



Integration of Chemistry in Modern Life and Environmental Sustainability

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Abstract

Chemistry is an essential part of human life and its influence can be observed in almost every daily activity. From the food we consume to the medicines we use, chemical principles play a major role in improving human comfort, health, and technological development. Many people associate chemistry only with laboratories and experiments, but in reality it exists in household products, agriculture, cosmetics, environmental processes, and biological systems of the human body. Modern lifestyles depend greatly on chemical substances and reactions for cleaning, cooking, preservation of food, healthcare, and industrial production.

This paper discusses the importance of chemistry in everyday life through various practical applications such as toothpaste, soaps, detergents, food preservatives, cosmetics, medicines, fertilizers, and pesticides. It also highlights the role of chemistry in body functions including digestion, respiration, energy production, and brain activities controlled by biochemical compounds and enzymes. In addition, the study explains how chemistry contributes to agriculture and environmental protection while also addressing challenges caused by chemical pollution and industrial waste. Understanding the significance of chemistry helps people develop scientific awareness and encourages the safe and effective use of chemical products in

society. The study concludes that chemistry is deeply connected with human existence and remains one of the most important sciences for sustainable development and improved quality of life.

Keywords: Chemistry, Daily Life, Environmental Sustainability, Green Chemistry, Healthcare, Agriculture, Chemical Products



I. Introduction

Chemistry is one of the fundamental branches of science that explains the composition, structure, properties, and transformations of matter. In modern society, chemistry has become inseparable from human life because almost every activity directly or indirectly involves chemical substances and reactions. From the moment a person wakes up in the morning until the end of the day, chemistry plays an essential role through food, medicines, cosmetics, cleaning agents, fuels, agricultural products, and biological processes occurring inside the human body [1]. Although many students traditionally associate chemistry only with laboratory experiments and theoretical equations, the actual influence of chemistry extends far beyond classrooms and research laboratories.

In daily life, people regularly use products such as toothpaste, soaps, detergents, shampoos, perfumes, medicines, and preservatives without realizing the scientific principles behind them. These products contain chemical compounds designed to improve hygiene, healthcare, food preservation, and quality of life. For example, fluoride compounds in toothpaste help prevent tooth decay, surfactants in soaps remove dirt and microorganisms, and preservatives increase the shelf life of food products. Similarly, fertilizers and pesticides used in agriculture improve crop production and food security [2]. Therefore, chemistry acts as a bridge between scientific knowledge and practical human needs. Chemistry is also deeply connected with the human body and biological systems. The processes of digestion, respiration, circulation, nerve signalling, and energy production occur because of various biochemical reactions. Neurotransmitters such as dopamine, serotonin, and acetylcholine regulate emotions, memory, and body coordination. Enzymes and hormones continuously control metabolic activities necessary for survival. Thus, the human body itself can be considered a highly organized chemical system operating through complex molecular interactions [3]. With rapid industrialization and technological advancement, the importance of chemistry has further increased in sectors such as medicine, environmental science, agriculture, energy production, and material science. Modern healthcare depends on chemical synthesis for drug development, diagnostic testing, and biomedical research. Green chemistry and sustainable chemical technologies are currently gaining attention because of growing environmental concerns such as pollution, global warming, ozone depletion, and industrial waste management [4,5]. Recent educational research has highlighted that chemistry learning becomes more effective when students relate theoretical concepts to everyday experiences. Context-based learning approaches involving household chemicals, fuels, detergents, plastics, and food products help students understand chemistry more meaningfully and improve their interest in science [1]. Furthermore, advanced technologies such as artificial intelligence, digital learning tools, and technology-enhanced learning methods are being integrated into chemistry education to improve chemical literacy and student engagement [6,7]. Therefore, understanding chemistry in everyday life is essential not only for academic learning but also for making informed decisions related to health, environment, technology, and sustainable living. This study focuses on the role of chemistry in common daily activities and highlights its applications in household products, healthcare, agriculture, environmental protection, and body mechanisms. The paper also discusses the positive and negative impacts of chemical substances on human life and emphasizes the importance of responsible chemical usage in modern society.

