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Comparative Analysis of Air Pollution Tolerance Index and Dust Carrying Capacity in *Calotropis procera*, *Polyalthia Longifolia*, and *Nerium oleander L*. from Different Locations

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Abstract:- Air pollution from industrialization and vehicle emissions is a serious hazard. This study assesses three native Indian plant species' resilience to pollution and adaptability for various environments by evaluating their Dust Carrying Capacity (DCC) and Air Pollution Tolerance Index (APTI). Four biochemical parameters—pH, ascorbic acid levels, chlorophyll, and relative water content—were examined in order to determine APTI. By comparing leaf area to dust deposition capacity, DCC was ascertained. The investigation was carried out at Mewar University utilizing conventional techniques for chemical analysis. The results indicate that, in line with the lower pollution levels at Mewar, Calotropis procera had the highest APTI value (13.71) and the lowest in Chanderiya (4.15). Nerium oleander and Polyalthia longifolia both followed a similar pattern. Because of its wider, hairy leaves, Calotropis procera had the maximum capacity (4.8) for dust capture at Mewar Campus. Comparable DCC values (3.8) were noted in Chanderiya (3.9) and beyond the campus, suggesting that it is environment-adaptable. At the Mewar Campus, Polyalthia longifolia displayed the highest DCC (1.8), whereas Nerium oleander consistently displayed lower DCC (0.8) everywhere it was found, most likely as a result of its smaller leaves. The significance of plant species in urban design and environmental management in contaminated areas is highlighted by these findings.

***Keywords**:- APTI, Dust Carrying Capacity, Calotropis Procera, Polyalthia Longifolia, Nerium Oleander, Air Pollution.*

I. INTRODUCTION

The relationship between air pollution and vegetation impacts has gained increasing attention throughout the last 20 years. Three main issues are driving the present interest in the impacts of air pollution on plants: ecological, aesthetic, and economic. The most evident issue is the economic one [1]. The harvestable product's yield has decreased or its quality has been compromised due to air pollution, most of the air pollutant have effect on the plants photosynthetic activities [2]. It can also have an impact on the product's internal components, which may have an impact on its nutritional content, or its look, which may have an impact on its marketability. Economic losses resulting from air pollution in horticulture and other agricultural enterprises reach hundreds of millions of dollars per year. The aesthetic value is significant even if it is the least important. Air pollution can cause foliar symptoms and development abnormalities that differ from how native plants look in natural areas or ornamental plants in landscaped properties, public parks, and along highways, the nature of the effects are not known until 20th century [3]. India ranks seventh globally in terms of environmental pollution, the rapid growth in vehicular activities in Indian cities has caused serious environmental pollution [4].

Most of the Indian cities are suffering from air pollution due to emission of toxic gases by industrial activities within the cities [5]. The majority of industries disregard environmental rules, regulations, and recommendations. In India, this cloud postpones the monsoon. In India, a lot of taxis and auto rickshaws run on tainted fuel. Although the price is being lowered, in the end, the environment and we will bear the cost. Since they release dangerous pollutants into the air, certain adulterants are truly highly damaging to the environment and aggravate the already poor quality of the air.

According to scientific research, low-speed traffic, particularly when there is a barrier, burn fuel inadequately and emit 4 to 8 times more air pollutants.

The engine exhaust (diesel and gas) contains around 40 distinct types of harmful contaminants. Vehicles are the source of 70% of air pollution. India's growing rice crop has decreased due to the burning of leftover fuels like coal and diesel. India is first when it comes to CO_2 emissions and third in the world for coal production, coal power plants are the major source of sulphur dioxide and nitrogen dioxide [6].

Asthma affects thirty percent of children in Bangalore because of air pollution. The city is referred to be the capital of asthma in India. Video from NDTV claims that Delhi has overtaken Beijing as the most air-polluted city in the world. The amount of pollution has escalated to this level because of industry and car emissions [7].

