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Physico-Chemical and Bacteriological Water Quality of Drinking Water in Chitrakoot Nagar Panchayat Area (M.P): Review

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Abstract: ***The aim of present work is isolation and screening of the micro organisms from water of various sites of Chitrakoot area, Nagar Panchayat M.P. These organisms are too small to be clearly perceived by unaided human eye and main key of biodiversity on earth is due to evolution.. Now a days, the demand of water has been increased due to the increase in human population in cities. The main problem before the world is that of safe drinking water, which is fast assuming alarming properties problem related to storage, misuse and pollution of water are wide spread both in the rural areas. The problem is becoming increasingly complex with growing population, industrialization and urbanization.***
Keywords: Pollution, Drinking water, Bacteria

I. ENVIRONMENTAL POLLUTION

Environment pollution is a worldwide problem and its potential to influence the health of human populations is of great importance. "Pollution is an undesirable change in the physical, chemical or biological characteristics of air , water and soil that may harmfully affects the life or create potential health hazard of any living organisms". Pollution reaches its most serious proportions in the dens harmful in settled urban-industrial centers of the more developed countries**.** The main pollutants found in the air we breathe include, particulate matter, polycyclic aromatic hydrocarbon, lead, ground-level ozone, heavy metals, sulphur dioxide, benzene, carbon monoxide,nitrogen dioxide, etc. In poor countries of the world more than 80% polluted water is used for irrigation with only seventy to eighty percent food and living security in industrial, urban and semi urban areas[1] **.** Industry, clustered in urban and semi-urban areas surrounded by densely populated, low-income localities, continues to pollute the environment with impunity. Over the last three decades there has been increasing global concern over the public health impacts attributed to environmental pollution. Human exposure to pollution is believed to be more intense now than at any other time in human existence. Pollution can be made by human activity and by natural forces as well, Tehran is one of victim cities in terms of environmental pollution nominated Indian cities, among the most polluted cities in the world. The significance of environmental factors to the health and well-being of human populations 'is increasingly apparent The general area of environment geochemistry encompasses the many factors that influence the sources, dispersion and distribution of elements in the environment , their pathway in to soil, food stuffs and water supplies and their influence on plants, animal and human health.[2]

II. WATER

Groundwater is generally considered a "safe source" of drinking water because it is abstracted with low microbial load and little need for treatment before drinking. However, groundwater resources are commonly vulnerable to pollution, which may degrade their quality. Water has curious and unusual properties, and plays an important role in living systems. Thus, "no life without water" is common saying. It is a master solvent and all metabolic reaction of the living organism depends on the presence of water**.** 97.4% of the world's water is found in Oceans, 2% in poles, 0.59% is ground water and 0.01% is safe water. Water is lost from the earth by the way of evaporation, transpiration, exhalation, and is returned to the earth by the way of precipitation. Microorganism get into natural water from air, soil, sewage, organic waste, dead plants and animals, etc. thus almost any types of organisms may be found in water.[3] Water is one of the most important requirements for survival of life on the earth. Now a days, the demand of the water is increasing due to the increase of human population in cities. The main problem now before the world is that of safe drinking water. The change in natural properties of water to storage, misuse and pollution is wide spread specially in the rural areas. The problem is becoming increasingly complex with growing population, industrialization and urbanization. The source of drinking of water is river, lakes, stream, ground water etc. Drinking water should be suitable for human consumption and for all usual domestic

purposes. The importance of water in daily living makes it imperative that through examinations be conducted on it before consumption. Water is usually used as a dumping ground for waste water disposal both from point and diffuse sources. Point sources include municipal sewage treatment plants, sewer system and waste outlets from various industrial units. Wastes from these sources include sewage, phenols, oil, acid, alkalis, heat, solid waste, heavy metals, detergents, salts, organic and inorganic material, dissolved solids and many other toxic and inert materials.[4] The diffuse or non-point sources are overland run off from urban, rural and agricultural land and some times solid wastes from municipalities and industries. Waste water inputs from run off generally contribute silt, salts, oil, nutrients, pesticides, herbicides and other deleterious matter. The consequences of waste loading are deterioration of water quality, ecological loss of aquatic life and uptake of polluted water by plants and animals which eventually gets into human body resulting in health related problems.[5]

