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Atmospheric Content of Particulate Matter PM2.5 in Gazipur and Mymensingh City Corporation Area of Bangladesh

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Abstract: *The particulate matter $PM_{2.5}$ concentrations in the air of Gazipur and Mymensingh city-corporation during February to April, 2019 have been studied. The $PM_{2.5}$ status and the sources of air pollution in these cities have been investigated. Sampling was done by "SNDWAY SW-825 Laser $PM_{2.5}$ Detector tester gas monitor Digital Air Quality Monitor. The sampling sites were Joydebpur road, Vogra Bypass Bus Stop, Gazipur Chowrasta Bus stop, Telipara and Salna in Gazipur city-corporation In Mymensingh city-corporation the sampling sites were BAU Campus, Bridge Moor, Chorpara, Town-hall, Bypass Moor Bus stop, respectively. The concentrations of $PM_{2.5}$ significantly changed with respect to that of previous years. Though Gazipur is a very busy traffic point and Mymensingh is a semi residential area, the concentrations of $PM_{2.5}$ Gazipur city-corporation has been found higher than that of Mymensingh city-corporation. $PM_{2.5}$ concentration in the air of Gazipur city-corporation ranged (137.25 - 341.44 µg m^{-3}), the highest $PM_{2.5}$ concentration 282.50 µg m^{-3} was found in Telipara and the lowest concentration 147.08 µg m^{-3} was found in Salna, with mean value of 203.68 µg m^{-3}, while standard deviation was 55.39 µg m^{-3}. $PM_{2.5}$ concentration in the air of Mymensingh city-corporation ranged from (120.67-268.67 µg m^{-3}), the highest $PM_{2.5}$ concentration 233.83 µg m^{-3} was found in Bridge moor and the lowest concentration 128.58 µg m^{-3} was found at BAU Campus, with mean value of 172.73 µg m^{-3}, while standard deviation was 40.10 µg m^{-3}. During sampling period the highest concentration 230.30 µg m^{-3} was found in the month of February, 2019 and the lowest concentration 183. 05 µg m^{-3} was found in the month of April, 2019 in Gazipur city-corporation. During sampling period in Mymensingh city-corporation, the highest concentration 242.40 µg m^{-3} was found in the month of February, 2019 and the lowest concentration 101.15 µg m^{-3} was found in the month of April, 2019. Considering the daily fluctuation between the study areas the $PM_{2.5}$ concentration was found higher during noon to evening period and lower at night. From the result it might be concluded that the concentration of $PM_{2.5}$ in the air of Gazipur and Mymensingh city were comparatively higher than the values observed in most of the European cities and also exceeded the Bangladesh National Air Quality Standard.*

Keywords: *Particulate Matter, Bangladesh, Air pollution, Vehicle emission*

1. INTRODUCTION

Air pollution has become a public health concern in Bangladesh and regarded as one of the major environmental hazards in Bangladesh as well as worldwide. Particulate matter pollution is a major concern in the large cities of Bangladesh. The main contributors of air pollution are motor vehicles, brick kilns, diesel generators and industries. In recent years much research interest has been shown on atmospheric particles as they influence on climate change and cause adverse health effects (Islam *et al.*, 2017; Hoque *et al.*, 2014). Atmospheric PM is of great concern to the public and to government agencies because of its significant impact on human health, visibility reduction, agriculture and atmospheric chemistry (Sarker *et al.*, 2018; Begum *et al.*, 2012). Particle pollution is the term for a mixture of solid particles and liquid droplets found in the air. These include "inhalable coarse particles," with diameters between 2.5 micrometers and 10 micrometers, and "fine particles," 2.5 micrometers and smaller (EPA, 2016). Developing (like Bangladesh) or rapidly industrializing countries are most vulnerable to air pollution because a great amount of air pollutants from various sources mix continuously in the environment. In developing countries like Bangladesh, population explosion along with widespread urbanization has resulted in dense urban centers with poor air quality. Biomass burning and dust deposition profound deterioration of air quality which reported by a

research group in Bangladesh (Miah *et al.*, 2019). In parallel with the advancement of technology, industrial revolution has imported new problems.