Air pollution and climate change have gained major global concerns, climate change is primarily caused by excess release of greenhouse gases into the atmosphere [8]. It is clear that we now know a great deal more about how air pollution impacts both naturally occurring and artificially grown plants. While the effects of pollution on plants have been known for hundreds of years, the number and kind of pollutants that cause these effects, as well as the dose response connections and causative mechanisms, were not well understood until the middle of the 20th century [3]. Due to human activities, a variety of pollutants are released into the atmosphere. Most of these pollutants directly influence plants, including carbon dioxide (CO_2), the substrate for photosynthesis, and ozone (O_3), a dangerous oxidant [8]. Air pollution is a huge worry for all living things, including humans, animals, and plants, as well as the ecosystem. It is mostly caused by automobile emissions and industrialization. Plants have a crucial role in lowering air pollution. Given that air pollution is a major problem worldwide, screening sensitive and tolerant plants is essential for their role as bio indicators and sinks for pollutants [9]. Air pollution is a serious problem in many heavily industrialized and populated areas of the world. These biochemical traits provide an easy-to-use, non-invasive way to assess how plants respond to environmental stressors; these traits may also be used to analyse responses in other species. Plants absorb and integrate environmental pollutants into their systems due to their constant exposure to them. Depending on their sensitivity level, plants have been seen to display visible variations, such as changes in metabolic processes or the accumulation of certain metabolites [10].

II. MATERIALS AND METHODS

➢ *Experimental location*

The study was conducted in phases, phase one (1) was the sample collection from three (3) location namely; Mewar University Campus, outside the Mewar University Campus located between latitude 25.03215^0 North and 74.63616^0 East and Chanderiya industrial area located between latitude 24.88 North and 74.64 East, whereas the second phase of the study was conducted at the laboratory of Life Science Department Mewar University Gangrar, Chittorgarh India.

During the research the following materials, equipment and reagents were used; Leaves sample, mortar and pestle, conical flask, measuring cylinder, micropipette, micropipette tips, Acetone (80%), Oxalic Acid, Ascorbic Acid, 2, 6-dicholorophenolindophenol (DCPIP dye), Sodium Bicarbonate, Distilled Water, Centrifuge, Spectrophotometer.

➢ *Sample Collection*

Averagely, 10-15 Fresh healthy leaves were selected from Nerium, Ashapala and calotropis plant species for the analysis. The selection of this plant species was based on their availability in the study areas. The samples were placed in sampling envelopes and transported back to the laboratory for proper storage and subsequent analysis.

➢ *Determination of Dust Deposition and Carrying Capacity*

Initial weight of oven dried petri dish was taken (W1). After weighing dry petri dish, a single leaf of each sampled tree species was washed in dry petri-plates and dried in the oven at 80 degree Celsius for overnight to evaporate the water present in the petri-plates due to leaf washing. After drying again the weight of petri-plates was taken (W2). The dust deposition on the leaves was measured using following formula: W = W2– W1 Where, W = Dust content (g), W1 = Weight of petri dish without dust, W2 = Weight of petri dish with dust. Dust capturing capacity of the selected plant species was measured applying dust load on the leaf surface and leaf area on the following formula: W = W2– W1/ A Where, W = Dust content (mg/cm^2), W1 = Weight of petri dish without dust, W2 = Weight of petri dish with dust, A = Leaf Area (cm^2).

➢ *Air Pollution Tolerance Index (APTI) Determination*

Four key biochemical characters—pH, ascorbic acid concentration, relative water content, and chlorophyll—are needed to estimate the APTI value. The following describes the specific techniques used to extract and calculate those parameters. Throughout the whole investigation, aqueous extract of fresh leaves was utilized.

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➢ *Evaluation of APTI Value*

The formula APTI = {A (T+P) + R}/10 was utilized to estimate the air pollution tolerance index. Where P is the pH of the leaf extract, R is the relative water content of the leaf (%), T is the total chlorophyll content (mg/g), and A is the ascorbic acid concentration (mg/g). Plant tolerance measured by the APTI scale: Depending on the APTI value, different plant groupings (Deciduous, Evergreen, Herbs, and Crops) may have different tolerance categories. Based on the declining APTI score, there are four kinds of tolerance level: tolerant, somewhat tolerant, intermediate, and sensitive.

