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MICROBES: IMPORTANT PART OF LIFE

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ABSTRACT

In this era of COVID-19 everyone consider microbes as a threat. As people are dying because of one tiny virus which has ability to shake the whole world, we can see the ability of the being which we can't even see with our naked eye. But microbes are much more than that. Harmful microbes are just tiny fraction of microbial community **[2]**. There are so many positive applications of microbes which are making our life easier day by day. Microbes are the essential part of our life, and present everywhere around us. We can simply say that Microbes runs the world **[1]**. Microbes plays important role in research. Research in Molecular biology: how living organisms functions and use this knowledge in biotechnology, by use of different biological systems to develop new applications. Microbes contributes in making of essential elements of carbon, oxygen, sulfur and nutrients available for different communities on planet and also helps in important process like photosynthesis and help environment by lowering carbon levels and helps in increasing oxygen level **[1]**. This review is a study of importance of microbes in our life.

Keywords: Microbes, Microbiomes, Microbites, *Pseudomonas aeruginosa*, Azotobacter, Fungi, *mycorrhizae*, *Trichoderma*, *Aspergillus oryzae*, Agriculture applications, Microbes and environment

INTRODUCTION

Microbes are the too little forms but it contributes big role on earth and in human life. In way to remain healthy, humans need microbes and microbes need humans as specific environment for their survival **[3]**. It makes air breathable, improves our

health in many ways, improve medical application by providing different new sources for drugs, helps in agriculture field **[2]**. It is a vast community which contains a large amount of beneficial microbes, which helps us in so many ways. It is nearly impossible to have life on earth without microbes as humans could not be able to evolve without help of microbes. Some microorganisms fight with pathogens for a space and help our body to remain healthy **[2]**. Human body is a home of trillions of microbes which are living in different forms of viruses, fungi, bacteria, microbita and many more **[3]**. Soil Microorganisms are essential part of life **[1]**. Different industries included Pharmaceutical industries, Agriculture industries, Cosmetic industries, Dairy, fermentation industries, are using microbes in so many ways. Industries started making different formulation which includes microbes for the better yield. Microbes can be grown in a little lab to big industries as desirable quantity and it can be isolate from any sources. Microbes are major part of all industries, where fungal biotechnology plays an important role in many industries like food, pharmaceutical, bio-fuel, detergent and also use in molecular genomic and metabolomic analyses **[9]**. Yeast plays a vital role in the production of alcoholic beverages and it is very important to choose the perfect strain for particular beverage for better taste, aroma, and quality **[4]**. Microbe plays an important role in biochemical cycling of different metals in the environment and has ability to oxidize and reduce metals **[14]**. Cosmetic industry is well developing, where Cosmetology is the developing branch of science and working on finding biological alternatives for production **[17]**. Microbes have ability to survive in different habitats and it is a favorable resource for production of metabolites **[17]**. Microbes are also rich in many substances e.g. Fatty acids, Enzymes, Vitamins, Peptides, Lipopolysaccharides and pigments **[17]**. For the public concern, Human health, Safety of agricultural products, Environment, Biological pesticides replaced the chemical pesticides **[19]**. From recent years more focus is drive towards the bio-fertilizer than chemical-fertilizer as bio-fertilizers proven healthy for environment in so many ways, when chemical-fertilizer causing significant damage to the environment **[20]**. Living microbes can be used into various useful formulations as conidia suspensions, in liquid culture filtrates and stored for months without losing efficacy **[19]**. Some specific bacterial strains in certain natural environment prevent plants from infectious disease **[21]**.

Application of Microbes in fermentation

Microbes play a major role in fermentation process. They are essential part of

fermentation of Food, Beverages, Beer, Wine, etc. On steamed rice grains, rice koji is a solid culture of *Aspergillus oryzae* **[9]**. Into steamed rice hyphae grows into rice and secrete amylases and digest starch and the growth of mycelial correlates with good digestion **[9]**. Filamentous fungi plays an important role in decomposing process, it secrete some enzymes which helps to degrade extracellular organic compound, this fungi have high secretory capacity and for production of organic acids, drugs, antibiotics and enzymes, filamentous fungi also utilized as cell factories **[9]**.

