**APPLICANT NAME AND SURNAME**

**RESEARCH AREA:**

Environmental microbial biotechnology applied to circular economy and Bio-economy

**PROJECT DURATION:**

**PROJECT TITLE:**Microorganism’s interactions with plants/animals to obtain biomolecules of relevant biotechnological applications

**Keywords**

Bacteriology, symbiosis, genomics, ecology, aerobic, Rhizobium

**Abstract**

Studies focusing around the interactions between plants and animals cannot be studied in partiality without turning focus to microorganisms. Micro-organisms play a critical part in the economy and survival of both species in the ecosystems. In fact, the whole food chain can merely survive without the influence of both organism. This symbiotic relationship has made research scientists gain a keen interest in the beneficial outcomes that could come as a result of such an interaction. Studies have been done, more are still on-going into how some of these microorganisms’ interact in their habitual locations.

Even though so small to be seen by the naked eye, most microorganisms stay in the water, soil and air, where they are more likely to interact with their hosts. With the ongoing studies and research around biotechnology, scientist are shifting more focus into harnessing the power of these microorganisms to sustain more plant and animal survival species with the aim of improving the advantages derived from plant and animal life. Whereas the world is also setting its agenda on combating food insecurity, one of the ways to achieve this is by critically analysing the crucial role that these microbes play in the food ecosystems. By the end of the day, all research should help organizations, governments and scientists harness the full power of micro- organisms during their environmental interactions.

From intraspecific to interspecific interactions between plants and animals, some of these microbes have gone a notch higher to gain and colonize their territories in the midst of plant/animal ecological interactions having the full potential to colonize both the external and internal parts of their hosts, resulting in new co-evolutions among species and new plant and animal kingdoms. Further research also indicate that these interactions between plants and animals exist in different categories that include: interactions between microorganism and plants and then microorganisms and the animal life.

Inline of this, this paper tries to examine the Biomedical and biotechnological research inputs established from these interactions in a bid to solve some of the problems encountered in the economical production of food and industrial bio-medical productions. Even though economises have not yet put enough programs and resources to help growing countries achieve substantial research and benefits from this relationship, a lot has been done and currently most agro-food markets are currently implementing this. For instance, as we shall also see later, that great hunger and food related solutions could actually be solved by studying the power of microbial and plant related interactions.

**Chapter 1 Background study and problem statement**

Within the biotic environment, it is notable to mention that order has been restored by the microorganisms that inhabit these regions. Across the biotic environments, that involve water, soil and air, different plant and animal life exists, Schulenburg et al (2017). Water regions like swamps, lakes, ponds, seas, oceans, rivers and seas are home to quite a number of plant and animal species. Whereas some of these waters are salty, others are fresh and still harbour some of the thriving organisms found in these areas. The ability of these plants and animals to thrive in these regions is attributed to their capacity to adaptive natures.

Most plants living in hydrophilic environments have certain elaborate features from within to help achieve this capability. For example, they possess large leaves that have large stomata to help them release excessive amount of water stored in their xylem and phloem, their leaf surfaces are also large in nature and are dull in colour to help them absorb more sunlight so as to release the excessive water that they have stored, consequently, they possess loosely hanging roots that do not reach the water bed. According Mo et al (2019), tropical plants have exploited their capability on land to enable them best survive in given climatic condition regardless of the water or the ph. levels of the soil from which they survive given their ability to store food on their leaves, stem, roots and seeds.

As a result, the four most important biomolecules can be extracted from these plants are lipids, carbohydrates, nucleic acids and proteins. In aquatic life and environments, fish are able to survive given their various abilities under these aquatic conditions like their extended bladder, that enable them to float in water and the possession of fins that give them the ability to move around deep water regardless of the speed and direction of the water.

It is also worth noting that different water levels and sources have different compositions like salinity levels, temperature and chemical compositions despite these animals being able to survive in such ecosystems. The human cell and body needs quite a number of nutrients like proteins, calcium, carbohydrates and lipids to survive. Human interactions with these micro-organism help to achieve this processes. Most plants contain a lot of carbohydrate and as a content needed by animals and humans to survive.