III. RESULT

Table 1: Results of APTI Values for Three Different Sample Species from Chenderiya, Mewar University Campus and Outside Mewar University Campus

Location	Name of Specie	Total Chlorophyll (mg/g)	Relative Water Content (%)	Ascorbic Acid Conc. (A) (mg/g)	pH of Leaf Extract (P)	APTI Value
Mewar University campus	*Calotropis Procera*	5.4	85	4.5	6.18	13.71
	Polyalthia longifolia	4.5	55	6.5	6.06	12.36
	Nerium Oleander	4.8	70	5.0	6.34	12.57
Outside Mewar University Campus	*Calotropis Procera*	4.02	62	4.0	6.78	10.52
	Polyalthia longifolia	3.81	40	3.2	7.10	7.49
	Nerium Oleander	2.91	51	4.5	6.70	9.42
Chanderiya Industrial Area	*Calotropis Procera*	1.20	30	2.02	4.5	4.15
	Polyalthia longifolia	1.00	28	0.90	6.2	3.45
	Nerium Oleander	0.12	15	1.21	5.3	2.16

Table 2: Results of Dust Capturing Capacity for Three Different Sample Species from Chenderiya, Mewar University campus and Outside Mewar University Campus

Sample Location	Name of Specie	W1 (g)	W2 (g)	DCC (mg/cm^2)
Mewar University campus	*Calotropis Procera*	45.1	49.9	4.8
	Polyalthia longifolia	45.1	46.9	1.8
	Nerium Oleander	45.1	45.6	0.8
Outside Mewar University Campus	Calotropis Procera	45.1	48.9	3.8
	Polyalthia longifolia	45.1	46.3	1.2
	Nerium Oleander	45.1	45.9	0.8
Chanderiya Industrial Area	Calotropis Procera	45.1	49.00	3.9
	Polyalthia longifolia	45.1	46.72	1.62
	Nerium Oleander	45.1	45.89	0.79

Table 3: Results of APTI for Three Different Sample Species from Chenderiya, Mewar University campus and Outside Mewar University Campus

SN	Sampling Location	Species	APTI Value
1	Mewar University Campus	*Calotropis Procera*	13.71
		Polyalthia longifolia	12.36
		Nerium Oleander	12.57
2	Outside Campus Mewar University Campus	*Calotropis Procera*	10.52
		Polyalthia Longifolia	7.49
		Nerium Oleander	9.42
3	Chenderiya Industrial Area	*Calotropis Procera*	4.15
		Polyalthia Longifolia	3.45
		Nerium oleander	2.16

Table 4: Results of Dust Capturing Capacity for Three Different Sample Species from Chenderiya, Mewar University campus and Outside Mewar University Campus

S/N	Sampling Location	Species	Dust Capturing Capacity (mg/cm^2)
1	Mewar University Campus	*Calotropis Procera*	4.8
		Polyalthia longifolia	1.8
		Nerium Oleander	0.8
2	Outside Campus Mewar University Campus	*Calotropis Procera*	3.8
		Polyalthia Longifolia	1.2
		Nerium Oleander	0.8
3	Chenderiya Industrial Area	*Calotropis Procera*	3.9
		Polyalthia Longifolia	1.62
		Nerium oleander	0.79