Table 1: Fermented food and microorganisms involved in specific process [11]

Sr. No.	Name of Fermented food	Name of microorganisms involved in process
01	Fufu	*Alcaligenes, Candida, Citrobactr freundii, Geotrichum spp., Candida spp., Streptococcus, Clostridium spp., Lactobacillus spp., Leuconostoc spp.*
02	Gari	*Lactobacillus plantarum, Geotrichum candidum, Leuconostoc, Corynebacterium*
03	Agbelima	*Lactobacillus brevis, Lactobacillus plantarum, Leuconostoc mesenteroides, Bacillus subtilis. Bacillus licheniformis, Bacillus cereus, Bacillus mycoides, Bacillus polymixa, Panicillium spp., Candida krusei, Candida tropicalis, Zygosaccharomyces*
04	Lafun	*Bacillus subtillis, Klebsiella, Leuconostoc, Corynebacterium, Candida, Lactobacillus, Streptococcus.*
05	Attieke, Placali	*Leuconostoc spp., Lactobacter spp., Enterococcus faecalis*
06	Cassava sourflour, Startch, Sour starch	*Lactobacillus cellobiosus, Streptococcus lactis, Corynebacterium spp.,*
07	Kivunde	*Lactobacillus spp.*
08	Tapai	*Chlamydomocular oryzae*
09	Soy sauce	*Aspergillus oryzae, Aspergillus sojae*
10	Vineger	*Acetobacter spp.*
11	Sochu	*Saccharomyces cerevisiae*
12	Sweet potato curd, Yoghurt	*Lactobacillus bulgaricus, Streptococcus thermophiles, Leuconostoc spp.*
13	Lacto-pickle, Lacto-juice	*Lactobacillus plantarum*
14	Yams, Taro, Cococyams Amala	*Lactic acid bacteria*
15	Poi	*Lactococcus lactis, Lactobacillus plantarum, Weissela confuse*
16	Sapal	*Leuconostoc mesenteroides, Lc. paramesenteroides*

Food fermentation categorize in two different states, which are solid culture (where growth of microbes occurs on surface of solid materials) and submerged culture (Growth and anaerobic de-composition of carbohydrates by microbes occurs in liquid medium) **[11]**. Different microorganisms produce different flavours and aroma, also produces different level of acidity and alkalinity and provide protein content **[11]**. Fermented foods are found in root and tuber crops **[11]**. Some root crops successfully converted into value-added products by solid state fermentation, where products like curd, wine, beer and others are products of submerged fermentation **[11]**. The pre-treatment before fermentation and hydrolysis steps, required to obtain different sugars from lignocellulosic biomass and it also release some inhibitory components (5-hydroxym-ethylfurfural, furfural, acetic acid) which are strongly affected the growth of microbes and fermentation of ethanol **[6]**. Fungi

Aspergillus oryzae use in fermentation of different products like rice wine, soybean paste and soy sauce **[9]**.