The determination of drinking water quality guideline value is essential in order to avoid health risks to the consumers. In developing countries only a small proportion of the waste water produced by severed communities is treated. Developing country governments and their regulatory agencies, as well as local authorities (which maybe city or town councils or specific waste water treatment authorities or more generally waste and sewage authorities) need to understand that domestic and other waste waters require treatment before discharge or preferably recycle and reuse in agriculture or aquaculture. The qualities of water need to be evaluated thoroughly to generate base line information for welfare of society. It is necessary to isolate and identify the microorganisms present in the different water samples.[6]

III. BACTERIA

Microorganisms are widely present in the world. They are involved in basic ecosystem processes such as the biogeochemical cycles and food chains, as well as maintain required relationships between them selves and higher organisms. Hence it is essential to explore, preserve, conserve and utilize the unique microbial flora fulfilling emerging needs of society, industries and clean environment. Microorganisms are the pioneer colonizer of the Earth and can survive in different situations and habitats like in extremes of temperature, pH and water and salt stresses.

Drinking or potable water has acceptable quality in terms of its physical, chemical and bacteriological parameters so that it can be used without short or long term harmful effects.[7] Humans have insufficient access to drinking water throughout the world and consume contaminated sources of water, which have objectionable levels of dissolved chemicals and a huge amount of pathogens. These can lead to widespread, acute and persistent diseases and is amajor cause of death. Mostly, the disease-causing organisms are transmitted through drinking water from fecal source, because organic wastes serve as food for bacteria.[8]

A huge amount of polluted water is returned to natural sources of water from the surrounding area and makes them hazardous as it carries pathogenic organisms and toxic chemicals.[9] Over large parts of the world, the most common contamination of raw water sources is due to anthropogenic activities, which are usually of two categories: chemical/physical and microbiological. Chemicals/physical contaminants are heavy metals, trace organic compound, total suspended solids, while bacteria, and some other species of bacteria and viruses are microbiological parameters of contamination. Some of the disturbances that happen in study area in Chitrakoot area are anthropogenic and natural. Anthropogenic disturbances are water extraction for irrigation, washing activities, toilet use, waste and littering, sewage inflow, picnic, animals, deforestation, etc.,while natural disturbances are droughts, floods, snow melting, erosion, landslides and earthquake, etc.[10]

IV. DRINKINGWATERAS A VEHICLE OF DISEASES

Water is essential to life. An adequate, safe and accessible supply must be available to all. Improving access to safe drinking-water can result in significant benefits to health. Every effort should be made to achieve a drinking water quality as safe as possible Many people struggle to obtain access to safe water. A clean and treated water supply to each house may be the norm in Europe and North America, but in developing countries, access to both clean water and sanitation are not the rule, and waterborne infections are common. Two and a half billion people have no access to improved sanitation, and more than 1.5 million children die each year from diarrheal diseases . According to the WHO, the mortality of water associated diseases exceeds 5 million people per year. From these, more that 50% are microbial intestinal infections, with cholera standing out in the first place.[11]

In general terms, the greatest microbial risks are associated with ingestion of water that is contaminated with human or animal feces. Wastewater discharges in fresh waters and costal seawaters are the major source of fecal microorganisms, including pathogens[12] . Acute microbial diarrheal diseases are a major public health problem in developing countries. People affected by diarrheal diseases are those with the lowest financial resources and poorest hygienic facilities. Children under five, primarily in Asian and African countries, are the most affected by microbial diseases transmitted through water . Microbial waterborne diseases also affect

developed countries. In the USA, it has been estimated that each year 560,000 people suffer from severe waterborne diseases, and 7.1 million suffer from a mild to moderate infections, resulting in estimated 12,000 deaths a year [13]. The most important bacterial diseases transmitted through water are listed in TABLE 1**.**