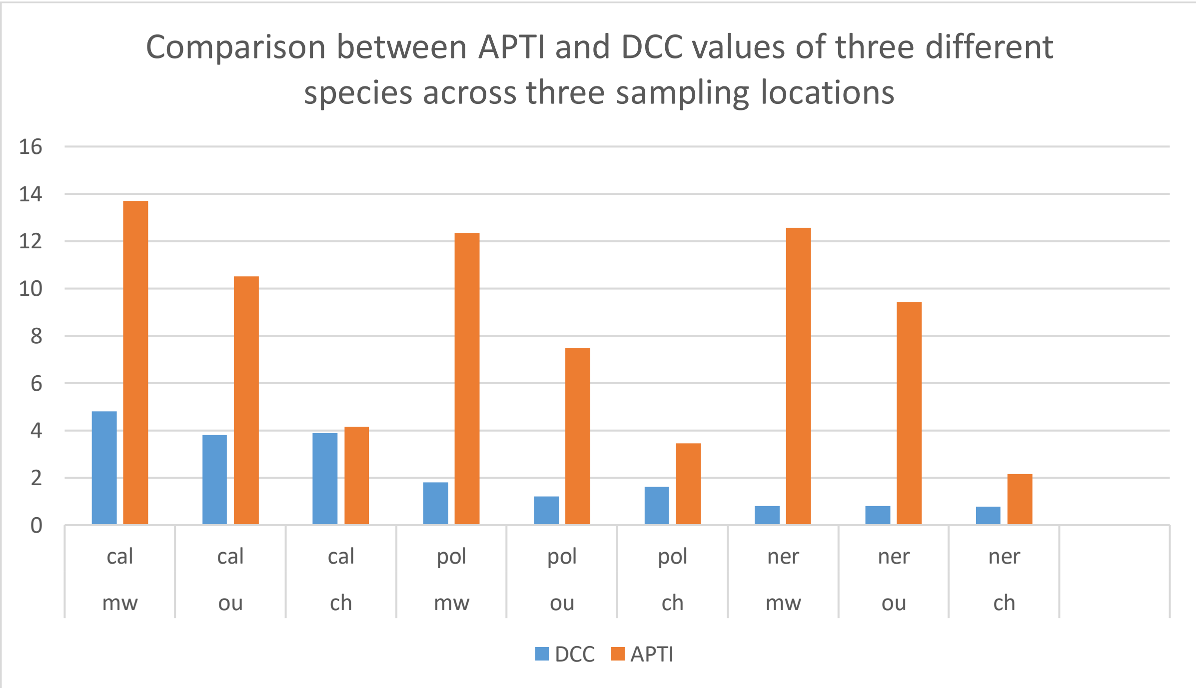

Fig 1: Comparison between APTI (Air Pollution Tolerance Index) and DCC (Dust CAPTURING Capacity) Values of three Different Species Across three Sampling Locations.

INTERPRETATION

- **Table 1:** Table one (1) represent the APTI values of calotropis procera, Polyalthia longifolia and Nerium oleander from three different sampling locations. The final APTI value of each specie was obtained through the evaluation of four different parameters from the plant samples namely: pH, ascorbic acid, chlorophyll and relative water content.
- **Table 2:** The dust capturing capacities, of Polyalthia longifolia, Calotropis procera, and Nerium oleander from three distinct sample sites are shown in Table 2 (2). By weighing W1 (the weight of the oven-dried petri dish) and W2 (the weight of the petri dish with dust), the dust-capturing capability was determined.
- **Table 3:** Table three (3) shows the comparison between APTI values of three different species across three different sampling locations. Calotropis procera has the highest APTI value from all the three sampling locations.
- **Table 4:** Table four (4) show the comparison between the dust capturing capacities of three different species across different sampling locations. Calotropis procera presents the highest dust capturing capacity across the sampling locations.
- **Figure 1:** The comparison of the dust carrying capacity (DCC) and air pollution tolerance indices (APTI) for Calotropis procera, Polyalthia longifolia, and Nerium oleander from the Mewar University Campus, Outside University Campus, and Chanderiya Industrial region is shown in Figure 1.

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IV. DISCUSSION

The study's findings demonstrate that the APTI and dust carrying capacity of plant species examined from various places varied. It was discovered that the same species was intermediately or tolerant in one location and sensitive in another. In contrast to a research by "[11]" that found some plant species, such Ficus benghalensis, grow well in a contaminated environment, It was discovered that the studied plant species in this study were not doing well in the contaminated surroundings. Table 1 displays the biochemical properties and the APTI for plants from the Chanderiya industrial area, the Mewar University campus, and locations outside the Mewar University campus.

The pH range of 4.5 to 6.2 is acidic for all plant species obtained from the industrial site in Chanderiya. On the other hand, the pH range of 6.0 to 7.10 is neutral to slightly acidic for plant species gathered from non-industrial areas in Mewar and outside Mewar Campus. Pollutants like SOX and NOx in the surrounding air can alter the pH of leaf extract to an acidic state, which could be the source of the more acidic medium in industrial species [12].

Relative water content (RWC) of plant species collected from non-industrial sites (Mewar and Outside Mewar Campus), where found to be within range of 40% to 85%, all plant species obtained from industrial sites were lower in this study (15% to 30%).

The result of this study is in contrary to the findings of "[13]" where he concluded that some plant species exhibit higher relative water content in industrial areas compared to species found in non-industrial areas. The contradictions might be due the type of species used for the study.

