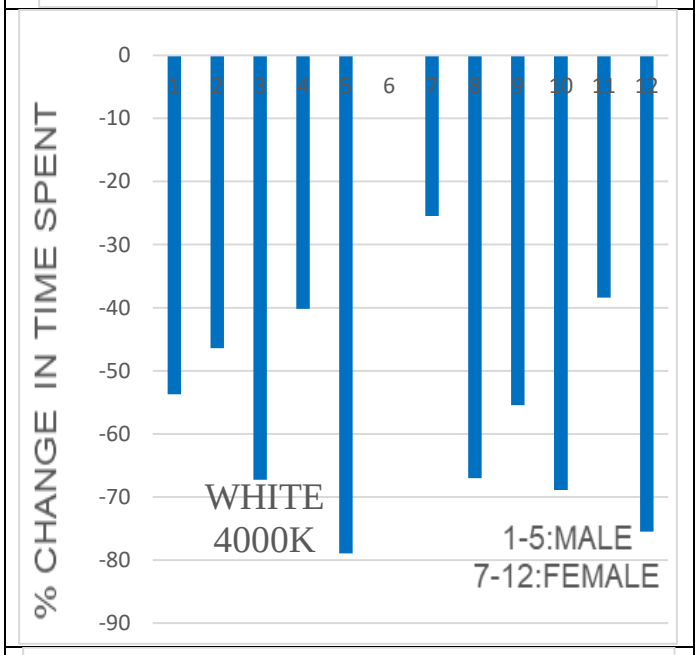

RED
% change in rotarod
60
40
20
0
-20
-40
-60
-80
-100
1 2 3 4 5 6 7 8 9 10
1-5:MALE
7-12-FEMALE
WHITE
4000K
% change in rotarod
3000
2500
2000
1500
1000
500
0
-500
1 2 3 4 5 6 7 8 9 10 11 12
1-5-MALE
7-12:FEMALE
CONTROL
% change in rotarod
600
500
400
300
200
100
0
-100
-200
1 2 3 4 5 6 7
1-3:MALE
5-7:FEMALE

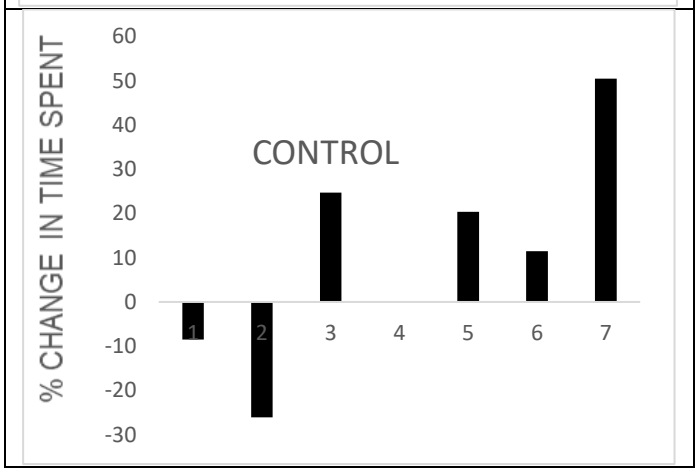
PARAMETER - % CHANGE IN RETENTION TIME OUT OF 180 SECONDS ON OPEN END OF ELEVATED PLUS MAZE OF MALE (chart-4)