Air pollution is one of such problems and has been severely affecting the urban as well as rural are environmental quality in the globe. In recent years much research interest has been shown on atmospheric particles as they influence on climate change and cause adverse health effects (Hasan *et al.*, 2016). Air quality monitoring data is limited in Bangladesh, however, periodic surveys by the Department of Environment (DOE), indicate that the ambient levels of SPM, SO_2 and airborne lead are higher than the Bangladesh air quality guidelines. The pollutants emitting from automobiles are obvious contributor to the pollution problem in Bangladesh; however, no emissions inventory detailing sources of pollution in national level is currently available (Sarker *et al.*, 2018). Particle sources (from coal and biomass burning in brick field) impacts may be contributing haze at urban and semi-urban areas of Bangladesh.

Concern about atmospheric particulate pollution in urban region is receiving growing importance worldwide. Urban areas are mainly affected by suspended particles, which pose a series risk to human health (Wahid, 2006). It is understood that aerosol particulate matter has a correlation with toxic trace metals and affects human health in urban and rural environments (Begum *et al.*, 2013). Previous studies have indicated that the severe $PM_{2.5}$ pollution resulted in more than 3 million premature deaths around the world in the year of 2010 (Lim *et al.*, 2012).

Rapid industrialization and economic development occurred in Gazipur cities during the recent years which may increase the emission of various pollutants. The number of motor vehicles increased significantly in Gazipur, there has been a steep rise in a heterogeneous mixture of old technology vehicles despite that the road space is narrowing and the traffic congestion is reaching in unmanageable proportions. As a result major traffic intersections in the city have turned to hot spots for air pollution from vehicular emissions. Gazipur, a new city corporation is considered as one of the industrially developed city in Bangladesh. Unplanned land use and inadequate traffic management system cause various problems with the air in the study areas. That's way researcher felt importance to conduct a research on air pollution between the study areas. The objectives of the study are to determine the atmospheric particulate matter concentration $PM_{2.5}$ in the study areas and to compare the particulate matter $PM_{2.5}$ between the study areas.

2. MATERIALS AND METHODS

Study area: Particulate matter sampling was performed in two different location Gazipur and Mymensingh city-corporation in Bangladesh. Each city-corporation areas five 5 sampling location were selected randomly. In Gazipur the sampling location were Joydebpur Road, Vogra Bypass Bus stop, Gazipur Chowrasta, Telipara, and Salna. In Mymensingh the Sampling location were BAU Campus, Bridge Moor, Chorpara, Town-hall, Bypass Moor Mymensingh, respectively. Sampling location are presented in Figure 1 and Figure 2 respectively.

Site selection: Data collection sites were the most important for proper study of air quality. In this study data were collected from crowed areas like bus stop and mainly traffic areas both location.

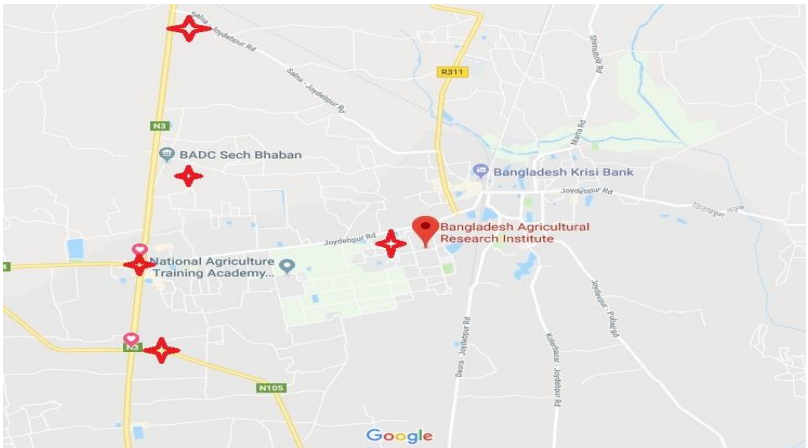

Figure1. *Show the study area of research work in Google Map view (Gazipur city-corporation area)*