Ascorbic acid is an antioxidant that is largely present in all of a plant's growth sections and aids in resistance to harsh climatic circumstances. Table 1 lists the average amount of ascorbic acid in plant leaves from both industrial and non-industrial areas. It was shown that ascorbic acid concentrations in leaves of plants from non-industrial areas (Mewar and Outside Mewar Campus) were greater than those in leaves from industrial areas, ranging from 0.9 to 2.0, this finding also contradicts the research by "[14]", which finds that ascorbic acid concentration rises as pollution rates rise, However, this study demonstrates that, depending on the kind of pollutant present in the environment and the species of plant, the ascorbic acid concentration of leaves falls in extremely highly contaminated situations [15].

Chlorophyll concentration affects both the growth and development of biomass as well as its photosynthetic activities. Plant species differ in their levels of chlorophyll content, which is influenced by environmental factors and pollution levels [16]. The current investigation found that, in comparison to plant species examined both inside, outside of Mewar University campus and Chanderiya industrial area, the chlorophyll content of every investigated species of plants in the Chanderiya Industrial Area was lower. Calotropis procera from Mewar University Campus (control) had the maximum chlorophyll content (4.8), whereas Nerium oleander from the Chanderiya industrial area (polluted region) had the lowest chlorophyll content (0.12). This finding's outcome confirms the research or conclusions of "[17]", which shows that the higher the pollution in an area, the lower the concentration of chlorophyll in the plant species found within that area. Reduction of chlorophyll content in variety of plants due to NO_x and SOx have also been recorded by "[18]".

The APTI values calculated for each plant species at three sites are presented in table one (1). Table 1 clearly showed the APTI values of plant species studied within and Outside Mewar University Campus is higher compared to plant species obtained from Chanderiya industrial area.

Calotropis Procera has the highest APTI value of 13.71 at Mewar University campus and lowest at Chanderiya industrial area(Polluted environment), the findings of this study indicates that calotropis procera is sensitive due to air pollution, which is why the APTI value in the control region is greater and the APTI value in the polluted area is lower. Severe air pollution can harm the physiological processes of plant leaves, which lowers the plants' tolerance to air pollution. As indicators, sensitive plant species can warn the public or a community about rising pollution levels.

[19]. Plants growing along the roadsides and industrial areas becomes easily affected at a maximum level as they are the first recipients of different air pollutants and show varied levels of tolerance and sensitivity [20]. Certain plants have an increased APTI score when exposed to high levels of air pollution because they become more tolerant of it [21]. This high APTI value at Mewar University can be attributed to the plants high relative water content (85%), and substantial total chlorophyll content (5.4). The ascorbic acid concentration is also significant, although it is the lowest among the three species, suggesting that other factors such as high water content and chlorophyll levels play a more dominant role in raising the APTI value. The pH of 6.18 indicates a slightly acidic leaf environment which might help in neutralizing some pollutants.

Polyalthia longifolia (Ashapala) has an air pollution tolerance index that is modest at Mewar University campus with an APTI value of 12.36. It has the highest ascorbic acid concentration (6.5 mg/g) among the three species, indicating strong antioxidant properties which help in combating oxidative stress caused by pollutants Ascorbic acid is a potent antioxidant, protecting plant cells from oxidative stress by scavenging reactive oxygen species (ROS). This helps in maintaining cellular health and mitigating damage from environmental stressors such as drought, extreme temperatures, and pathogen attacks. However, its relative water content is the lowest (55%), which might reduce its overall pollution tolerance. The total chlorophyll content is also lower compared to Calotropis Procera, further impacting its APTI value. The pH of 6.06 is close to neutral, which is generally favourable for metabolic processes.

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Nerium Oleander has an APTI value of 12.57 within Mewar Campus, Several studies have indicated that Nerium oleander exhibits a high APTI value, suggesting its strong tolerance to air pollutants, For instance, research conducted in urban areas with high vehicular emissions showed that oleander maintained high levels of ascorbic acid and total chlorophyll content, indicating its robust defence mechanisms against oxidative stress caused by pollutants [22], but in contrary to this research, Nerium oleander is less tolerant to air pollution because it has lower APTI value and grows badly in the industrial area which is likely affected by severe industrial pollution. Its relative water content is 70%, which is significant and helps maintain cellular functions under stress conditions. The total chlorophyll content is moderate at 4.8, which contributes to its photosynthetic efficiency and overall health. The ascorbic acid concentration is 5.0 mg/g, which provides a good level of antioxidant protection. The pH of 6.34 is slightly more alkaline compared to the other species, which might influence its enzymatic activities and metabolic processes. This research proves that Nerium oleander is more susceptible to air pollution than calotropis procera and Polyalthia longifolia.

