Beneficial Microorganisms

Production of Enzymes

Enzyme	Microorganism	Application
α-Amylase	*Aspergillus oryzae* *A.Niger* *Bacillus subtilis* *B.licheniforms*	Production of beer and alcohol Preparation of glucose syrups As a digestive aid Removal of starch sizes
Cellulase	*Aspergillus niger* *Trichoderma sp*	Production of alcohol and glucose
Pectinase	*Aspergillus sp* *Sclerotina libertina*	Clarification of fruit juices and wine Alcohol production, coffee concentration
Lipase	*Candida lipolytica* *Aspergillus niger*	Preparation of cheese Flavor production
Invertase	*Saccharomyces cerevisiae*	Preparation of artificial honey Confectionaries
Protease	*Aspergillus niger*	Digestive aid Substitute for calf rennet
Lactase	*Kluyveromyces sp*	Lactose hydrolysis

Production of organic solvents

Organic Solvent	Microorganism	Application
Alcohol	*Yeast* *Saccharomyces cerevisiae* *S. ellipsoideus* *Kluyveromyces fragilis* *Bacteria* *Zymomonas mobilis* *Candida pseudotropicalis* *C. utilis*	Alcohol as a fuel
Acetone	*Clostridium acetobutylicum*	Gelatinizing agent for nitrocellulose in the manufacture of explosive.
Butanol	*Clostridium acetobutylicum*	Required for the synthesis of butadiene to produce synthetic rubber.
Glycerol	*Bacillus subtilis*	Starting material for the manufacture of explosives

Production of Organic acids

Organic acid	Microorganism	Application
Citric acid	*Aspergillus niger* *Penicillium luteum* *Candida catenulata* *Corynebacterium sp*	Flavouring agent in food and beverages. Antifoam agent. Agent for stabilization of fats, oils or ascorbic acid.
Gluconic acid	*Gluconobacter sp* *Aspergillus niger*	Additive to foods and beverages Used in the manufacture of metals, stainless steel and leather.
Lactic acid	*Lactobacillus sp*	Textile industry, Food additive, Intestinal treatment.
Acetic acid	*Gluconobacter sp* *Acetobacter sp*	Food industry

Production of antimicrobial agents

Type	Agent	microorganism
Antibacterial	Penicillin G Streptomycin Gentamicin	*Penicillium sp* *Streptomyces sp* *Micromonospora purpurea*
Antitumor	Actinomycin D Mitomycin C	*Streptomyces sp* *Streptomyces sp*
Antifungal	Griseofulvin	*Penicillium sp*
Food preservative	Natamycin Nisin	*Streptomyces sp* *Streptomyces sp*
Antiprotozoal	Daunorubicin	*Streptomyces sp*
Antituberculosis	Refamycin	*Nacardia sp*

Production of amino acids and vitamins

Type	Microorganism	Application
Amino acids		
Glutamic acid	*Corynebacterium glutamicum*	Flavour enhancer
Lysine	*Corynebacterium glutamicum*	Feed additive
L-Threonine	*E.coli* *Corynebacterium glutamicum*	Feed additive
L-Phenylalanine	*E.coli* *Corynebacterium glutamicum*	Aspartame production
L-Tryptophan	*E.coli* *Corynebacterium glutamicum*	Antioxidant
Vitamins		
Vitamin B12 (cyanocobalamin)	*Rhodopseudomonas protamicus*	Deficiency leads to pernicious anemia
Vitamin B2 (Riboflavin)	*Ashbya gossypii*	Growth and reproduction
β-Carotene (provitamin A)	*Blakeslea trispora*	Vision, proper growth and reproduction (Deficiency causes night blindness).

Production of Food and Beverages

Type	Products	Microorganism
Dairy products	Cheese	*Streptococcus lactis* *Lactobacillus lactis* *Penicillium roqueforti*
	Yogurt	*Streptococcus thermophilus* *Lactobacillus bulgaricus*
	Bread	*Saccharomyces cerevisiae*
Alcoholic beverages	Beer	*Saccharomyces cerevisiae* *S. carlsbergensis*
	Wine	*Saccharomyces cerevisiae*
Single-Cell Protein		*Spirulina maxima* *Chlorella pyrenoidosa* *Saccharomyces cerevisiae* *Agaricus bisporus*

Production of polysaccharides, polyhydroxyalkanoates, and lipids

Type	Microorganism	Application
Polysaccharides Xanthan Dextran Alginate	*Xanthomonas campestris* *Acetobacter sp* *Pseudomonas aeruginosa*	Food additive Wound dressing Thickening agent in food industry
Polyhydroxyalkanoates Polyhydroxybutyrate	*Ralstonia eutropha*	Biodegradable polymer
Lipids Docosahexaenoic acid	*Crypthecodinium cohnii*	Baby food

Microorganism	Application
Rhizobium sp	Nitrogen fixation
Cyanobacteria	Nitrogen fixation
Bacillus thuringiensis	Biocontrol agent
Methanobacterium sp	Methane production
Thiobacillus ferrooxidans *Thiobacillus thiooxidans*	Bioleaching (Extraction of metals from low grade ores)
Pseudomonas sp	Bioremediation
Pseudomonas sp, *Flavobacterium sp,* *Alcaligenes sp*	Waste water treatment