2. Theory and Practical Aspects of Chemistry in Daily Life

2.1 Common Daily-Life Products and Major Chemical Components

Chemistry plays a significant role in the preparation and functioning of products used in everyday life. Most household products contain specially designed chemical compounds that improve cleanliness, health, preservation, and personal care. The effectiveness of these products depends on the chemical composition, molecular interactions, and reactions occurring during their use. The following sections explain the major daily-life products and their important chemical components in detail.



Table 1. Common Daily-Life Products and Major Chemical Components

Daily-Life Product	Important Chemical Compounds	Main Function
Toothpaste	Sodium fluoride, calcium carbonate	Protection against tooth decay
Soap	Sodium stearate, fatty acids	Removal of dirt and germs
Detergent	Sodium lauryl sulphate	Cleaning and emulsification
Shampoo	Citric acid, surfactants	Hair cleaning and conditioning
Food Preservatives	Sodium benzoate, vinegar, salt	Prevention of microbial growth
Medicines	Paracetamol, antibiotics	Treatment of diseases
Fertilizers	Urea, ammonium phosphate	Increase soil fertility
Cosmetics	Waxes, pigments, polymers	Skin and beauty care

2.1.1 Toothpaste

Toothpaste is one of the most commonly used personal care products for maintaining oral hygiene and preventing dental diseases. It contains a combination of chemical substances that clean teeth, remove plaque, strengthen enamel, and provide freshness. Fluoride compounds such as sodium fluoride or sodium monofluorophosphate are added to reduce tooth decay by strengthening the outer enamel layer of teeth. Mild abrasives like calcium carbonate and hydrated silica help remove stains and food particles from the tooth surface. Humectants such as glycerine and sorbitol prevent the toothpaste from drying, while detergents like sodium lauryl sulphate produce foam and improve cleaning action. Flavouring agents and sweeteners are also added to improve taste and user acceptance. Modern toothpastes may contain antibacterial agents and herbal extracts for additional protection against gum diseases. Thus, toothpaste demonstrates how chemistry contributes directly to oral health and hygiene.

2.1.2 Soap and Detergents

Soaps and detergents are chemical cleaning agents widely used for bathing, washing clothes, and household cleaning. Traditional soaps are generally prepared by the saponification process, in which fats or oils react with alkali substances such as sodium hydroxide. The resulting soap molecules contain two important parts: a hydrophilic end that attracts water and a hydrophobic end that attracts oils and grease. This dual nature allows soap to remove dirt effectively. Detergents are synthetic cleaning agents developed to improve cleaning efficiency in hard water conditions. Compounds such as sodium lauryl sulphate and sodium Lauretha sulphate act as surfactants that reduce surface tension and allow oily substances to mix with water. Builders like phosphates improve washing performance by softening water. Modern detergents may also contain enzymes, fragrances, and antibacterial compounds. Although these chemicals improve cleaning efficiency, excessive release into the environment may contribute to water pollution and ecological imbalance.

2.1.3 Food Preservatives

Food preservatives are chemical substances added to food materials to increase shelf life and prevent spoilage caused by bacteria, fungi, and oxidation. Common household preservatives include salt, sugar, vinegar, edible oils, and sodium benzoate. Salt removes moisture from food products and inhibits microbial growth, while sugar acts similarly in jams and sweet products. Vinegar creates acidic conditions that reduce bacterial activity. Commercial preservatives such as sodium benzoate and potassium metabisulfite are widely used in beverages, sauces, and processed foods. Antioxidants are also added to prevent oxidation of fats and oils. Food colouring agents and flavour enhancers are additional chemical additives used to improve appearance and taste. Although preservatives are useful for food storage and transportation, excessive consumption of artificial additives may cause health concerns in sensitive individuals.