CHART – 4



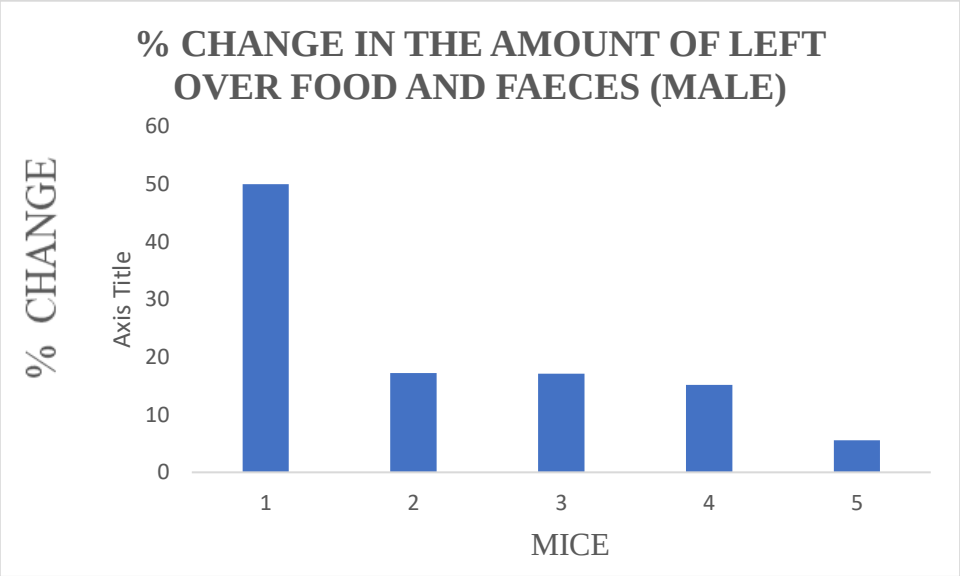

% CHANGE IN TIME SPENT
0
-10
-20
-30
-40
-50
-60
-70
1
2
3
4
5
6
7
8
9
10
RED
1-6:MALE
8-10:FEMALE


% CHANGE IN TIME SPENT
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
6
7
10
11
12
WHITE
4000K
1-5:MALE
7-12:FEMALE


% CHANGE IN TIME SPENT
60
50
40
30
20
10
0
-10
-20
-30
1
2
3
4
5
6
7
CONTROL

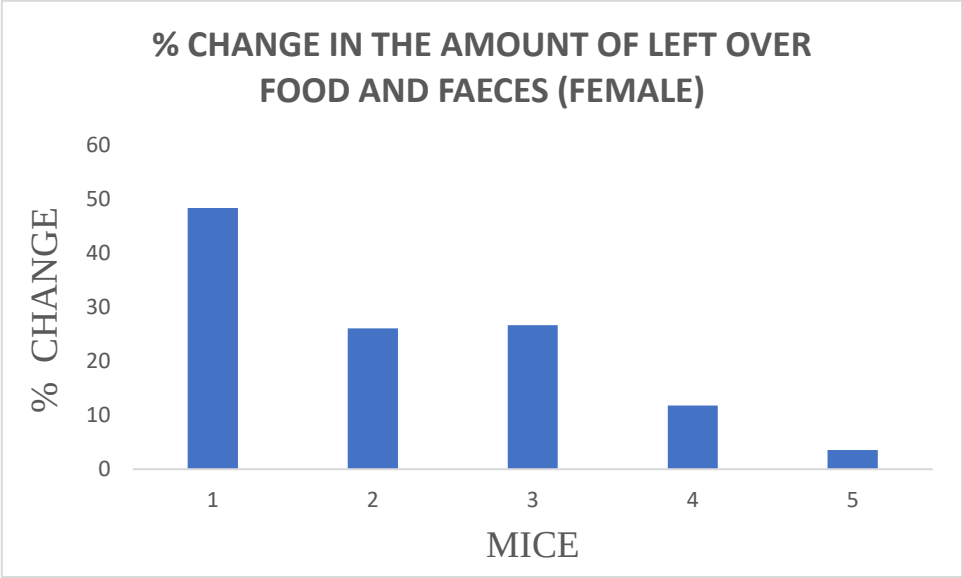
PARAMETER - % CHANGE IN THE AMOUNT OF LEFT OVER FOOD AND FAECES IN MALE (chart-5)

CHART-5



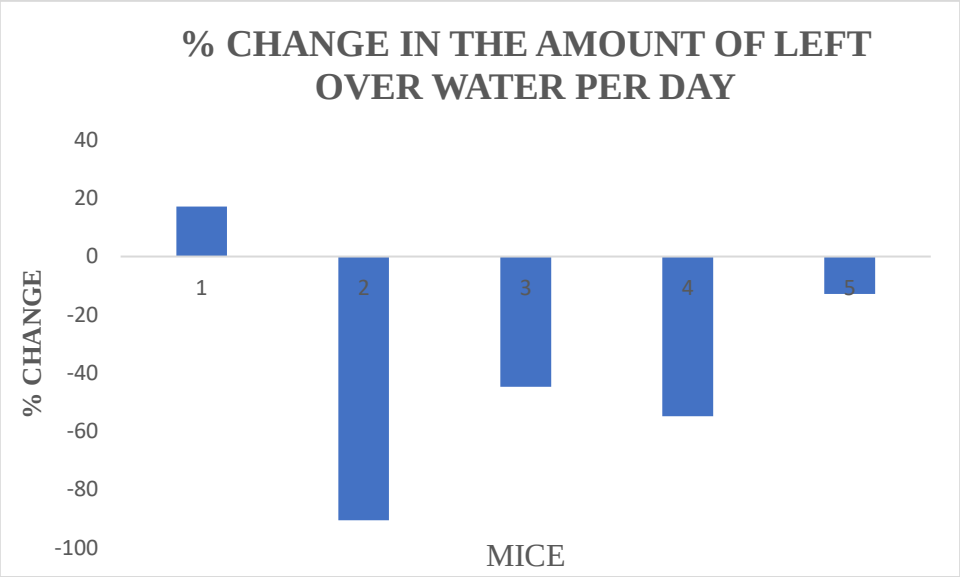
PARAMETER - % CHANGE IN THE AMOUNT OF LEFT OVER FOOD AND FAECES IN FEMALE (chart-6)