Lactobacilli present in different foods and products like Dairy products, fermented meat, Sour doughs, vegetables, Fruits, Beverages, Sewage, Plant materials and respiratory and also in Genital tracts **[12]**. Some species of *Lactobacillus* produce different nutrients during the process of fermentation and Lactic acid bacteria also produces different vitamins e.g. riboflavin, folate and cobalamin and this bacteria proved harmless in fermentation process it also selected for millet bioprocessing **[13]**. Fermentation of kunu in the presence of *Lactobacillus spp*. (*L. plantarum, L. acidophilus*) turned out improved in nutrients and reduce in microbial load **[13]**. Studies showed that in 45 hour 20% (v/v) of ethanol produced by *Saccharomyces cerevisiae* in a fully aerated fed-batch process as *Saccharomyces cerevisiae* is a major industrial ethanol producer **[8]**. High level of ethanol production can be done by anaerobic and micro-aerobic fermentation process, as in this process in high osmotic pressure proceed with yeast cells and accumulate high levels of ethanol in medium **[8]**. Differed studies proved that when complex elements like amino acids and Yeast Extract added to the process, *Saccharomyces cerevisiae* is only seems to be grown on glycerol as sole source of carbon **[7]**. *Saccharomyces cerevisiae* titled as a production host for many industrial processes, and it is also the novel product formation pathways **[7]**. When *Saccharomyces cerevisiae* use DHA pathway and grows on glycerol, Per carbon consumed high yield of cytosolic NADH generated, which is supposed to be increased as compare of L-G3P pathway and cause significant formation of ethanol from nn-fermentable carbon source glycerol **[7]**. In several studies the different fixed frequency ultrasound can effect positively on rate of the fermentation process **[5]**. Low-intensity rate of ultra sound could effect on growth rate of *Bacillus subtilis*, *Candida tropicalis*, *Aspergillus niger*, etc. and increase growth **[5]**. In small scale production or fermentation of beverages the microbiological flora which are present in different types of raw materials are also used. Strain of *Saccharomyces cerevisiae* helps in fermentation of sugar **[4]**. And in the presence of sugar and some other essential nutrients like amino acids, vitamins and different minerals, *Saccharomyces cerevisiae* starts fermentative metabolism to carbon dioxide and ethanol and under anaerobic condition it regenerates coenzyme NAD+. There are different types of Yeast involved in the production of different types of products. E.g. Beer (*Saccharomyces pastorianus*,

Saccharomyces cerevisiae, Brettanomyces bruxellensis, etc.), Wine (*Saccharomyces cerevisiae, Saccharomyces bayanus and other naturally-occuring yeasts*), Whisky (*Saccharomyces cerevisiae*), Rum (*Saccharomyces cerevisiae, Schizo-saccharomyces pombe*), Tequila, Mezcal, Bacanora (Natural yeast in artisanal Agave fermentations), Brandies, Gin, Vodka etc. (*Saccharomyces cerevisiae*), Cheese, whey derived beverages (*Kluyveromyces marxianus*) **[4]**.

Application of Microbes in Industries

Microbes contributes in the recovery of elements in industries by Bioleaching, the process in which microbes and minerals interact naturally and extract valuable metals **[14]**. *Acidithiobacillus ferrooxidants* which is *chemolithoautrophic, γ-proteobacterium* using in industries for recovery copper **[14]**. It solubilizes copper and different other metals from rocks and also plays an important role in nutrients and metal biogeochemical cycling in acid environments **[14]**. *Acidithiobacillus ferrooxidans* thrives optimally at 30° C and it can grow at pH lower than 1 and can meet its nitrogen needs by nitrogen fixation or ammonia assimilation **[14]**. In the two step bioleaching process *Acidithiobacillus ferrooxidans* plays important role by reoxidizing Iron and it also obtained energy by reduced sulfur compounds, hydrogen and formate **[14]**. Presence *Thiobacillus ferrooxidans* bacteria increase the leaching rate at the leaching process of sulfide materials **[15]**. According to studies *Thiobacillus ferrooxidans* oxidized iron when ferrous iron and element sulfur both were provided **[15]**. *Acidianus ambivalens, Aquifex aeolicus, Thiobacillus denitrificans* and *Thiocapsa roseopersicina* and *Allochromatium vinosum* are chemoautotroph which lives in extreme environment and use inorganic energy sources have an active sulfur metabolism so it can oxidize and reduce inorganic sulfur compounds **[14]**. *Thiobacillus ferroxidans* is a chemolithotrophic bacterium which obtains energy by the ferrous ion oxidation to ferric ion **[16]**. Herbal products and organic ingredients in cosmetics from several biological sources reduced chances of side-effects in cosmetics, Developing the formulation of cosmetic products from fungal, bacterial and algal origin is healthy for consumers and from all sources exists, microbes are one of the cheapest, renewable and novel source of any chemical **[17]**.

