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Survival of Plants Seeds and Bacteria in a Picosatellite Sent to the Stratosphere

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Summary- The theory that life on planet Earth is based on the fact that plant seeds and prokaryotes have shown the ability to survive extreme environmental conditions. The objective of this research was to analyze the survival of plant seeds and genera of probiotic bacteria released in a picosatellite to the atmosphere. In that sense seeds of *Beta vulgaris* (beet), *Lactuca sativa* (lettuce), *Solaneum lycopersicum*, as well as probiotics *Lactobacillus plantarum, Leuconostoc lactis, Bifidiobacterium citreum*, were prepared in petri dishes and placed in a container of a picosatellite sent from the city of Morelia, Michoacan, Mexico: the seeds were germinated and the probiotic bacteria were evaluated before and after of the trip by the picosatellite, the experimental data were analyzed by ANNOVA-Tukey. The results indicated that only survival the seeds of *B. vulgaris* as well as the genera of *La. plantarum* and *Le. lactis*. This shows that in seeds and bacteria there are mechanisms that prevent the death of both in extreme conditions of the stratosphere.

Keywords: *extreme physical conditions, life. latency, prokaryote.*

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Strictly as per the compliance and regulations of:

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I. Introduction

There is a theory that the origin of life on planet Earth comes from outer space, at the same time it has been shown that genetically both plants and microorganisms on this planet have information that allows them to survive extreme conditions of temperature, pressure, UV radiation and other that they prevent it (Rothchild and Mancinelli, 2001; Beck-Winchatz and Bramble, 2014; Coleman and Mitchell, 2014; Caro et al., 2019; Antunes, 2020; DasSarma et al., 2020; Diez et al., 2020;). The foregoing is supported by the response of both life lines subjected to such conditions (Berry et al., 2010) in addition to the research known as exobiology that endorses it with tests of seeds and microorganisms launched into the stratosphere by means of spikes and nanosatiles (Murcray et al., 1969; Coleman and Mitchell, 2014; Caro et al., 2019). The objective of this research was to demonstrate the survival capacity of seeds of *Beta vulgaris, Lactuca sativa, Solanum lycopersicum, Bifidiobacterium citreum, Lactobacillus plantarum and Leuconostoc lactis* in a Picosatellite trip to the stratosphere.

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II. Material and Methods

a) CanSat-type picosatellite

The biological samples were sent to stratosphere in CanSat-type picosatellite was made by students of directed by Dr. Edgar Cárdenas-Escamilla from Engineering Electronic. National Technology of Morelia, Morelia, Michoacan, México. Have three prefabricate printed circuit board. The sensor board has two analogues sensors, one pressure sensor to calculate the altitud of the CanSat. Also, to program the processor board to handle data the transmission frecuency is adjusted in the program and container with two Petri dishes containing plant seeds and bacterial samples that were exposed to direct stratospheric environmental conditions (Smith et al., 2014; Smith and Sowa, 2017).

The CanSat picosatellite was launched on February 20 of 2020 at 11 am from Morelia, capital of State of Michoacan, México (video playback https://youtu.be/ICQQFuayN2w). The balloon ascended for 2.5 h to a mean float altitude of 38.2 km where it remained for 4 h, followed by a 35 min parachute descent, at Ciudad Hidalgo, Michoacan, México landing at 97 km from Morelia at the northwest of the launch site 19◦42 north latitude I00◦33. The sample exposure began during the ascent to 21.4 km with the opening of the Trex-Box shutter at 1521 UTC and ended 6 h and 10 min later with the closing of the Trex-Box shutter during the descent to 22.0 km at 2040 UTC. To evaluate the effect of the environmental conditions: 20-25km high, -70ºC, 10-12% relative humidity; 0.0042, including the UVB radiation estimated total of 1148kJ m^{-2} of UVA. The CanSat was transferred from Ciudad Hidalgo to Morelia for 1.50 minutes, but the petri dishes with plant seeds and bacteria in a container with ice at 5oC to measure the viability of both, plant seed and bacteria at the stratosphere on the viability of seeds of *B. vulgaris* (beetroot), *S. lycopersicum* (tomato), and *L. sativa* (lettuce). A viability test was performed before and after (Saruyama and Tanida, 1995), being sent to the stratosphere on the CanSat 6 picosatellite (Beck-Winchatz and Bramble, 2014; Caro et al., 2019). As well as the genera and species of probiotic bacteria isolated from natural yogurt: *B. citreum, La. plantarum, Le. lactis* by viable plate count in nutrient agar (g/L): 10.0, glucose; 5.0, casein peptone; 1.0, yeast extract; 18.0, bacteriological agar, the concentration of each was reported as colony- forming units per ml (Smith et al., 2014).

Table 1: Percentage of germination of *Lactuca sativa, Solanum lycopersicum and Beta vulgaris* at solarium and sent to the stratosphere

Seed+	Germination percentage (%)	
	In solarium	sent to the stratospher4
Solanum lycopersicum	96.66[a*]	0.0[b]
Lactuca sativa	90.33[b]	0.0[b]
Beta vulgaris	96.66[a]	46.6[a]

*+n=4 *values with different letters had a statistical difference ($P<0.05$) according to ANOVA-Tukey*

III. Results and Discusion

Table 1 shows the survival of 46.6% of the *B. vulgaris* seed in the picosatile at the environmental conditions of the stratosphere 25 km high at a temperature of -60 C as well as UV radiation and cosmic rays for a interval between 2 hours before declining, it is possible that the type of crioprotector, combined with the relatively short time of exposure to these conditions, favored the survival of the *B. vulgaris* seed in contrast to the total loss of viability of the *L. sativa* seeds. and *Solaneum lycopersicum* (Saruyama and Tanida, 1995; Wang et al., 2018) compared to the high viability of all seeds under controlled conditions of temperature 25 C in the absence of light and normal atmospheric pressure in a terrestrial environment.

Table 2 shows the survival of the genera and species of probiotic bacteria *B. citreum* that, launched in the satellite peak into the stratosphere, did not survive in that environment, in contrast, *La. plantarum* of the original total exposed survived 3%, while *Le. lactis* reach 6.9%. It is possible that the cryoprotectants that they possess as well as the DNA repair enzymes have prevented the death of these probiotics based on the relatively short time in which they were exposed (Berry et al., 2010; Smith and Sowa, 2017 DasSarma et al., 2020).

Table 2: Survival of *Bifidiobacterium citreum, Lactobacillus plantarum* and *Leuconostoc lactis* sent to the stratosphere

Probiotic strain tested	Probioctic strain (control)	Sent to stratosphere
	Bacteria UFC X10^7	Bacteria UFC X 10^6
Absolute control (AC)	0[c*]	0[b**]
Lactobacillus plantarum	263[a]	102[a]
Bifidobacterium citreum	107[b]	0[b]
Leuconostoc lactis	133[b]	92[a]

+n=4, values with different letters had statiscally difference ($P<0.05$) according ANOVA-Tukey*

III. Conclusion

Experimentation with picosatellites launched into the stratosphere containing plant seeds and probiotic genera and species that do not produce spores are a model for the survival of life on Earth despite adverse conditions. What can help the understanding of diseases in humans, plants and animals that are dispersed by the wind in the different environments of the planet. Ongoing research will help establish public policy in human and plant epidemiology.

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