Table 1. The main bacterial diseases transmitted by water

S. N	Disease	Causal bacterial agent
1	Cholera	Vibrio cholerae
2	Typhoid fever and other serious salmonellosis	Salmonella spp.
3	Acute diarrheas and gastroenteritis	Escherichia coli

A. Vibrio Cholera

Vibrio are small, curved-shaped Gram-negative rods, with a single polar flagellum. Vibrios are facultative anaerobes capable of both fermentative and respiratory metabolism. Sodium stimulates growth of all species and is an absolute requirement for most. Most species are oxidase-positive and reduce nitrate to nitrite. Cells of certain species (V. cholerae, V. parahaemolyticus and V. vulnificus) have pili (fimbriae), structures composed of protein TcpA. TcpA formation is co-regulated with cholera toxin expression and is a key determinant of in vivo colonization[14]**.**

Vibrios are primarily aquatic bacteria. Species distribution depends on sodium concentration and water temperature. Vibrios are very common in marine and estuarine environments, living free or on

the surfaces and in the intestinal contents of marine animals. Species with a low sodium requirement are also found in freshwater habitats . Vibrio cholerae cells can grow at 40 °C with pH 9–10. The growth is stimulated by the presence of sodium chloride.The incubation period for cholera is ca. 1–3 days. The disease is characterized by an acute and very intense diarrhea that can exceed one liter per hour. Cholera patients feel thirsty, have muscular pains and general weakness, and show signs of oliguria, hypo volemia, hemo concentration, followed by anuria. Potassium in blood drops to very low levels. Patients feel lethargic. Finally, circulatory collapse and dehydration with cyanosis occurs

In the absence of treatment, the mortality of cholera-patients is ca. 50%. It is mandatory to replace not only lost water but also lost salts, mainly potassium. In light dehydrations, water and salts can be orally-administered, but in severe conditions, rapid and intravenous-administration is obligatory. The most efficient antibiotic is currently doxicyclin. If no antibiotic is available for treatment, the administration of water with salts and sugar can, in many cases, save the patient and help in the recovery**.**[15]

B. Salmonella Spp

The genus Salmonella was designated by Lignières in 1900. Antigenic analysis began when Castellani described, in 1902, a method for absorbing antisera. The first antigenic scheme for Salmonella was published by White in 1926, and subsequently developed extensively by Kauffmann, in two classical works published in 1966 and 1978. The Kauffmann-White antigenic scheme contained, by 1988, about 2,250 different serovars . The genus Salmonella, a member of the family Enterobacteriaceae, include Gram-negative motile straight rods. Cells are oxidase-negative and catalase-positive, produce gas from D-glucose and utilize citrate as a sole carbon source. Salmonellae have several endotoxins: antigens O, H and Vi .Salmonellae pathogenic to humans can cause two types of salmonellosis: (1) typhoid and paratyphoid fever (do not confuse with typhus, a disease caused by a rickettsia); (2) gastroenteritis . Low infective doses (less than 1,000 cells) are sufficient to cause clinical symptoms. Salmonellosis of newborns and infants presents diverse clinical symptoms, from a grave typhoid-like illness with septicemia to a mild or asymptomatic infection. In pediatric wards, the infection is usually transmitted by the hands of staff **16.**

Food-borne Salmonella gastroenteritis are frequently caused by ubiquitous Salmonella serovars such as Typhimurium. About 12 h following ingestion of contaminated food, symptoms (diarrhea, vomiting and fever) appear and last 2–5 days. Spontaneous cure usually occurs. Salmonella may be associated with all kinds of food. Prevention of Salmonella food-borne infection relies on avoiding contamination (improvement of hygiene), preventing multiplication of Salmonella in food (constant storage of food at 4

°C), and use of pasteurization (milk) or sterilization when possible (other foods). Vegetables and fruits may carry Salmonella when contaminated with fertilizers of fecal origin, or when washed with polluted water .The incidence of typhoid fever decreases when the level of development of a country increases (*i.e.*, controlled water sewage systems, pasteurization of milk and dairy products). Where these hygienic conditions are missing, the probability of fecal contamination of water and food remains high and so is the incidence of typhoid fever .

