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Bacterial Behavior under Different Environmental Conditions

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ABSTRACT

Bacteria show different behavior in diverse environments. Within these environments the organisms follow specific physiology. The change in bacterial behavior can occur by interacting with the host. They are able to survive under harsh conditions. They show enormous metabolic versatility specific to the environment, which is reflected in different genomics and proteomics studies. It is important to understand the multi-drug resistance (MDR) pattern in bacteria which pose a global threat today, to know the behavioral patterns of the organisms under varied conditions that can decipher the exact mechanism of eliciting change in behavior. In this review, we are trying to discuss bacterial behavior under different environmental conditions.

Key words: Bacterial behaviour, Environmental factors, Genomics, Proteomics

INTRODUCTION

Every organism grows under specific environmental conditions. Within these environments the organisms follow specific niches. Bacteria by virtue of their omnipresence are found in almost all nooks and corners of the world and are adapted to survive in different environmental conditions. They are able to survive under extreme conditions. Thus, they show enormous metabolic versatility specific to the environment (Prosser *et al*., 2007, Rampelotto, 2013). It is observed that bacteria are able to tolerate subtle to significant alterations in their environmental conditions.

Humans are almost entirely covered with microorganisms off which bacteria account for a significant part. They are present on the skin, in the gut and also in the respiratory tract but lungs. Presence of bacteria on/in humans can be a boon or a bane. Presence of certain bacteria in and on the body is beneficial as it helps in development of anatomy and physiology and at times lifespan of an individual. However, the bane being that many of the residents are involved in causing diseases (Balloux, van Dorp, 2017

and Wang *et al*., 2017). *Staphylococcus aureus, Escherichia coli* are some of the facultative pathogens which cause deadly infections in humans, however, are part of the normal flora (Kaper *et al*., 2004, Krismer *et al.*, 2017). Recently, Siddiqee *et al*. (2019), studied variation in invasive power of *Salmonella typhimurium* isolated from Yorra river estuary, Melbourne Australia in summer and winter. The invasiveness was found to be more in winter than summer isolates. This indicates that bacterial behavior shows seasonal changes. Therefore, further understanding on bacteria and different environmental factors is needed. In this commentary, we are trying to discuss bacterial behavioral under different environmental conditions.

Environmental factors affecting the bacterial behavior:

Factors affecting bacterial growth are temperature, pH, salt concentration, nutrient availability, presence of host secretions, etc. It is clear that environmental factors have an impact on the bacterial growth. The function of genetic circuits is coupled with the physiological state of bacterial cell (Klumpp and Hwa, 2014).

Jordan and Jacobs stated that the temperature shows a linear relationship with the growth rate (Jordan and Jacobs, 1946). This indicates that change in the growth rate is dependent on the temperature. Phadtare (2004), showed that within a bacteria cold shock or temperature change promotes alteration in transcription, translation metabolism. Membre *et al.*(2005) proposed that temperature affects the proliferation of pathogenic bacteria in stored food. Their study also clears the fact that temperature affects the growth of bacteria. The authors also conclude that no significant difference was observed in the growth patterns of the strains of the same species. Thus, strains of same species behave in a similar manner to each other in response to a particular stimulus.

Tienungoonetal *et al* (2000) integrated nonlinear logistic regression modeling with the growth pattern study of *Listeria monocytogens.* The model showed a relationship between the growth of the organism and the environmental factors like temperature, pH, NaCl and lactic acid. Antoniou *et al* (1990) proposed that the specific growth rate of the organism (*Nitrosomonas*) is largely dependent upon the pH and temperature. With change in the pH, numbers of genes are activated to confer membrane stability at low pH (Cotter and Hill, 2003).

Perhaps, of all the environmental factors, the paramount is the availability of nutrient concentration. Shehata and Marr (1971) described the fact that the nutrient concentration affects the specific growth rate of *E. coli*. The authors proposed that if excess of nutrients is available then the specific growth rate is independent of the nutrient concentration, however, at minimal concentrations of the nutrients it is a strong function of the nutrient concentration. Thus, specific growth rate is an apparent function of the nutrient concentration.

Lyte (2014) mentioned the relationship between the hormonal stress and development of bacterial pathogenicity. Production of a major class of virulence toxins, Shigella-Like toxins was observed in EHEC 0157:H7 when incubated in the neurohumoral environment (Lyte *et al*., 1997). Thus, in presence of host induced stress condition bacteria projects a change in the behavioral patterns.