Based on this research, when compared to the industrial region, the three examined species were shown to be growing more effectively on the university campus and in the near vicinity.

This research contradicts the findings of "[11]", which concluded that plants found in polluted areas tend to have higher APTI values compared to those found in a clean environment. However, this research is limited to few number of species, , more plant species should be included in future studies to broaden the coverage.

- *Dust Capturing Capacity*

Plants have different morphological features like leaf shape, size and texture, presence or absence of hairs, surface roughness etc. All these features determines the dust capturing capacity of a plant species [14].

The result of dust capturing capacity of the three species studied from three different location is presented in table two (2) above, the results were obtained from samples from Chenderiya, Mewar University campus and Outside Mewar University Campus. Of the three species, Calotropis Procera exhibits the greatest potential for trapping dust with a value of 4.8 g. This is due to the large surface area and dense trichomes that traps dust particles more effectively, it can also adapt to harsh environmental conditions including high dust levels [23]. This suggests that this species can be rather successful in capturing dust particles in the air.

Used in environment where there is high air pollution due to dust particles released into the environment. Similar studies have proved that calotropis procera played a vital role in capturing dust from its surrounding environment, the high dust holding capacity of *Calotropis procera* and *Delbergia sissoo* is due to the morphology and texture of the leaves [24].

Polyalthia longifolia has a moderate dust capturing capacity of 1.8 g. While it is not as effective as Calotropis Procera, it still contributes to dust removal from the air. The dust capturing capacity indicates that Polyalthia longifolia can trap a reasonable amount of dust, making it beneficial for areas with moderate pollution levels. The leaf morphology and surface texture are essential to its moderate dust capturing capacity as observed by "[25]".

Nerium Oleander shows the lowest dust capturing capacity within Mewar campus (0.8 g). This proves that it is the least effective in capturing dust among the three species studied within the campus and this may be linked to the smaller surface area possessed by the Nerium leaves. Nerium oleander has relatively smaller leaves compared to other dust-capturing species like Polyalthia longifolia. Smaller leaves provide a reduced surface area for dust deposition. Additionally, the orientation of oleander leaves may not be as effective in intercepting airborne particulates as the more vertically oriented leaves of other species [26].

The Air Pollution Tolerance Index (APTI) and Dust Capturing Capacity (DCC) values of three distinct plant species at three sample locations are compared in Figure 1 above. The three species exhibit higher levels of APTI at Mewar University, where pollution levels are low, whereas they show lower values in the industrial area. This study suggests that Calotropis procera, Nerium, and Polyalthia longifolia can be used as bio indicators to indicate the presence of pollutants in an environment.

APTI value increases with increase in the amount of pollution, APTI score, however, tends to drop in cases of high or severe pollution [19]. The following graphic also shows each plant's capacity to capture dust for the three distinct sites. The larger leaves of Calotropis, followed by waxy nature of the leaves, gives it more chance to trap dust particles from the air. Dust capturing capacity is greatly increased with increase in leaf surface area [27].

V. CONCLUSION

The effects of air pollution on people, plants, and animals are widespread. The ability of different plant species to absorb dust and their tolerance to pollution vary. Higher values on the Air Pollution Tolerance Index (APTI) indicate plants that are appropriate for polluted locations, while lower values may indicate contamination. The APTI is a helpful indication. This study looks at three species from Rajasthan and finds that because of pollution, plants in industrial regions have lower APTI values than those in control zones. The plants with the greatest capacity to capture dust were discovered to be Calotropis procera, Polyalthia longifolia, and Nerium oleander.

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- *Ethical Statement*

This research does not require ethical approval.

- *Author Contributions*

Umar Abdussalam Kura: Writing – review & editing, Methodology, Writing – original draft. Dr. Umesh Garu: Formal analysis and Investigation. Prachi Singh: Conceptualization, Supervision. Dr. Ramgopal Dhakar: Conceptualization, Project administration. Habiba Aminu: Editing. Mr. Praveen Kumar Tiwari: Reviewing.

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- *Conflict of Interest*

Because there were no financial or commercial ties that may be seen as having a conflict of interest, the authors state that there was no conflict of interest during the research.

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