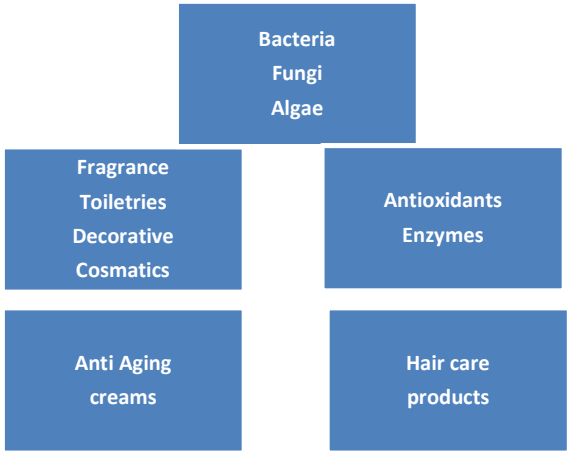

Figure 1: Main categories of cosmetics [17]

Table 2: Application of cosmetics and name of species include in process of formulation

Cosmetic Applications	Microbial species
UV and Photo-protective potential, protection from oxidative damage	***Speudonocardia sp., Actinosynnema mirum, Streptomyces avermitilis, Streptomyces lividants, Corynebacterium glutamicum, Aurantiochytrium sp.***
Improves skin, Antioxidant	***Paracoccus, Agrobacterium aurantiacum, Thraustochytrids, Rhodotorula, Phaffia rhodozyma***
UV protectant, Antioxidant, Skin hydration, Brightening agent, Smoothing agent, Moisture retainer, Gelling agent, Thickening, emulsification	***Corynebacterium autotrophicum, L. mesenteriodes, Streptococcus mutans, P. aeruginosa, A. vinelandii, Xanthomonas spp., Sinorhizobium meliloti M5N1CS, Gluconacetobacter hansenii***
Skin repair, Anti-aging, Detergent, Foaming, Emulsifying agent, Skin hydrating properties	***Streptococcus thermophiles, Pseudomonas spp., Pseudozyma spp., Ustilago spp., Candida antartica, Bacillus subtilis, Bacillus pumilus A, B. licheniformis, B. amyloliquefacien, Acinetobacter calcoaceticus , Candida spp.***
Sustainable release of aroma, Reduce foaming	***Bacillus subtillis Strain 313, Brevibacterium spp. Strain 9605, Brevibacillus brevis Strain CD 162, Microbacterium terrae KNR 9***
Treat stretch marks, Scar tissues	***Aspergillus, Penicillium, Rhizopus, Mucor, Humicola, Thermoascus, Thermomyce, Conidiobolus coronatus***
Skin regeneration	***Clostridium histolyticum, Vibrio alginolyticus, Bacillus cerus***
Hair removal	***Microsporum, Epidermophyton, Chrysosporiu, Scopulariopsis brevicaulis, B. subtilis, B. licheniform***
Antioxidant, Free radical scavenging, anti-aging	***Sulfolobus acidocaldarius, Marinomona, Thermus thermophilus***

Application of Microbes in Agriculture

Microbial Biological Control Agents which are currently used in agriculture are mainly classified into the two groups, (1) Generalists - Includes different species of *Bacillus, Pseudomonas, Streptomyces, Trichoderma, Clonostachys*, Yeast, etc. (2) Specialists – Includes bio-control species of *Agrobacterium, Ampelomyces, Coniothyrium, non-pathogenic Fusaria, Atoxigenic Aspergillus*, etc. Biopesticides are derived from natural sources (Naturally occurring chemicals, Pheromones, Bacteria, Fungi, Insect predators) **[19]** Microbes can directly improve plant growth by helping them with several nutrients like nitrogen,

