Journal of Ecobiotechnology 2012, 4(1): 51-53
ISSN: 2077-0464
Available Online: http://journal-ecobiotechnology.com/

Journal of Ecobiotechnology

Evaluation of the effect of solar radiations on the growth of potential water borne and food borne pathogens during solar eclipse

Bhute Shrikant S[1]*, Kukreja Girish P.[1], Talek Shaikh[2] , Prashant Katke[3], Amar Swami[3], Pratik More[3] and Priyank Nimje[4]

[1] Department of Microbiology, New Arts, Commerce and Science College, Ahmednagar-414002, Maharashtra, India.
[2]Department of Biotechnology, New Arts, Commerce and Science College, Ahmednagar-414002, Maharashtra, India.
[3] Department of Biotechnology, Ferguson College, Pune-414002, Maharashtra, India.
[4] Department of Environmental Science, University of Pune, Pune -411007, Maharashtra, India

Abstract

On new moon day when Moon passes between Earth and Sun solar eclipse can be seen from Earth. Although solar eclipse is a fascinating astronomical event, even in today's fast, modern and civilized life, people have not been able to go away with superstitious beliefs related to outer space activity behind solar eclipse. These misbelieves eventually lead to great socio-economic losses due to discarding of cooked food and drinking water that was exposed to the eclipse directly or indirectly. So considering these misbelieves a study was conducted to see possible biological effects of solar radiations during solar eclipse on bacteria responsible for water borne and food borne diseases. *E. coli, S. aureus, B. subtilis, S. typhi,* which are known water and food borne pathogens, were exposed to solar radiations throughout the eclipse period. The effect of these radiations on the survival and growth rate of these organisms was assessed by suitable method and compared with that on control day. When such comparison was made, it indicated that there was no statistically significant effect of solar eclipse on the survival and the growth rate of these organisms. Hence, we insist dumping the cooked food or drinking water after solar eclipse should be avoided.

Keywords: Solar eclipse, misbelieves, pathogens, survival, growth rate.

INTRODUCTION

The solar eclipse is viewed from some location on Earth, on new moon day when the Moon passes between the Sun and the Earth [1]. The solar eclipse of January 15, 2010 was an annular eclipse of the Sun with a magnitude of 0.9190. It was the longest eclipse of the millennium with length of 11 min 08 s. It was seen as annular within a narrow stretch of 300 km width across Central Africa, Maldives, South Kerala, South Tamil Nadu, North Sri Lanka, Burma and China. The best location in India lied between *Kodandaramar* Temple islet and *Dhanushkodi* (*Rameshwaram*), which falls on the central line of the Eclipse.

Solar eclipses are always an event of enthusiasm and excitement for amateur astronomers, astrologists and also to the layman. There are many misbelieves in the minds of layman about the solar radiations during eclipse. People from many countries including India, believe that during solar eclipse the number of germs increase and therefore no food is eaten or cooked during the event, and any cooked food before the eclipse is discarded considering it as impure. Although there are no statistical evidences, only in India, tons of cooked food and gallons of drinking water are discarded on the day of solar eclipse. This leads to socio-economic losses in the country.

Many studies indicate that both UV and/or visible solar radiations can negatively affect metabolism of many bacterial species [2]. The present study aimed at assessment of bacterial growth during eclipse; two representative organisms of each Gram positive and Gram negative group of bacteria, known to cause water borne and food borne diseases were selected for the study. The study included analysis of survival of bacteria on control and eclipse day. It also included study of growth rate; as increased number of bacteria themselves or the secondary metabolites and/or toxins produced by them are responsible for food spoilage.

MATERIALS AND METHODS

The eclipse at location of study

The study was carried out at *Killakarai*, District *Rameshwaram*, *Tamilnadu*, India. The eclipse started with first contact at 11.14 am and ended with fourth contact at 03.08 pm. The total duration of eclipse was 03 hrs and 52 min with annular phase of 10.00 min between 01.20 pm to 01.30 pm.

Microorganisms used

Standard cultures of microorganisms known to cause water borne or food borne diseases were procured from NCL, Pune and were used in the present study. These included *E. coli* (NCIM-2341), *S. typhimurium,* (NCIM-2501), *S. aureus* (NCIM 2079) and *B. subtilis* (NCIM 2063). The cultures were taken to the location of study in lyophilized state and were revived at the time of study.

Received: Nov 18, 2011; Revised: Dec 20, 2011; Accepted: Jan 18, 2012.

*Corresponding Author

Bhute Shrikant S
Department of Microbiology, New Arts, Commerce and Science College, Ahmednagar-414002, Maharashtra, India.