2.1.4 Cosmetics and Personal Care Products

Cosmetics are chemical formulations designed to improve appearance, skin care, and personal hygiene. Products such as creams, lotions, shampoos, perfumes, lipsticks, talcum powder, and nail polish contain both organic and inorganic compounds. Emulsifiers help mix oil and water phases in creams and lotions, while waxes and oils provide smooth texture and moisture retention. Shampoos contain surfactants for cleaning hair and conditioners to reduce dryness. Lipsticks and cosmetics include pigments, waxes, and polymers for colour stability and texture. Preservatives are added to prevent microbial contamination. Some modern cosmetic products may also contain ultraviolet protection compounds and antioxidants. However, prolonged exposure to certain synthetic chemicals such as parabens, phthalates, and perfluoroalkyl substances (PFAS) may have harmful effects on human health and the environment. Therefore, the development of safer and eco-friendly cosmetic formulations has become an important area of research in modern chemistry.

2.1.5 Drugs and Medicines

Medicines are prepared using carefully controlled chemical compounds that interact with biological systems to diagnose, prevent, or treat diseases. Pharmaceutical chemistry involves the design, synthesis, and testing of medicinal compounds. Drugs such as antibiotics, analgesics, antipyretics, and antihistamines contain active chemical ingredients that produce therapeutic effects inside the body. For example, paracetamol is commonly used to reduce fever and pain, while antibiotics destroy harmful bacteria by interfering with their metabolic activities. Medicines are manufactured through precise chemical reactions and purification methods to ensure safety and effectiveness. Chemistry is also essential in medical diagnostic techniques such as blood analysis, urine testing, and biochemical investigations. Modern pharmaceutical research focuses on improving drug efficiency, reducing side effects, and developing targeted drug delivery systems. Thus, chemistry plays a central role in healthcare and disease management.

2.1.6 Agricultural Chemicals

Agriculture heavily depends on chemistry for improving crop production and protecting plants from diseases and pests. Fertilizers supply essential nutrients such as nitrogen, phosphorus, and potassium required for plant growth. Urea, ammonium nitrate, and superphosphate are commonly used fertilizers that improve soil fertility and increase agricultural productivity. Pesticides, insecticides, herbicides, and fungicides are chemical substances used to control insects, weeds, fungi, and harmful organisms affecting crops. Compounds such as organophosphates and carbamates are commonly used in pest control. Plant growth regulators are also used to improve flowering, fruit formation, and crop yield. Although agricultural chemicals help meet food demands for increasing populations, excessive use can lead to soil degradation, water contamination, and harmful effects on ecosystems. Therefore, sustainable and environmentally friendly agricultural practices are becoming increasingly important.

2.2 Chemistry in Human Body Mechanism

The human body functions through a complex network of biochemical reactions. Digestion involves enzymes and acids that break large food molecules into simpler absorbable forms. Hydrochloric acid present in the stomach creates an acidic medium necessary for enzyme activity and digestion. Respiration is another chemical process in which oxygen reacts with glucose to release energy required for body functions. Neurotransmitters such as dopamine, serotonin, acetylcholine, and gamma-aminobutyric acid regulate emotions, thinking, memory, and nervous system activities. Hormones and proteins continuously control growth, metabolism, and immunity. The body also maintains chemical balance through electrolytes such as sodium, potassium, calcium, and chloride ions. Any imbalance in these chemicals may affect normal physiological activities. Hence, chemistry forms the fundamental basis of all biological mechanisms in living organisms.