phosphorus, and other essential minerals and also by modulation of root growth and build through the release of auxins and cytokinins and at other side they release several chemical compounds(hydrogen cyanide, siderophores, antibiotics, antifungal substances) to inhibit the growth of pathogens **[20]**. *Trichoderma* species usually used as biological control agents which is active ingredient for Bio-pesticides, Bio-fertilizers, Growth enhancers and stimulates of natural resistance **[19]**. *Trichoderma* has different positive abilities towards plants which include protection of plants, enhance vegetative growth and also can act as soil inoculants for different purpose **[19]**. Different studies investigated that Vanillin or p-hydroxybenzaldehyde used as a substrate to isolate lignin-decomposing fungi and the different soil micro-fungi have ability to grow on different aromatic compounds and some yeast can also utilize them. Some isolates of *Trichoderma* (biocontrol generalists) have ability to function against fungal pathogens (*Botrytis cinerea, Rhizoctonia solani, Sclerotinia sclerotiorum, Sclerotium spp., Pythium ultimum, Phytophthora spp., Armillaria spp., Fusarium oxysporum, Verticillium spp., Gauemannomyces graminis*) **[10, 19]**. *Arbuscular Mycorrhiza* and *Rhizobacteria* are major plants symbionts, they strengthen the root architecture and stimulate the plant growth and productivity **[20]**. Auxin produced by *Rhizobacteria* can modulate plant growth and architecture of root **[20]**. Nitrogen fixing capacity found enhanced in *mycorrhizal* plants **[20]**. *Pseudomonas fluorescens* is a part of plant growth promoting rhizobacteria, bacteria which plays a major role on plant growth **[21]**. It is Gram negative, rod-shaped bacterium and group of nonpathogenic saprophytes which colonize in water, soil and on the surface of plant **[21]**. Studies proved that Some strains of *Pseudomonas fluorescens* known to control plant disease in crops of Cereals, Fruits, Vegetables, Flowers, Oil crops, Cotton and other crops, It also proven effected on fungal disease. *Pseudomonas fluorescens* secrets Greenish fluorescent pigment (fluorescein) under low iron availability, where pyrollnitrin is an antibiotic compound produced by native isolate of *Pseudomonas fluorescens* which inhibit the growth of *M. phaseolina* **[21]**. *Pseudomonas fluorescens* strain CHA0 play an important role in suppression of different root disease of plant, Other strain of*Pseudomonas fluorescens* EPS62e have high efficacy to control infection Erwinia amylovora in flowers, immature fruits and pear plants and In Chinese cabbages *Plasmodiophora brassicae* showed significant controlled on pathogens **[21]**. In bio-control capability of *Pseudomonas fluorescens*, The anti-fungal metabolite 2,4-

diacetyl phloroglucinol plays a major role **[21]**. *Arbuscular Mycorrhizal* symbiosis involve in around 80% species of plants and 92% of plant families **[23]**. In Phosphorus deficient soils *Arbuscular Mycorrhiza* can increase the growth of plant andin low availability of sulfur, *Mycorrhizal* fungi transfer Nitrogen and sulfur from the several organic compounds **[23]**. Studies showed that plant with *Mycorrhizal* colonized have increased sulfur uptake than non- Mycorrhizal plants. Laccaria laccata also showed increase sulfur uptake in sulfur deficient condition **[23]**. *Arbuscular mycorrhizal* fungi improve plant nutrient and diversity by symbiosis **[22]**. Segregation in *Arbuscular mycorrhizal* fungi glomus intraradices and it can enhance the growth of rice **[22]**.