Tel: +918421262953; Fax: +91-0241-2324024
Email: shrikantbhute@gmail.com

Experimental design for quantitative analysis of bacterial survival and statistical analysis

The four test organisms were revived and a 24 hr old culture of each organism was prepared. These culture broths were then centrifuged at 6000 rpm for 10 min. The collected biomass was suspended in the control saline and the turbidity of the suspensions was adjusted to 0.5 Mc Farland standard. The experiment was conducted for two days, on the day of solar eclipse and a day before eclipse considering it as control day. On both the days the initial CFU/ml of each test organisms was estimated by the plate count method using spread plate technique. Then the suspensions were exposed to solar radiations for the duration of four hrs. On both the days the exposure time was between 11.00am to 03.00pm (which corresponded to the duration of eclipse on the eclipse day at the site of study). After exposure, final CFU/ml of each test organism was determined as above. For each test organism the experiment was repeated five times on both the days. On both the days, the survival of each organism was evaluated by comparing the mean values of CFU/ml of each organism before and after exposure to solar radiations. The significance of the difference was analyzed by applying two tailed t-test for paired samples. To determine whether solar radiations on eclipse day have any effect on the survival of test organisms; the mean values of the differences in CFU/ml of the organisms before and after exposure on the ordinary and eclipse day were calculated. The significance of these differences was compared by applying two-tailed t-test for unpaired samples.

Experimental design for measurement of bacterial growth rate and generation time

This experiment was conducted on two days, on the day of solar eclipse and control day. The cultures of test organisms were revived and a 24 hr old culture of each organism was prepared and 1 ml cultures were transferred to separate 100 ml sterile nutrient broths. These inoculated broths were then exposed to the solar radiations for a period of three hrs. During exposure samples were withdrawn under aseptic conditions at the interval of 30 min, CFU/ml was determined in triplicates and mean values of CFU/ml were used to estimate growth rate of each test organism. Growth rate and generation time were calculated using following formula

$$k = \frac{\mathrm{Log(N2) - Log(N1)}}{0.301 \times t}$$

$$tgen = \frac{1}{k}$$

Where N_2 = CFU/ml at time t_2 and N_1 = CFU/ml at time t_1, *k* is growth rate and *tgen* is generation time.

Measurements of temperature and humidity

Variations in temperature and humidity during eclipse day were monitored using dual channel temperature data logger (T log 2, Tiny Tag). The data logger was placed at the site where the samples were exposed to solar radiations. Temperature and humidity data were recorded at the interval of five min.

RESULTS

Bacterial survival

Apparent reduction in the number of bacteria was observed, on both control and eclipse day after exposure to solar radiation. When differences of mean values CFU/ml (before and after exposure) were compared, it revealed that there was no significant ($p < 0.05$) difference in the reduction of bacteria on control and eclipse day (Table 1).

Table1. Mean values of CFU/ml x 10^7 (n=5) of all four-test organisms on both, control and eclipse day, before and after exposure to solar radiations.

Day	Test organisms							
	E. coli		*S. typhimurium*		*S. aureus*		*B. subtilis*	
	Before	After	Before	After	Before	After	Before	After
Control	59.6	52.0	56.8	52.2	59.6	57.8	54.6	44.8
Eclipse	67.6	57.8	52.8	57.2	61.2	53.2	54.6	43.4

Growth rate and generation time

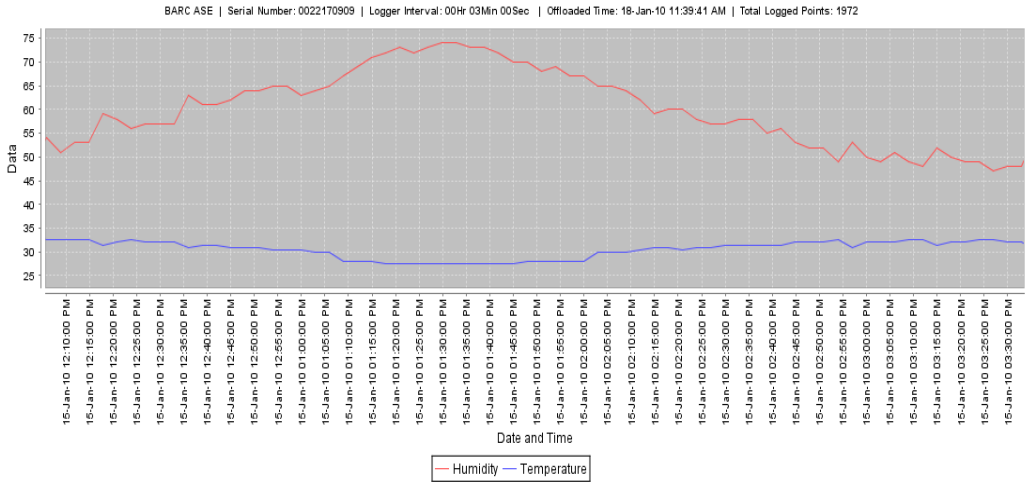
Comparison of growth rate and generation time revealed that none of them changes significantly on control and eclipse day for all test organisms (table 2).