The principal habitat of Salmonella is the intestinal tract of humans and animals. Salmonellae are constantly found in environmental samples, because they are excreted by humans, pets, farm animals, and wild life. Municipal sewage, agriculture pollution, and storm water runoff are the main sources of these pathogens in natural waters .Salmonellae do not seem to multiply significantly in the natural environment, but they can survive several weeks in water and in soil if conditions of temperature, humidity, and pH are favorable. Unlike cholera, humans infected with salmonellae can carry the bacteria in the gut without signs of disease. Infected humans can harbor the bacteria for considerable periods of time. About 5% of patients clinically cured from typhoid fever remain carriers for months or even years. These people can be chronic holders of the bacterium in the gut, and constitute the main reservoir of the bacteria in the environment.[17]

The Salmonellosis cycle in the environment can involve shellfish. Salmonellae survive sewage treatments if suitable germicides are not used in sewage processing. If effluent from the sewage plant passes into a coastal area, edible shellfish (mussels, oysters) can become contaminated. Shellfish concentrate bacteria as they filter several liters of water per hour. Ingestion by humans of these seafoods (uncooked or superficially cooked) may cause typhoid fever or other salmonellosis. Evidence of such a cycle has been obtained by the use of strain markers, including phage typing .

C. Escherichia coli

E.coli strains isolated from intestinal diseases have been grouped into at least six different main groups, based on epidemiological evidence, phenotypic traits, clinical features of the disease and specific virulence factors. and can be transmitted through contaminated water . Entero toxigenic E. coli (ETEC) can cause infantile gastroenteritis. The number of reports of their occurrence in developed countries is comparatively small, but it is an extremely important cause of diarrhea in the developing world, where there is no adequate clean water and poor sanitation. In developing countries, these strains are the most commonly isolated bacterial entero pathogen in children below 5 years of age, and account for several hundred million cases of diarrhea and several ten of thousand deaths each year.[18]

Disease caused by ETEC follows ingestion of contaminated food or water and is characterized by profuse watery diarrhea lasting for several days that often leads to dehydration and malnutrition in young children. ETEC also are the most common cause of ―travelers‘ diarrhea that affects individuals from industrialized countries travelling to developing regions of the World .E. coli causes abdominal pain, bloody diarrhea, and hemolytic uremic syndrome. This bacterium produces Shiga-like toxins. The incubation period is 3–4 days, and the symptoms occur for 7–10 days. It is estimated that 2–7% of E. coli infections result in acute renal failure.

Although E. coli is not usually a concern in treated drinking water, outbreaks involving consumption of drinking water contaminated with human sewage or cattle feces have been documented. An increasing number of outbreaks are associated with the consumption of fruits and vegetables (sprouts, lettuce, coleslaw, salad) contaminated with feces from domestic or wild animals at some stage during cultivation or handling.