Table 2. Role of Chemistry in Human Body Mechanism

Biological Activity	Chemical/Compound Involved	Function
Digestion	Enzymes, hydrochloric acid	Breakdown of food
Respiration	Oxygen and haemoglobin	Energy production
Brain Activity	Dopamine, serotonin	Mood and memory control
Muscle Movement	Calcium ions, ATP	Muscle contraction
Immunity	Antibodies, proteins	Protection against infection
Energy Generation	Glucose oxidation	Production of body energy

2.3 Environmental Chemistry

Industrial growth and urbanization have increased the release of chemical pollutants into the environment. Harmful gases, industrial waste, plastics, and toxic chemicals contribute to air pollution, water contamination, soil degradation, and global warming. Chemical reactions involving greenhouse gases such as carbon dioxide and methane are major contributors to climate change. Environmental chemistry focuses on understanding pollutant behaviour and developing methods for pollution control and waste management. Green chemistry promotes eco-friendly chemical processes that minimize hazardous substances and reduce environmental damage. Renewable energy technologies, biodegradable materials, and sustainable industrial practices are important developments in this field. Thus, chemistry not only contributes to industrial and technological progress but also provides solutions for protecting the environment and maintaining ecological balance.

3. Estimated Usage of Chemical Products in Daily Life

The use of chemical products in daily life has increased significantly with modernization, industrial growth, and technological advancement. Human beings depend on a wide variety of chemically formulated products for maintaining hygiene, food safety, healthcare, personal appearance, and agricultural productivity. The estimated distribution of chemical product usage presented in Table 3 highlights the relative contribution of different categories of chemical products used in everyday activities. Although the percentage values are approximate, they provide an understanding of how chemistry influences multiple aspects of modern life.

Table 3. Estimated Usage of Chemical Products in Daily Life

Product Category	Approximate Daily Usage (%)
Cleaning Products	30%
Food and Preservatives	25%
Medicines and Healthcare	15%
Cosmetics and Personal Care	20%
Agricultural Products	10%



3.1 Cleaning Products (30%)

Cleaning products represent one of the highest categories of chemical usage in daily life because hygiene and sanitation are essential for human health and disease prevention. This category includes soaps, detergents, floor cleaners, disinfectants, toilet cleaners, dishwashing liquids, hand sanitizers, and washing powders. These products contain surfactants, antimicrobial agents, bleaching compounds, fragrances, and other chemical additives that improve cleaning efficiency. The high percentage usage of cleaning chemicals reflects the growing awareness regarding personal hygiene and environmental cleanliness. In homes, schools, hospitals, industries, and public places, cleaning agents are used regularly to remove dirt, grease, microorganisms, and harmful contaminants. During recent years, the demand for disinfectants and sanitizers has increased considerably because of concerns regarding infectious diseases and public health safety. Despite their benefits, excessive use of cleaning chemicals may create environmental concerns. Wastewater containing detergents and surfactants can affect aquatic ecosystems and water quality. Some cleaning products also release volatile compounds that may contribute to indoor air pollution. Therefore, the development of biodegradable and environmentally friendly cleaning agents has become an important area of chemical research.

3.2 Food and Preservatives (25%)

Food-related chemicals constitute another major portion of daily chemical usage. Preservatives, flavouring agents, colouring compounds, antioxidants, and stabilizers are widely used in processed and packaged food products. Chemicals play an essential role in preserving food quality, increasing shelf life, preventing microbial growth, and maintaining nutritional value during storage and transportation. Common food preservatives such as salt, sugar, vinegar, sodium benzoate, and citric acid are regularly used in household and industrial food processing. Chemical additives are also used to improve taste, texture, aroma, and appearance of food products. Modern food industries depend heavily on chemistry to ensure food safety and large-scale production efficiency. The estimated 25% usage indicates the importance of chemistry in meeting the food demands of growing populations and reducing food wastage. However, excessive consumption of artificial additives and highly processed foods may lead to health problems such as allergies, obesity, digestive disorders, and metabolic diseases. Therefore, food safety regulations and proper monitoring of chemical additives are necessary to ensure safe consumption.