Table 2. Growth rate (generation/hr, k) and generation time (min, t_{gen}) of test organisms.

Day	Test organisms							
	E. coli		*S. typhimurium*		*S. aureus*		*B. subtilis*	
	K	t_{gen}	K	t_{gen}	K	t_{gen}	K	t_{gen}
Control	2.027	29.60	1.362	44.03	1.746	34.34	0.834	71.93
Eclipse	2.139	28.04	1.291	46.46	1.707	35.12	0.879	68.19

Temperature and humidity

Following graph indicates variation in temperature and humidity on eclipse day. It can be seen from the graph, temperature fell during the annular phase of eclipse with simultaneous increase in humidity.



DISCUSSION

Our study focused on survival and growth rate analysis of microbes, potentially responsible for food and water spoilage. It included two representative organisms of Gram-positive bacteria, *S. aureus* (NCIM 2079) *B. subtilis (*NCIM 2063) and two of Gram-negative bacteria, *E. coli* (NCIM-2341)*, S. typhimurium,* (NCIM-2501). Earlier published results of S. K. Banrjee and S.N. Chaterjee [3] on *E. coli* K-12 4401(wild type) and AB2480 *uvr* A and *rec* A mutant, indicated that killing of bacteria is enhanced during solar eclipse, although the killing was not due to the sunlight induced photoproducts of tryptophan. In contrast to this in the present study no difference in the reduction of bacteria was observed during the control and eclipse day. The reduction in the number of bacteria before and after exposure on the eclipse day seems to be more than that on the control day. But the statistical analysis of the data using *t* test revealed that this difference was not significant. This may be because most of the part of Sun is covered at the time of eclipse and amount of cosmic radiations significantly decreases during this period as indicated by R. Bhattacharya *et al* [4].

Assessment of growth rate and generation time shows that they do not vary on control day and eclipse day. This excludes the possibility that bacteria are outnumbered on eclipse day; hence the possibility that bacteria themselves or toxin produced by them is leading to food spoilage or that some unknown mechanism enhances the growth of bacteria on eclipse day.

During the eclipse day significant increase in the humidity was observed which might favor the growth of bacteria but the consistent results were not obtained. This may be because there was simultaneous fall in the temperature, which has negative effect on bacterial growth. These factors do not show pronounced effect on bacterial growth, since the time for which these altered conditions persisted was too short to affect bacterial growth.

In conclusion, present study puts down the myth that solar eclipse leads to enhancement of bacterial growth and hence possibilities of microbial food spoilage are negligible. Thus, the traditional practice of discarding the cooked food or drinking water after solar eclipse should be prohibited.

ACKNOWLEDGEMENT

Authors are thankful to Mr. Dinesh Nisang, President, *Bhaskaracharya Astronomy Research Centre* Dist. Ahmednagar, Maharashtra for providing the funds. Authors are also thankful to the principal New Arts, Commerce and Science College for granting permission to carry out the work and Thassim Beevi Abdul Kadir College for women, *Killakarai*, Dist. Rameshwaram, Tamilnadu for providing the necessary infrastructure to carry out the research work.

REFERENCES

[1] Littmann, Mark; Fred Espenak, Ken Willcox, 2008, *Totality: Eclipses of the Sun*. Oxford University Press. pp. 18–19.

[2] Sudarat Chadsuthi, Jirasak Wong-ekkabut, Wannapong Triampo, Galayanee Doungchawee and Darapond Triampo , 2010, Comparison of the effects of UV-A radiation on *Leptospira interrogan* serovar Bataviae, Canicola and Pomona, *African J Biotechnol.,* Vol. 9(21), pp. 3196-3206.

[3] S.K. Banarjee, S. N. Chaatterjee, 1983, Killing of bacteria during solar eclipse and its biological implications, *Radiation and environmental biophysics,* 22: 235- 238.

[4] R. Bhattacharya, M. Roy, M. Biswas, R. Guha and A. Bhoumick, 2009, Cosmic ray intensity and surface parameters during solar eclipse on 22 July 2009 at Kalyani in West Bengal, *Current Science,* Vol. 98, No. 12.