The human microflora differs in different parts of the body. The organisms in one part of the body are better adapted to those microenvironments than others. The human microflora is rather dynamic and is prone to vary with diet, age, drugs, pre and probiotics (Lozupone *et al*., 2012). It will be interesting to investigate if one places pathogenic *Staphylococcus aureus* from skin to trachea will cause an infection as being exposed to conditions distant from normal?

Analyzing behavior:

The global gene response profile changes due to change in the physiological conditions of bacteria; also, the presence of antibiotics elicits antibiotic resistance response (Klumpp *et al*., 2009). The behavior of bacteria cannot be studied as easily as can be for higher organisms like animals. As in the case prokaryotes and protozoan, it is difficult to depict the behavioral change as vividly as in the case of other eukaryotic organisms.

Growth and behavior can be studied using genomic and proteomic expression patterns. Mandlik *et al.* (2011) did a genomic expression pattern analysis for *Vibrio cholerae* genome. Pathogens acclimatize to the host environment by shifting their patterns of gene expression. Large numbers of proteins are synthesized

at specific stages of the cell cycle suggesting periodic protein expression for optimum utilization of nutrients (Grunenfelder *et al*., 2001).

Perez-Llarena and Bou (2016) observed that the proteomic response is specific to different antibiotics. The authors discussed that the vancomycin resistance factors, metabolism, translation and conjugation were regulated. Therefore, it will be interesting to see whether like antibiotic stress, the host induced stress can cause change in the proteomic profile of bacteria?

Change in the environmental conditions *in vivo* is able to induce pathogenicity among bacteria (Chowdhury *et al*., 1996). The authors also explained that the bacteria monitor the environmental parameters and adjust the gene expression accordingly. Virulence genes are expressed at different stages of the infection dependent on the host microenvironment. It will be exciting to see the scenario of genomics and proteomics by arresting the growth at equal time intervals. In addition, proteomic profile study can give an idea regarding the current proteomic status of the cell in response to stimulus. We can detect the change in the proteomic profile as the pathogenicity is induced in facultative pathogens.

The preference to having a proteomic study over genomic expression is that within the cells there are RNAs which are transcribed and translated to form proteins, however, there are also RNAs which are transcribed but do not get translated like micro RNAs and long non-coding RNAs to form a functional protein or none at all (Fernandez *et al*., 2019). But for every protein to exist there is a specific RNA and to that is a specific gene being transcribed. Therefore, we believe that the proteomic profile might suggest less ambiguity in results for the above-mentioned study.

CONCLUSION

Environmental factors govern the bacterial behavior and physiology. The proteomic profiles in test organisms before they are pathogenic and after they express pathogenesis can give frontiers to design new drugs. Perhaps we can also find certain unknown areas or bacterial behavior and also understand their pathogenesis with a different perspective. The study might open doors for understanding treatments against MDR pattern in bacteria which pose a global threat today, to comprehend the behavioral patterns of the organisms under varied conditions and can decipher the exact mechanism of eliciting change.

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Conflict of interest

The author declares that there is no conflict of interest.

REFERENCES

Antoniou P, Hamilton J, Koopman B, Jain R, Holloway B, Lyberatos G, Svoronos S (1990) Effect of temperature and ph on the effective maximum specific growth rate of nitrifying bacteria. Water Research 24, 97–101. https://doi.org/10.1016/0043-1354(90)90070-M

Balloux F, van Dorp L (2017) Q&A: What are pathogens, and what have they done to and for us?. BMC Biol 15, 91. https://doi.org/10.1186/s12915-017-0433-z

Chowdhury R, Sahu G, Das (1996) Stress response in pathogenic bacteria 12

Cotter PD, Hill C (2003) Surviving the Acid Test: Responses of Gram-Positive Bacteria to Low pH. Microbiology and Molecular Biology Reviews 67, 429–453. https://doi.org/10.1128/MMBR.67.3.429-453.2003

Fernandez J, Acuña S, Aoki J, Floeter-Winter L, Muxel S (2019) Long Non-Coding RNAs in the Regulation of Gene Expression: Physiology and Disease. ncRNA 5, 17. https://doi.org/10.3390/ncrna5010017