3.3 Medicines and Healthcare Products (15%)

Chemicals used in medicines and healthcare products account for a significant portion of daily-life chemical consumption. This category includes pharmaceutical drugs, vaccines, antiseptics, disinfectants, diagnostic chemicals, nutritional supplements, and medical testing reagents. Healthcare chemistry has greatly improved human life expectancy and reduced mortality from infectious and chronic diseases. Medicinal compounds are carefully formulated to interact with biological systems and provide therapeutic effects. Antibiotics help control bacterial infections, analgesics reduce pain, and antipyretics lower fever. In addition, chemistry is essential for laboratory investigations such as blood analysis, urine testing, and biochemical diagnosis. The estimated usage percentage reflects the increasing dependency of society on healthcare products for disease prevention and treatment. With advancements in medical science, the demand for pharmaceutical products continues to grow worldwide. However, misuse of medicines, self-medication, and excessive antibiotic consumption may create serious health issues such as drug resistance and side effects. Proper medical guidance and controlled usage are therefore essential in healthcare applications.



3.4 Cosmetics and Personal Care Products (20%)

Cosmetics and personal care products form an important category of daily chemical usage because they are associated with hygiene, skin care, grooming, and personal appearance. This category includes shampoos, creams, lotions, perfumes, deodorants, lipsticks, hair oils, soaps, talcum powder, and makeup products. These formulations contain surfactants, emulsifiers, pigments, preservatives, fragrances, and moisturizing compounds. The estimated 20% usage indicates the growing influence of lifestyle changes, beauty awareness, and personal care practices in modern society. Chemical formulations in cosmetics are designed to improve texture, stability, fragrance, and skin compatibility. Sunscreens and antioxidant-containing products also provide protection against ultraviolet radiation and skin damage. Although cosmetic chemistry has improved product quality and consumer convenience, certain synthetic ingredients may cause allergic reactions, skin irritation, or long-term health concerns. Some compounds used in low-quality cosmetic products may also affect environmental safety after disposal. As a result, there is increasing research interest in herbal, natural, and eco-friendly cosmetic formulations.

3.5 Agricultural Products (10%)

Agricultural chemicals represent an important but comparatively smaller percentage of daily chemical usage because they are mainly used in farming and food production activities. This category includes fertilizers, pesticides, herbicides, fungicides, and plant growth regulators. These chemicals improve crop productivity, protect plants from pests and diseases, and enhance agricultural efficiency. Fertilizers provide essential nutrients such as nitrogen, phosphorus, and potassium that support plant growth and increase crop yield. Pesticides and herbicides help reduce crop damage caused by insects, weeds, and microorganisms. The use of agricultural chemicals has played a major role in supporting food security for rapidly increasing populations. However, excessive application of agricultural chemicals may negatively affect soil fertility, groundwater quality, and ecological balance. Chemical residues may accumulate in food chains and affect both human and animal health. Therefore, sustainable agricultural practices, organic farming methods, and controlled chemical application are increasingly encouraged.

4. Positive and Negative Effects of Chemicals

Chemicals play a crucial role in the development of modern civilization and contribute significantly to human health, agriculture, industry, food preservation, and technological advancement. Almost every sector of society depends upon chemical substances and reactions for efficient functioning and improved quality of life. However, along with their beneficial applications, improper handling, excessive usage, and uncontrolled disposal of chemicals may produce harmful effects on human health and the environment. Therefore, understanding both the positive and negative impacts of chemicals is essential for achieving sustainable development and safe utilization of chemical products.

Table 4. Positive and Negative Effects of Chemicals

Area	Positive Impact	Negative Impact
Agriculture	Increased crop yield	Soil contamination
Medicine	Disease treatment	Drug side effects
Food Industry	Longer shelf life	Excess additives harmful
Cosmetics	Improved appearance	Skin irritation/allergy
Industry	Technological advancement	Air and water pollution