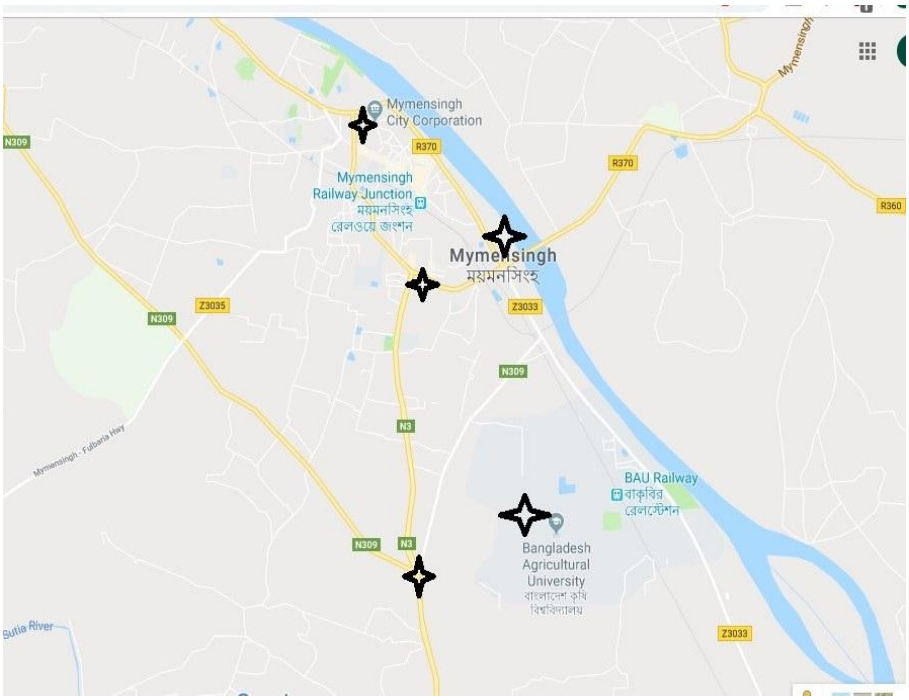

Figure2. *Show the study Area of research work in Google map (Mymensingh city-corporation area)*

Timing of data collection: At the two study location, data were recorded on both working days and holidays during the month of February 2019 to April 2019. During sampling period 120 $PM_{2.5}$ data were recorded from two locations. Data were collected from 7:00 am to 1:00 am with six hour interval. Each location 24 hours data collection was done than averaged to get final value. Each month five average data was recorded from each sampling areas. To identify 24 hours fluctuation, data recorded Salna in Gazipur city-corporation and town-hall in Mymensingh city-corporation area respectively Data were collected when a vehicle was passing or made smoke by vehicle or crowded situation occurred.

Measurement process:

- Short press to turn on the device. The devices start to monitor $PM_{2.5}$ after 10s. Long press to turn off the device.
- When the detected result over the setting value, the result will blink in red to alarm.
- Short press to set the alarm. Short press or to adjust the value when the value is twinkling. Long press or to adjust more quickly.
- Short press to save the setting. Or short press to cancel the setting and return to the main screen

General description of $PM_{2.5}$ detector: This is a real-time $PM_{2.5}$ air quality monitor instrument used to monitor the concentration of $PM_{2.5}$ in the indoor/outdoor environment. It features clear LED display screen to indicate $PM_{2.5}$ pollution level. Very good and helpful for environmental protection. Suitable for home, office, outdoor, car and other places use. The super mini pocket design that can carry around and detect anywhere you like. An ideal multi-function testing tool to monitor the air quality, a safeguard for family health.

Specification of $PM_{2.5}$ detector:

Brand	SNDWAY
$PM_{2.5}$ Measuring Range	0~500 μg m^{-3}
Single Response Time	<1s
Composite Response time	≤10s
Resolution Rate	1 μg m^{-3}
Counting Efficiency of Particulate Matter	50%@ 0.3 μm 98%@ ≥0.5 μm

Mass Concentration Consistency of Particulate Matte	±10%@100~500 μg m^{-3}; ±10 μg m^{-3}; @0~100 μg m^{-3}
Temperature Measuring Range	-10.0~50.0 °C
Temperature Accuracy	±0.3 °C
Humidity Measuring Range	0%~99% RH
Humidity Accuracy	±3% RH
$PM_{2.5}$ Sensor	Laser Particulate Matter Sensor
Working Time for Once Charging	>4.5/h
Charging	DC5V 500mA USB Connector
Battery	Li-ion Battery 580mAh
Product Size (appr.)	60 x 60 x 26 mm / 2.4 x 2.4 x 1.0 inch
Package Weight (appr.)	184 g

Data processing, analysis and interpretation: After collecting data, those were recorded in a excel spreadsheet. Statistical analysis was done. The collected data have been processed, analyzed and interpreted for final presentation of the thesis. The analyzed data are presented through table and graphical form. Final report has been prepared in the form of a thesis by using the result of the analyzed information in accordance with objectives of the study.