The carbohydrate content in animals is stored as starch which is a complex monosaccharide. The carbohydrate component produced by plants is later broken down into its simplest form of monosaccharide sugars needed by humans. As this study continues, much attention has been drawn to the micro-nutrients component of the plants, however, considering their macro – elements composition, leguminous plants contain high level nitrogen that is beneficial to humans in building their muscle. Animals on the hand contain higher levels of fats and proteins, fish have higher nutritional content of proteins and oils.

**1.1 The relationship**

In an ecosystem where survival for the fittest dominates the ecological environments, these organisms have advanced their adaptive/survival mechanisms to peacefully co-exist among each other.

**1.1.2 The carbon cycle:**

Carbon as an element stands as the centre of energy. Carbon atoms are continuously stored and released to the environment. How this happens is through a series of interactions between the existing organisms and their counterparts in the system. For instance, since most plants contain starch in their systems, when such plants cease to exist, they decompose and rote, but since energy can never be destroyed or changed, it can only be transformed from one form to another, the starch levels in their system is broken down into lower level and simple starch called monosaccharide’s that are then broken down to carbon which is then consumed in the systems of their next prey Schmitz et al (2019).

In some cases, if the carbon is not consumed by the organisms, then it is absorbed in geographical rocks and oceanic bodies. Given their ability to harbour carbon, oceanic water and certain tropical rocks harbour and release this energy later on to the atmosphere. While in the air, the carbon is consumed again by the plants in form of carbon dioxide which then participates in the photosynthesis process and the resultant plant food is stored as sucrose in its simplest form but starch in its complex form. Animals on the other hand rely on this starch that is stored by plants as food. Now that carbon has been stored as energy by plants, animals consume it in and digest the starch component to get the carbohydrate component from it, and the cycle continues.

**1.1.3 The nitrogen cycle.**

It is baseless to discuss the symbiotic relationship of plants and animals without discussing the nitrogen cycle. The theory behind the nitrogen cycle is that nitrogen is continuously released into the environment in different forms. Naturally, nitrogen occurs as a component of proteins and certain leguminous plants and animals have it in their systems.

When leguminous plants and animals die and get buried in the soil, they decompose and their nutrients are passed on from their bodies and are absorbed into the soil. According to Wannicke et a (2018), in large water bodies and oceans, the nitrogen component is stored among certain rocks and ocean beds, during certain oceanic activities and process, the nitrogen is released onto the atmosphere where it’s converted into gas. Alternatively, such decomposed plants are also used as manure in crop production; which then consumes the nitrogen as a nutrient and stores it. Leguminous plants containing the nitrogen are consumed by humans who then obtain the nitrogen from the animals and the cycle continues.

**1.1.4 The role of microorganism in plant and animal symbiotic relationships**

Microorganisms are simple microscopic organism that cannot be observed with the naked eye. Most are either single celled or range to a few number of cells. They include fungi, bacteria, protozoa, algae and viruses. Even though most of these micro-organisms have been known from their negative side as causing intoxications, disease and infections, let us not forget that they are also of beneficial purposes to the human bodies and the animals that consume them.

There are two types of bacteria, aerobic and anaerobic. The aerobic bacterial species can survive in most soil conditions and under the influence of sufficient supply of oxygen, improve the soil fertility, the *aerobacter* and the *actinomycetes* bacteria give the soil its earthly smell. Decomposing bacteria play a key role in helping decomposing dead decaying organisms, during the process, the bacteria consumes most of the simple sugars and nitrogen components from the decaying organisms and attach it to their cell membranes. In as much as the decomposing bacteria dominate most of the agriculturally tilled lands, they are still efficient at carbon carrier-conversion.

Then there these three types of bacteria that convert the readily availed N2 from the air to a consumable nitrogen element by plants, thee bacteria survive freely and do not host themselves on plants to do this, these bacteria include the Azotobacter, Azospirillum and Clostridium.   The *Rhizobium* bacteria receive carbon from the plants and then take free existing Nitrogen from the air and with help of oxygen convert form nitrates and nitrites which are stored as food servers in the leguminous plants to form nodules.