4.1 Chemicals in Agriculture

Chemicals used in agriculture have greatly increased food production and improved crop quality. Fertilizers containing nitrogen, phosphorus, and potassium provide essential nutrients required for plant growth and enhance soil fertility. The use of chemical fertilizers has helped farmers increase agricultural productivity and meet the food demands of growing populations. Similarly, pesticides, insecticides, herbicides, and fungicides protect crops from harmful insects, weeds, and diseases, thereby reducing crop losses and improving economic returns. Despite these advantages, excessive and uncontrolled use of agricultural chemicals can negatively affect soil quality, water resources, and biodiversity. Continuous use of synthetic fertilizers may alter soil pH and reduce natural soil microorganisms. Pesticide residues may contaminate groundwater and food products, leading to possible health risks in humans and animals. Some toxic chemicals also accumulate in the food chain and disturb ecological balance. Therefore, modern agricultural practices emphasize controlled application, biofertilizers, and environmentally friendly pest management techniques.

4.2 Chemicals in Medicines and Healthcare

Chemistry has revolutionized the medical field through the development of medicines, vaccines, diagnostic agents, and medical instruments. Pharmaceutical compounds are used to prevent and treat infectious diseases, reduce pain, control chronic illnesses, and improve overall human health. Antibiotics, analgesics, antipyretics, and antiviral drugs are examples of chemical products that have significantly increased human life expectancy and reduced mortality rates. In addition, chemistry supports medical diagnostics through blood testing, urine analysis, biochemical investigations, and imaging technologies. Sterilization chemicals and disinfectants help maintain hygiene in hospitals and healthcare centres. However, improper use of medicines and chemical drugs may produce side effects and health complications. Excessive consumption of antibiotics can lead to antimicrobial resistance, reducing the effectiveness of treatment against infections. Certain drugs may also affect the liver, kidneys, nervous system, or cardiovascular system when used without proper medical guidance. Chemical waste generated by pharmaceutical industries may further contribute to environmental pollution if not managed correctly. Hence, safe dosage, medical supervision, and proper disposal practices are essential in healthcare chemistry.

4.3 Chemicals in the Food Industry

The food industry extensively uses chemical substances for preservation, flavour enhancement, colouring, and packaging. Food preservatives increase shelf life and protect food materials from microbial spoilage and oxidation. Additives such as antioxidants, emulsifiers, flavouring agents, and stabilizers improve food quality, texture, appearance, and taste. These chemicals play an important role in maintaining food safety during transportation and storage. Nutritional supplements and fortified foods are also developed using chemistry to address vitamin and mineral deficiencies in populations. Modern food processing techniques rely heavily on chemical principles to maintain consistency and quality in food products. On the other hand, excessive intake of artificial food additives and preservatives may adversely affect human health. Certain synthetic colouring agents and preservatives have been associated with allergic reactions, digestive disturbances, and other health concerns in sensitive individuals. Consumption of chemically processed foods in large quantities may also contribute to obesity and lifestyle-related disorders. Therefore, food safety regulations and controlled use of additives are necessary to protect public health.

4.4 Chemicals in Cosmetics and Personal Care Products

Cosmetic and personal care products are widely used for skin care, hygiene, and enhancement of physical appearance. Products such as creams, lotions, shampoos, perfumes, deodorants, and makeup formulations contain various organic and inorganic compounds that improve texture, fragrance, stability, and cleaning efficiency. These products contribute to personal confidence, hygiene, and protection from environmental



factors. Modern chemistry has enabled the development of advanced cosmetic formulations containing moisturizers, sunscreens, antioxidants, and anti-aging compounds. Herbal and bio-based cosmetic products are also gaining popularity because of their reduced toxicity and improved environmental compatibility. However, certain synthetic chemicals used in cosmetics may cause skin irritation, allergies, hormonal disturbances, and long-term health risks. Compounds such as parabens, phthalates, and some fluorinated substances have raised concerns regarding their possible toxic effects. Continuous exposure to low-quality cosmetic products may affect skin health and environmental safety. Consequently, research in green chemistry and safe cosmetic formulation is becoming increasingly important.