EHEC has also been isolated from bodies of water (ponds, streams), wells and water troughs, and has been found to survive for months in manure and water-trough sediments . Person-to-person contact is an important mode of transmission through the oral-fecal route. An asymptomatic carrier state has been reported, where individuals show no clinical signs of disease but are capable of infecting others .The illness is characterized by abdominal cramps, diarrhea, vomiting, fever, chills, a generalized malaise, and the appearance of blood and mucus in the stools of infected individuals Bettelheim[19]. Escherichia, a member of Enterobacteriaceae, are oxidase-negative catalase-positive straight rods that ferment lactose. Cells are positive in the Methyl-Red test, but negative in the Voges-Proskauer assay. Cells do not use citrate, do not produce H2S or lipase, and do not hydrolyze urea. E.coli is a natural and essential part of the bacterial flora in the gut of humans and animals. Most E.coli strains are nonpathogenic and reside harmlessly in the colon. However, certain serotypes do play a role in intestinal and extra-intestinal diseases, such as urinary tract infections. In a study of the enteric bacteria present in the feces of Australian mammals, Gordon and FitzGibbon[20]**.** reported that E.coli was the commonest species, being isolated from nearly half of the species studied.

V. MICROBIOLOGICAL WATER QUALITY IN THE WORLD

The 21 century will open with one of the most essential unmet conditions of human development: universal access to basic water services. More than a billion people in the developing world are deficient in safe drinking-water, a necessity being taken for granted by the populations of developed countries. Nearly three billion people live without access to adequate sanitation systems necessary to diminish exposure to water-related diseases. The failure of the states, local organizations and international aid community to ensure these essential human requirements has led to substantial, unnecessary yet preventable human suffering. An estimated 14-30 thousand people, mostly young children and the ealderly, die every day from water-related infections[21]. In the developing world, about 400 children below age of 5 years die per hour from water-borne diarrheal diseases[22]. Unsafe and hazardous water, poor sanitation and unhygienic conditions cause approximately 3.1% of annual deaths (1.7 million) and 3.7% (54.2 million) of the annual health encumber worldwide.

Microbial pathogenic parameters are usually of greatest concern because of their immediate health risks. Disease-causing organisms are known as enteric pathogens because these microbes are commonly of fecal derivation and transmit through drinking water. Since the pioneering epidemiology in the 1850 s, whereby the English physician John Snow recognized that cholera was waterborne, it is confirmed that water can cause the diseases in human beings**.** it has been observed that diarrhoea and other diseases in humans are caused by various pathogens which are transmitted through the use of potable water . In the faeces of all warmblooded animals and some reptiles, common fecal indicator bacterium, some reptiles, common fecal indicator bacterium, (E. coli), is responsible for cholera (Vibrio chlolera) and typhoid fevers (Salmonella para typhi). These bacterial species are considered necessary to be isolated from drinking water by treatment, traditionally filtration and chlorination[23]

It has been reported that atleast 52 nations are expected to face a severe deficiency of potable water, including half the world's population till 2025. In the next 25 years, water scarcity will be a major problem for about 3 billion people. Currently, the major issue of South Asia includes: non-availability or inadequate access to potable drinking water, outbreak of waterborne diseases, arsenic contamination of drinking water, seasonal limitation of availability of natural resource, depletion of fresh water aquifers and organic pollution . The study area was badly affected by the 2005 earthquake and was cut off from the outside world. Due to this calamity most of water sources and supply schemes were also damaged badly. [24]

Judging by the incidence of water-related illness in Africa, the continent is a very long way from providing ‘safe water’ for all its citizens. WHO (1984) estimated that 80% of ill-health in less developed countries stems from lack of safe water and adequate sanitation. Certainly, the majority of ill-health is due to diseases related in some way to water, or to impurities in water. To significantly reduce the rates of infectious water-related diseases, there is a need for improvements in water supply and sanitation services. Moreover, improved services must be accompanied by activities to promote changes in health-related behaviour.

WHO (1984) estimated that 37% of all cases of diarrhoea in the world occur in sub-Saharan Africa. Official government statistics suggest that in 1990, only 55% of Africans had reasonable access to safe water supply and this is likely to be an overestimation. Even fewer Africans had access to adequate sanitation facilities, with rural coverage rates estimated at 20-35% .[25]

A. Water for human consumption should

1) be free from microbiological contamination;
2) not have chemical concentrations greater than prescribed limits;
3) be available in sufficient quantities to enable adequate hygiene;
4) conform to local standards for taste, odour and appearance etc.