Under the presence of Hydrogen, nitrates react with hydrogen to form ammonia which is later broken down by plants cells to form amino acids which is a nutritional element in leguminous plants. The *nitrogenase* fixing bacteria has the ability to fix freely existing nitrogen into a form that plants can directly use. Bacterial blights are another category of bacteria that cause diseases in plants and animals. Nonetheless, there are other healthy bacteria that are harmless to the plants, the competition between the blight bacteria and the healthy bacteria strike a balance in the soil ecology and hence a healthy thriving of the plants.

Protozoa play a vital role in the regulation of other bacteria in the ecosystem. For instance, excess of the blight bacteria are fed upon by the existing protozoa that in turn help to regulate the soil balance by the organisms. Also, protozoa release excess nitrogen into the soil that is in turn consumed by the pants and animals. Fungi found in the soils help in the decomposition process by decomposing the hard to decompose materials in the soil through a special type of fungi called “hyphae”, the nutrients released by these fungi are released into the soil and atmosphere for later consumption. Also, soils that have better fungi, experience more compactness and water infiltration hence improving the fertility process.

Algae as microorganisms in the soil play a role in acting as green fertilizer, in their natural decompositions, they release nitrogen and phosphorus which is later consumed by the other plants in the ecology.

**1.1.5 Biotechnology and the human body**

Having discussed the relationship between microorganisms, the symbiotic relationships revolving around them and the role that each play in the ecosystem, applications of biotechnology applications can now be applied on this data.

Bacteriology is a field of biotechnology that is concerned with biological engineering bacteria to achieve certain levels of production efficiencies at industrial scale. During this process, the biochemistry, morphology, ecology and genetics of the bacteria is studied. As such, the specific identification, characterization and classification of the different levels of bacteria are established. Bacteriology has been applied to help provide solutions in the fields of medicine, agriculture, food industry.

**1.1.6 Applications of biotechnology and bacteriology**

There is a strain of bacteria called the *Lactobacillus, Lactococcus and Streptococcus,* these types of *bacteria* have been used in milk and mass production of dairy products such as cheese, yoghurt and butter.

Within the pharmaceutical industry, biotechnology and bacteriology have been applied to produce certain vaccines, some antibiotics and healthy human enzymes. The invention and use of the concepts of bacteriology in the field of pharmaceuticals have been used to provide some of the most outstanding immunizations and vaccines against diseases like diphtheria, whooping cough, tetanus and typhoid. Lots of human lives have been saved as a result of this process Kumar et al (2019).

Insulin as an enzyme and interferon and known tumor necrosis factor are proteins that have been derived from the biotechnology of human hormones. These alongside other products have been used to treat certain known diseases like diabetes, AIDS a and tuberculosis.

*Agrobacterium tumefaciens* is a bacterium that has been widely used in the in the plant and genome restructuring. *A. tumefaciens bacterium* has predominantly been used to produce plants that are resistant to harsh climatic conditions, diseases, herbicides and industrial pesticides.

**Chapter 2 Project aims and significance**

The researcher aims to establish the following from this study.

1. To establish the relationship between microorganisms and plants
2. To establish the role that micro-organisms play in plant and animal life
3. To establish how microorganism can be used to obtain biomolecules necessary for plant and animal survival
4. To determine how bio-molecular elements can be used in industrial biotechnology productions.

**2.1 The project hypotheses**

The researcher makes the below hypotheses based on the study:

1. Microorganisms exist in a symbiotic relationship
2. Microorganisms are the basic carriers and transfers of biomolecules in the ecosystem
3. Biotechnology solely depends on micro-organisms in order to develop better and more products

**Chapter 3 The literature review**

Research studies done by Sylvia et al (2005) indicate that soil microbiology runs on principles that keep the soil at equilibrium at any given point optimal, and that this is achieved with the knowledge and facts that within the soils there are harmful as well as healthy bacteria. Further, his research indicates that soil microbes play a vital role in decomposing dead organic matter, improving soil water infiltration and absorption of certain useful biomolecules like nitrogen and carbon. According to Alown et al (2017), the Phylogenetic as a branch of bacteriology is a study that has been used for a long time in identifying and marking the different strains of bacteria, this is achieved by using the 16 s Ribosamla DNS sequencing. Further, biodiversity has played a key role in the identification and checking the geographical distribution of certain bacteria species.