4.5 Chemicals in Industrial and Technological Development

Industrial chemistry has contributed immensely to economic growth and technological progress. Chemicals are used in the production of plastics, fuels, dyes, paints, synthetic fibers, electronics, construction materials, and energy systems. Chemical industries generate products that support transportation, communication, healthcare, manufacturing, and infrastructure development. Advanced materials developed through chemical research have improved efficiency in electronic devices, renewable energy systems, and engineering applications. Chemical processing industries also provide employment opportunities and contribute to national economic development. Nevertheless, industrial activities often release harmful gases, toxic waste, and pollutants into the environment. Industrial emissions contribute to air pollution, acid rain, ozone depletion, and climate change. Improper disposal of chemical waste may contaminate water bodies and soil, affecting living organisms and ecosystems. Industrial accidents involving hazardous chemicals may also threaten human safety. Therefore, strict environmental regulations, waste treatment methods, and sustainable industrial practices are necessary for reducing chemical pollution.

4.6 Environmental Impact of Chemicals

Chemicals influence both environmental protection and environmental degradation. Environmental chemistry helps in water purification, waste treatment, pollution monitoring, and development of eco-friendly technologies. Green chemistry focuses on minimizing hazardous substances and designing sustainable chemical processes that reduce environmental damage. Biodegradable materials, renewable energy technologies, and environmentally safe fertilizers are examples of positive contributions of chemistry toward sustainability. Scientific research in chemistry has also helped identify the causes of pollution and climate change, enabling the development of corrective measures. At the same time, excessive use of plastics, pesticides, fossil fuels, and industrial chemicals has increased environmental problems globally. Greenhouse gases such as carbon dioxide and methane contribute to global warming and climate imbalance. Toxic chemicals may persist in ecosystems for long periods and affect plants, animals, and human health. Therefore, responsible chemical management and public awareness are essential for environmental protection.

5. Results and Discussion

The present study highlights the significant contribution of chemistry to various aspects of human life including healthcare, hygiene, food preservation, agriculture, cosmetics, industrial development, and environmental protection. The analysis of daily-life chemical products demonstrates that chemistry is deeply integrated into routine human activities and modern technological advancement. The data presented in Table 1 indicate that a wide variety of chemical compounds are used in common household products for improving efficiency, hygiene, and convenience. Toothpaste containing fluoride compounds was found to play an important role in protecting teeth from decay and maintaining oral hygiene. Similarly, soaps and detergents containing surfactants such as sodium lauryl sulphate effectively remove dirt, oil, and microorganisms through emulsification processes. Food preservatives including sodium benzoate, vinegar, and salt were observed to increase shelf life and reduce microbial spoilage in food products. The study further revealed that cosmetics and personal care products contain



a combination of organic and inorganic compounds such as waxes, pigments, and polymers that improve appearance and skin protection. However, prolonged exposure to certain synthetic chemicals may create health concerns, emphasizing the need for safer and eco-friendly cosmetic formulations. The analysis of medicines and healthcare products demonstrated that chemistry has a major contribution in disease prevention, diagnosis, and treatment. Pharmaceutical compounds such as antibiotics and analgesics provide effective therapeutic action and improve human health conditions. In agriculture, fertilizers and pesticides were found to significantly improve crop productivity and food security, although excessive use may result in soil degradation and environmental contamination. Table 2 illustrates the importance of chemistry in human body mechanisms. Biological activities such as digestion, respiration, energy production, muscle movement, and brain functioning depend upon various biochemical reactions involving enzymes, neurotransmitters, proteins, and electrolytes. The study confirms that the human body itself functions as a highly organized biochemical system regulated through continuous chemical interactions. The estimated daily usage analysis presented in Table 3 showed that cleaning products constitute the highest percentage (30%) of chemical usage in everyday life due to increasing awareness regarding hygiene and sanitation. Food-related chemicals and preservatives accounted for approximately 25%, reflecting the importance of chemistry in food safety and preservation. Cosmetics and personal care products contributed around 20%, while medicines and healthcare products represented 15% of chemical usage. Agricultural chemicals accounted for nearly 10%, mainly associated with farming and crop protection activities. The positive and negative effects summarized in Table 4 revealed that chemical products provide major benefits including improved healthcare, increased agricultural productivity, enhanced food preservation, and technological advancement. At the same time, improper use and disposal of chemicals may result in environmental pollution, soil contamination, health disorders, and ecological imbalance. Industrial emissions, excessive pesticide usage, and non-biodegradable chemical waste remain major environmental concerns in modern society. The study also highlights the growing importance of green chemistry and sustainable chemical technologies. Eco-friendly products, biodegradable materials, renewable energy systems, and environmentally safe industrial processes are becoming essential for minimizing harmful environmental effects while maintaining technological progress. Therefore, responsible chemical management and public awareness are necessary to maximize the advantages of chemistry while reducing associated risks.