Grunenfelder B, Rummel G, VohradskyJ, Roder D, Langen H, Jenal U (2001) Proteomic analysis of the bacterial cell cycle. Proceedings of the National Academy of Sciences 98, 4681–4686. https://doi.org/10.1073/pnas.071538098

Jordan RC, Jacobs S (1946) The Effect of Temperature on the Growth of Bacterium coli at pH 7.0 with a Constant Food Supply 16

Kaper JB, Nataro J, Mobley H (2004) Pathogenic Escherichia coli. Nat Rev Microbiol 2, 123–140. https://doi.org/10.1038/nrmicro818

Klumpp S, Hwa T (2014) Bacterial growth: global effects on gene expression, growth feedback and proteome partition. Current Opinion in Biotechnology 28, 96–102. https://doi.org/10.1016/j.copbio.2014.01.001

Klumpp S, Zhang Z, Hwa T (2009) Growth Rate-Dependent Global Effects on Gene Expression in Bacteria. Cell 139, 1366–1375. https://doi.org/10.1016/j.cell.2009.12.001

Krismer B, Weidenmaier C, Zipperer A, Peschel A (2017)The commensal lifestyle of Staphylococcus aureus and its interactions with the nasal microbiota. Nat Rev Microbiol 15, 675–687. https://doi.org/10.1038/nrmicro.2017.104

Lozupone CA, Stombaugh JI, Gordon JI, Jansson JK, Knight R (2012) Diversity, stability and resilience of the human gut microbiota. Nature 489, 220–230.

https://doi.org/10.1038/nature11550

Lyte M, Arulanandam B, Nguyen K, Frank C, Erickson A, Francis D (1997) Norepinephrene induced growth and expression of virulence associated factors in enterotoxigenic and enterohemorrhagic strains of *Escherichia coli*. Advances in experimental medicine and biology 412: 331-339

Lyte M (2014) The effect of stress on microbial growth. Anim. Health. Res. Rev. 15, 172–174. https://doi.org/10.1017/S146625231400019X

Mandlik A, Livny J, Robins W, Ritchie J, Mekalanos J, Waldor M (2011) RNA-Seq-Based Monitoring of Infection-Linked Changes in Vibrio cholerae Gene Expression. Cell Host & Microbe 10, 165–174. https://doi.org/10.1016/j.chom.2011.07.007

Membre J, Leporq B, Vialette M, Mettler E, Perrier L, Thuault D, Zwietering M (2005) Temperature effect on bacterial growth rate: quantitative microbiology approach including cardinal values and variability estimates to perform growth simulations on/in food. International Journal of Food Microbiology 100, 179–186

Pérez-Llarena FJ, Bou G (2016) Proteomics As a Tool for Studying Bacterial Virulence and Antimicrobial Resistance. Front. Microbiol. 7. https://doi.org/10.3389/fmicb.2016.00410

Phadtare S (2004) Recent developments in Bactrial cold shock response. Ciaster Academic Press Current Issues Mol. Bio. 6: 125-136

Prosser JI, Bohannan B, Curtis T, Ellis R, Firestone M, Freckleton R, Green J, Green L, Killham K, Lennon J, Osborn A, Solan M, van der Gast C, Young J (2007) The role of ecological theory in microbial ecology. Nat Rev Microbiol 5, 384–392. https://doi.org/10.1038/nrmicro1643

Rampelotto P (2013) Extremophiles and Extreme Environments Life 3, 482–485. https://doi.org/10.3390/life3030482

Shehata TE, Marr A(1971) Effect of Nutrient Concentration on the Growth of Escherichia coli 7.

Siddiqee MH, Henry R, Deletic A *et al*. MicrobEcol (2019). https://doi.org/10.1007/s00248-019-01419-2

Tienungoon S, Ratkowsky D, McMeekinT, Ross T (2000) Growth Limits of Listeria monocytogenes as a Function of Temperature, pH, NaCl, and Lactic Acid. Applied and Environmental Microbiology 66, 4979–4987. https://doi.org/10.1128/AEM.66.11.4979-4987.2000

Wang B, Yao M, Lv L, Ling Z, LiL(2017) The Human Microbiota in Health and Disease. Engineering 3, 71–82. https://doi.org/10.1016/J.ENG.2017.01.008