In another article done by Ramakrishnaet al (2019), a new term was coined as plant growth promoting bacteria whose role has been to enhance productivity and supply of nutrients to growth while at the same time limiting the growth of plant pathogens in the soil. Also more research has been done to develop more microbial activities on genomics that end up producing more inoculants; these when used on crops, increase their production yield and levels.

In another separate study done by Yadav et al (2019), there is a recent advancement in white biotechnology, which involves the production of energy by combining living cells to form small factories to achieve this, they have to feed on biomass. This study also found that fungi could be used in the synthesis of certain agile bioactive compounds to promote plant growth and further applications in the biotechnological developments in crop and plant growth. These articles have address some of the various steps that have been taken to establish connections and benefits of microorganisms and the connections between them and other organism.

**3.1 Project experimental plan**

The researcher aims to use secondary literature materials to gather data and information and topics that have been previously worked on by other authors. Some of the topics considered during the literature reporting includes microbiology, aquatic and marine survival, biotechnology advancements in developed nations, cell genome modifications and benefits of biomolecules in human environmental interactions. Other sources of data will be obtained from open source verified data portals like Kaggle that hosts several community data on this subject.

As a final step to include more data sources, outdoor data collection can be done by observing the kind of relationships that exist between the micro-organisms plants and animals in their habitat. The second step in the project experimental plant is to wrangle the collected sample, by removing spaces, blank values or non-uniform variables. Part of this step also includes ensuring that all the values or consistent and no interference by unrequired data was added.

A secondary control measure will be established by replicating the sample from the original data set and substituting it with a different model from the main experiment, the objective here is to establish consistencies and uniformities in the dataset that the researcher is working on, and to also evaluate expected output from the studies.

Core variables like benefits, and biomolecule activity are closely monitored and checked against expected project outcomes and objectives. Some of the tools that the researcher will use to conduct the data analysis include the IBM SPSS data modelling software and Python Spider application for data science and analysis. Finally output of the analyzed data will presented on graphs, charts and tables, from where analyses will be drawn based on the expected projected objectives and expectations.

**3.2 Expected outcomes and output**

Based on the identified objectives and aims of the project, the researcher aims to come out with the following output. That:

1. There is a relationship between micro-organisms and plants/animals
2. Micro-organisms act as carriers of biomolecules
3. Micro-organisms can be genetically modified and used in industrial biotechnology production.

**References**

Sylvia, D. M., Fuhrmann, J. J., Hartel, P. G., & Zuberer, D. A. (2005). *Principles and applications of soil microbiology* (No. QR111 S674 2005). Pearson.

Alown, F., Alsharidah, A., & Shamsah, S. (2021). Genotypic characterization of soil bacteria in the Umm Al-Namil Island, Kuwait. *Saudi Journal of Biological Sciences*.

Ramakrishna, W., Yadav, R., & Li, K. (2019). Plant growth promoting bacteria in agriculture: two sides of a coin. *Applied Soil Ecology*, *138*, 10-18.

Yadav, A. N., Singh, S., Mishra, S., & Gupta, A. (2019). *Recent advancement in white biotechnology through fungi*. Springer International Publishing.

Schulenburg, H., & Félix, M. A. (2017). The natural biotic environment of Caenorhabditis elegans. *Genetics*, *206*(1), 55-86.

Mo, Q., Li, Z. A., Sayer, E. J., Lambers, H., Li, Y., Zou, B. I., ... & Wang, F. (2019). Foliar phosphorus fractions reveal how tropical plants maintain photosynthetic rates despite low soil phosphorus availability. *Functional Ecology*, *33*(3), 503-513.

Wannicke, N., Frey, C., Law, C. S., & Voss, M. (2018). The response of the marine nitrogen cycle to ocean acidification. *Global change biology*, *24*(11), 5031-5043.

Mitchard, E. T. (2018). The tropical forest carbon cycle and climate change. *Nature*, *559*(7715), 527-534.

Kumar, J., Singh, D., Tyagi, M. B., & Kumar, A. (2019). Cyanobacteria: Applications in biotechnology. In *Cyanobacteria* (pp. 327-346). Academic Press.

.