Scale of $PM_{2.5}$ air quality detector meter:

Grade of Air Quality	Average Value of $PM_{2.5}$ in 24 hours
Great	0~35 μg m^{-3}
Good	35~75 μg m^{-3}
Mildly Polluted	75~115 μg m^{-3}
Moderately Polluted	115~150 μg m^{-3}
Seriously Polluted	150~250 μg m^{-3}
Severely Polluted	>250 μg m^{-3}

3. Results and Discussion

The basic statistics of $PM_{2.5}$ concentration has been given in Table 1. $PM_{2.5}$ Concentration at Joydebpur road ranged (162.11-191.00) μg m^{-3}, with a mean value 182.75 μg m^{-3} while SD 25.99 μg m^{-3}, Gazipur Chowrasta ranged (159.00-232.44) μg m^{-3}, with a mean value 227.50, SD 31.93 μg m^{-3}, Vogra bypass ranged (147.75-212) μg m^{-3}, with a mean value 178.58 μg m^{-3}, while SD 26.51 μg m^{-3}, Telipara ranged (200.5-341.44) μg m^{-3}, with a mean value 282.50 μg m^{-3}, SD 45.66 μg m^{-3}, while SD 45.66 μg m^{-3} and Salna ranged (137.25-157.00) μg m^{-3}, with a mean value 147.08 μg m^{-3}, while SD 14.69 μg m^{-3} in Gazipur city-corporation. The total $PM_{2.5}$ concentration in Gazipur city-corporation ranged from (137.25 - 341.44) μg m^{-3} with a mean value of 203.68 μg m^{-3}, while standard deviation was 55.39 μg m^{-3}.

Table1. *Summary Statistics of $PM_{2.5}$ in Gazipur city-corporation area.*

Location	**$PM_{2.5}$ (μg m^{-3})**	
	Range	Mean (SD)
Joydebpur road	162.11-191.00	182.75 (25.99)
Gazipur chowrasta	159.00-232.44	227.50 (31.93)
Vogra bypass	147.75-212	178.58 (26.51)
Telipara	200.5-341.5	282.50 (45.66)
Salna	137.25-157	147.08 (14.69)
Total mean		203.68
SD		55.39
Min.		137.25
Max		341.44

The basic statistics of $PM_{2.5}$ concentration has been given in Table 2. $PM_{2.5}$ Concentration at BAU ranged (120.67-139.67) µg m^{-3}, with a mean value 128.58 µg m^{-3}, while SD 8.04 µg m^{-3}, Bridge moor(211.33-268.67) µg m^{-3}, with a mean value 233.83 µg m^{-3}, while SD 25.32 µg m^{-3}, Chorpara ranged (153.00-208.67) µg m^{-3}, with a mean 179.08 µg m^{-3}, while SD 24.05 µg m^{-3}, Town hall ranged (133.00-179.33) µg m^{-3}, with a mean 158.00 µg m^{-3}, while SD 22.71 µg m^{-3} and Bypass moor (144.00-190.00) µg m^{-3}, with a mean 164.17 µg m^{-3}, SD 19.09 µg m^{-3}. The total $PM_{2.5}$ concentration in Mymensingh city-corporation ranged from (120.67-268.67) µg m^{-3} with a mean value of 172.73 µg m^{-3}, while standard deviation was 40.10 µg m^{-3}.

Table2. *Summary statistics of $PM_{2.5}$ in Mymensingh city-corporation area.*

Location	**$PM_{2.5}$ (µg m^{-3})**	
	Range	Mean (SD)
BAU	120.67-139.67	128.58 (8.04)
Bridge moor	211.33-268.67	233.83 (25.32)
Chorpara	153.00-208.67	179.08 (24.05)
Town hall	133.00-179.33	158.00 (22.71)
Bypass moor	144.00-190.00	164.17 (19.09)
Total mean		172.73
SD		40.10
Min.		120.67
Max		268.67

Summary statistics of $PM_{2.5}$ during February to April in Gazipur city-corporation has been given in Table 3. The $PM_{2.5}$ concentration in Gazipur city-corporation during February ranged from (89 – 427) µg m^{-3} with a mean value of 230.30 µg m^{-3}, while standard deviation was 116.95 µg m^{-3}. During March $PM_{2.5}$ ranged (127-289) µg m^{-3}, with a mean value 197.60 µg m^{-3}, while standard deviation was 43.15 µg m^{-3} and finally in April $PM_{2.5}$ ranged (109-381) µg m^{-3}, with a mean value 183.15 µg m^{-3}, while standard deviation was 72.58 µg m^{-3}. The total mean value was 268.67 µg m^{-3} during sampling period.