Unfortunately, most Africans do not have access to such water. Microbiological
contamination is the most common reason for water to be deemed unsafe and is usually detected by testing for indicator bacteria such as faecal coliforms.

B. Infectious water-related diseases include-

1) water-borne diseases such as diarrhoea, cholera, typhoid and infectious hepatitis transmitted through drinking contaminated water.
2) water-washed diseases, which are diseases transmitted from person to person or from animal to a person transmitted through any faecal-oral route, infectious skin or eye diseases such as cabies and trachoma and infections carried by lice
3) water-based diseases transmitted via human-water contact either through penetration of the skin e.g. guinea worm or through ingestion.
4) water-related insect in vectors diseases, which occur when surface water provides a breeding medium for disease agent.[25]

Due to scarcity of drinkable, safe and potable water during the dry season and unavailability of treated public water supply in public taps even during the rainy season, the people around Ita-Nmo, Oloje Estate area of Ilorin Metropolis resort to this popular river for domestic, recreational and agricultural water. The health implication of the use of such water source has negative economic importance to the community and her people. Water meant for preparation or formulations of consumables need to be potable and safe.

The United Nations launched the International Drinking Water Supply and Sanitation Decade in 1980. Its aim was to provide clean water and adequate sanitation for all by the year 1990. Everyday during that programme, about 330,000 people in developing countries were given access to a safe supply of drinking water and some 210,000 were provided with improved sanitation facilities. However, at the same time, the population of developing countries was growing by some 200,000 each day. The problem of unwholesome water in the developing world is not science, but of politics and economics.

Water contains many bacteria as they are generally found in rivers, streams, lakes and mountain water that comprise innumerable number of autotrophs and saprophytic heterotrophs. Water becomes contaminated by intestinal pathogens such as coliform group of bacteria, Salmonellae, Vibrio and dysentery-causing bacilli. The human faecal material carried in sewage if often dumped in rivers and lakes can lead to water contamination. Therefore, water supply has to be checked from the microbial point of view. [26]

In the study carried out by [27]on bacterial population of the surface water and sediments of Oyun River at two point sources upstream and one point source downstream; he reported that the majority of bacteria found in the river belong to the following groups; fluorescent bacteria (Pseudomonas), chromogenic rods (Xanthomonas), coliform group (Escherichia, Enterobacter, etc.), non-gas forming, non-chromogenic, non-spore forming rods, spore formers of the genus Bacillus. Despite the ubiquity of bacteria in aquatic ecosystems and the large populations developed, little attention has been given to the use of indigenous bacteria in the assessment of pollution, with the exception of the biochemical oxygen demand. Because of their morphological, physiological and genetic characteristics, microbial communities could act as excellent early-warning systems for pollution. [28]

Of the Earth's total resource of water, a large percentage is in the oceans and is too salty to be used for drinking, irrigation or industry. The remaining is frozen in ice caps and glaziers, or is buried too deeply underground to be utilized. Not only is freshwater essential to life but it is also a relatively scarce resource, and is likely to become more so with the impacts of global warming and population growth: the human population currently estimated at 6.24 billion, is predicted to rise to 10 billion by the year 2050. Some 80 percent of the global population live in developing countries **.** Many freshwater resources are contaminated through human activities.

More than 20 percent of the world population do not have access to safe drinking water, a greater proportion still do not have even basic sanitation. Each day some 25,000 children die from their everyday use of water; 4 million of these deaths every year are simply from diarrhoea. It is not only children who suffer. It is estimated that, at any one time, half the inhabitants of developing countries are ill with diseases caused by dirty water and poor sanitation. Some 80 percent of all illnesses and a third of all deaths are due to un-wholesome water. As well as causing much suffering, water-borne diseases also result in great economic loss. In India, for example, it is estimated that 73 percent working days are wasted each year, costing $600 million in lost production and in healthcare. [29.30]