Application of Microbes in Medical

Microbes help in digestion, improvement in immune system, protection from some disease, produce vitamin K **[1]**. Gut bacteria in our intestine helps us in many ways; we eat some of the foods which are hard to digest, digestion would be impossible without gut microbes **[2]**. *Bacteroides thetaiotaomicron* helps our body to process complex sugars **[2]**. There are many types of drugs which now days we are deriving from different chemical components, first they were found in microbes **[2]**. There are different communities of micrbes which collectively known as a microbiome which is also the source of genetic diversity in humans and one of the most important components of immunity, metabolism and drug interaction **[3]**.

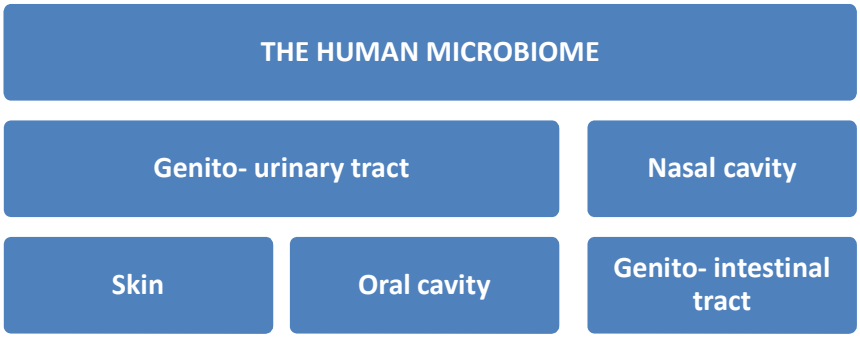

Figure 2: Different locations of microbiome in human body

Different microbita which are present in nasal cavity determine the reaction patterns of the mucosal and systemic immune system **[3]**. Oral microflora are the microbes which are living in oral cavity, and it comprises over 600 species; which includes, *Actinobacteria, Bacteroidetes, Chlamydiae, Chloroflexi, Euryarchaeota, Firmicutes, Fusobacteria, Proteobacteria, Spirochaetes, Streptococcus, Synergistetes* and *Tenericutes*; from them Lactobacillus, Streptococcus, Actinomyces generate an acidic pH and inhibit the growth of several bacteria **[3]**. In entire length of female reproductive system, there is several microbes are present which prevent body

from disease like human immunodeficiency virus, bacterial vaginosis and different other infections **[3]**. Gut microbita produces different molecules which prove positive in so many therapeutic responses like, kill pathogen and trigger the immune response to cancer, produce vitamins or some molecules which modulates our immune system **[26]**. Some combination of microbes which are isolated from stool proved therapeutic in people with *C. difficile* and also showed positive effect on bowel inflammation. **[26]**. Communication between Microbita which are present in gut and the brain plays important role in brain development and also in regulation of gut-brain axis and also improve the function of brain, provide pathway to improve bidirectional between brain and gut **[27] Gut**. microbita also influence the different Neuro mechanisms like Neurogenesis, neurotoxicity, neurotransmitter level, neurotransmitter receptors, different neurotropic signaling and synaptic system **[27]**. Gut micobita (*Lactobacillus reuteri, Faecali bacterium coprococus, Bacillus, Escherichia, Saccharomyces species, Candida, Enterococcus, Streptococcus*) positively affect central nervous system in many ways **[27]**. Some microbes significantly showed the positive effect on the wound healing process **[28]**. And Different skin microbiota has detrimental or beneficial effect on the wound repair and Microbiome of human chronic wound is linked to the healing process **[18]**.

CONCLUSION

Microbes are one of the major parts of healthy living. Day by day microbes involved in the improvement of the several processes in which chemical and harmful components were used. In the new medical evolutions and new discoveries of drugs, microbes are the essential part of everything. With the help of organic components and microorganism, it is possible to formulate the processes which may not cause any harm to the environment and earth. Future of organic agriculture is dominated by the application of PGPR. Different new molecular methods in genetics for modification of microorganisms will expand the range of beneficial approach. Continuous research on microbes and its uses will lead to better understanding of functions of microbes and make us to tackle global threats including climate change, pollution, food shortages, antimicrobial resistance and emerging infectious diseases.

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