6. Conclusion

Chemistry plays a fundamental role in human life and modern civilization. The present study demonstrates that chemistry is not limited to laboratories and scientific research but is continuously involved in everyday human activities such as cleaning, cooking, healthcare, agriculture, food preservation, cosmetics, and environmental protection. Common household products including toothpaste, soaps, detergents, medicines, fertilizers, and personal care products function effectively because of carefully designed chemical compounds and reactions. The study further confirms that biological systems of the human body depend heavily on biochemical processes involving enzymes, hormones, neurotransmitters, and electrolytes. Essential life activities such as digestion, respiration, energy generation, and nervous system functioning occur through complex chemical reactions. Thus, chemistry forms the scientific basis for both living systems and technological development.

The analysis of estimated chemical product usage indicates that hygiene-related products and food preservatives constitute a major portion of daily chemical consumption, followed by cosmetics, healthcare products, and agricultural chemicals. These findings demonstrate the widespread influence of chemistry on public health, food security, industrial development, and quality of life. At the same time, the study emphasizes that excessive or improper use of chemicals can create environmental and health-related challenges including pollution, toxicity, ecological imbalance, and long-term health effects. Therefore, sustainable chemical practices, environmental regulations, green chemistry approaches, and public awareness are essential for minimizing harmful impacts.



Overall, chemistry remains one of the most important sciences for the advancement of healthcare, agriculture, environmental protection, and modern technology. Proper understanding and responsible application of chemistry can contribute significantly toward sustainable development, improved living standards, and a safer future for society.

References

- [1] Boonanunt, S., Jomnum, S., & Chanchaorenrith, S., “Chemistry in Everyday Life: A Context-Based Course for High School Students Incorporating Household Application Topics with Explanatory Writing Assignments,” *Journal of Chemical Education*, vol. 101, no. 6, pp. 2372–2380, 2024.
- [2] Laohapornchaiphon, J., & Chenprakhon, P., “A Review of Research on Learning Activities Addressing the Submicroscopic Level in Chemistry,” *Journal of Chemical Education*, vol. 101, no. 11, pp. 4552–4565, 2024.
- [3] Iyamuremye, A. et al., “Utilization of Artificial Intelligence and Machine Learning in Chemistry Education: A Critical Review,” *Discover Education*, vol. 3, Article 95, 2024.
- [4] Venkatesan, K., Sundarababu, J., & Anandan, S. S., “The Recent Developments of Green and Sustainable Chemistry in Multidimensional Way: Current Trends and Challenges,” 2024.
- [5] “Green Chemistry and Its Impact on the Transition towards Sustainable Chemistry: A Systematic Review,” *Sustainability*, vol. 16, no. 15, p. 6526, 2024.
- [6] Aroch, I., Katchevich, D., & Blonder, R., “Modes of Technology Integration in Chemistry Teaching: Theory and Practice,” *Chemistry Education Research and Practice*, vol. 25, pp. 843–861, 2024.
- [7] Ardyansyah, A., & Rahayu, S., “Technology-Enhanced Learning Influence on Chemical Literacy: A Systematic Review,” *Eclética Química*, 2024.