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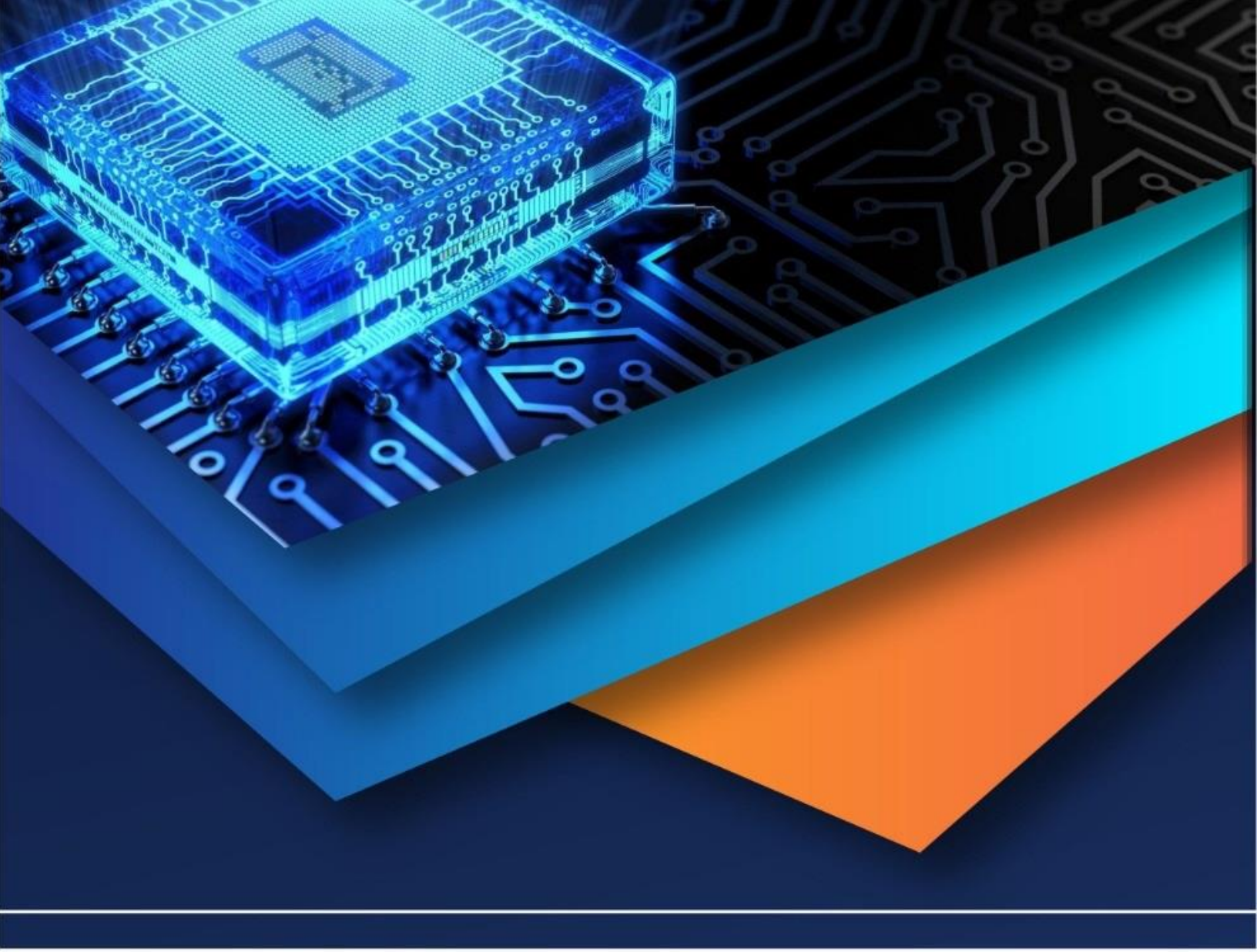

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