CHART-6



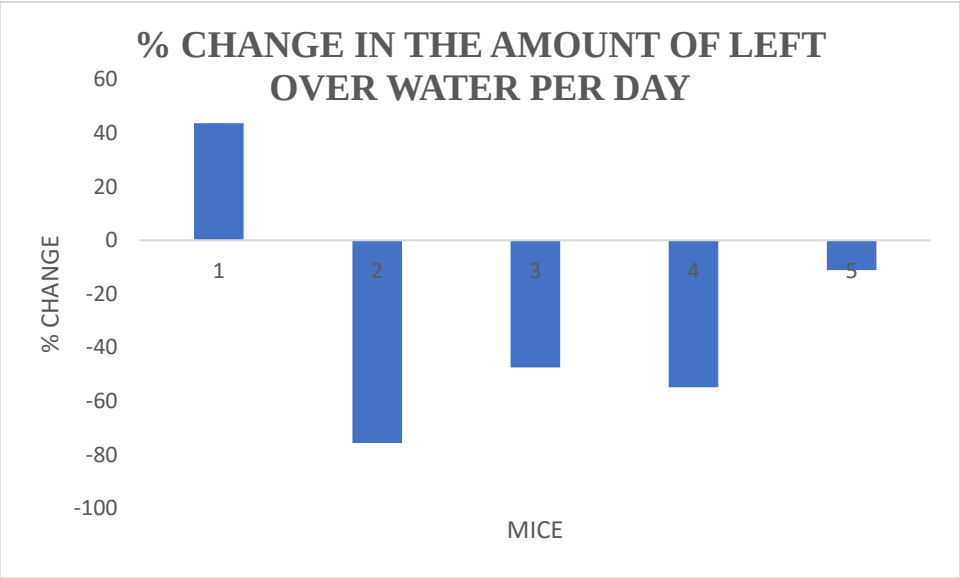
PARAMETER - % CHANGE IN THE AMOUNT OF LEFT OVER WATER FROM MAXIMUM TO MINIMUM PER DAY IN MALE MICE (chart-7)

CHART-7



PARAMETER - % CHANGE IN THE AMOUNT OF LEFT OVER WATER PER DAY IN FEMALE MICE (chart-8)

CHART-8



Chapter 6

CONCLUSION

It was observed that exposure to the artificial ambient light showed a gradual decrease in body weight .It will be important to mention that food intake of these animals also showed a gradual decrease under above condition.Therefore the reduction in body weight and its relation with reduced food intake might be co-related .however water intake was observed to increase over the period of experimentation.

From another view of the parameter spontaneous motility , the animal under the effect of ambient light showed a gradual increase which might have a co-relation to elevated alertness and anxiety in particular . In continuation with the statement it will be much relevant to mention that data of elevated plus maze indicates, a gradual increase in tendency of the animal with either sexes to retain at the closed end sparing the open end , this particular behaviour was generally believed to be associated with enhanced anxiety leading to fear psychosis .[7]

Similarly experiment with light dark box, revealed a gradual shift from light box to dark box with progress of time. This again might be due to above mention psychopharmacological reasons of anxiety and fear.

Animals showed increased retention time on rotarod being exposed to the artificial light, although animals kept under red light showed lower retention of rotarod.

Finally to conclude, effect of ambient light was clearly visible, so far the physiological parameters of the experimental animals are concerned, although the lack of a comprehensive statistical significance in these finding cannot be ignored.

Chapter 7

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7. Franz, Lauren, et al. "Stigma and treatment delay in first-episode psychosis: a grounded theory study. Early intervention in psychiatry" 4.1 (2010): 47-56.