Table3. *Summary statistics of $PM_{2.5}$ during February to April, 2019 in Gazipur city-corporation area.*

Months	**$PM_{2.5}$ (µg m^{-3})**	
	Range	Mean (SD)
February	89-427	230.30 (116.95)
March	127-289	197.60 (43.15)
April	109-381	183.15 (72.58)
Total mean		203.68

Summary statistics of $PM_{2.5}$ during February to April in Mymensingh city-corporation has been given in Table 4. The $PM_{2.5}$ concentration in Mymensingh city-corporation during February ranged (142 – 427) µg m^{-3} with a mean value of 242.40 µg m^{-3}, while standard deviation was 87.75 µg m^{-3}. During March $PM_{2.5}$ ranged from (107-278) µg m^{-3}, with a mean value 174.75 µg m^{-3}, while standard deviation was 47.48 µg m^{-3} and finally in April $PM_{2.5}$ ranged (45-167) µg m^{-3}, with a mean value 101.05 µg m^{-3}, while standard deviation was 30.64 µg m^{-3}. The total mean value was 172.73 µg m^{-3} during sampling period.

Table4. *Summary statistics of $PM_{2.5}$ during February to April, 2019 in Mymensingh city-corporation area.*

Months	**$PM_{2.5}$ (µg m^{-3})**	
	Range	Mean (SD)
February	142-427	242.40 (87.75)
March	107-278	174.75 (47.48)
April	45-167	101.05 (30.64)
Total mean		172.73

Concentration of $PM_{2.5}$ between Gazipur and Mymensingh city-corporation areas during February to April, 2019: Concentration of $PM_{2.5}$ between Gazipur and Mymensingh city-corporation has been given in the Figure 3. Between two study locations the highest $PM_{2.5}$ 242.40 µg m^{-3} was found in Mymensingh city-corporation and the lowest $PM_{2.5}$ 101.05 µg m^{-3} was found in Mymensingh city-corporation.

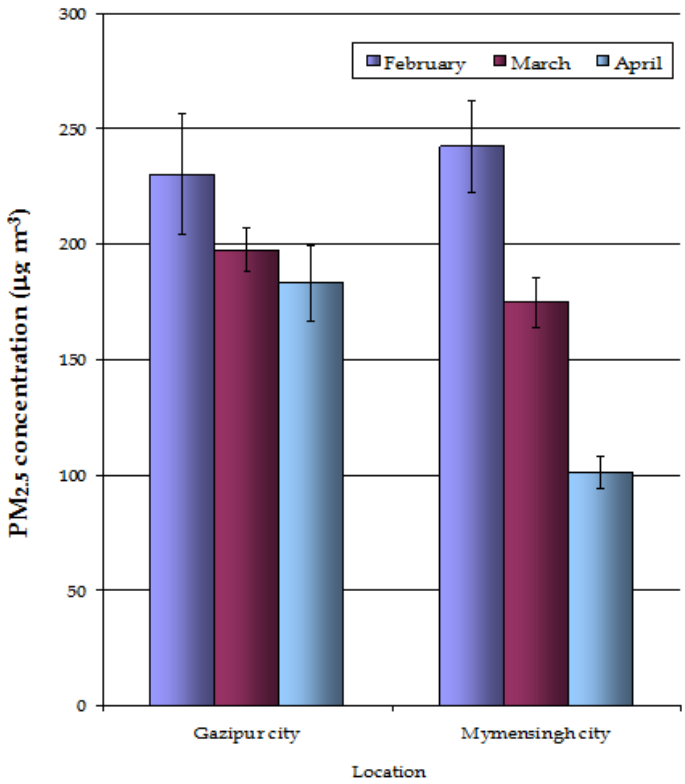

Figure3. *Concentration of $PM_{2.5}$ between Gazipur and Mymensingh city-corporation areas during February to April, 2019.*

Fluctuation of $PM_{2.5}$ concentration in Gazipur city-corporation area: Twenty-four hours fluctuation of $PM_{2.5}$ Concentration were presented in the Figure 4. Considering the sampling period the daily fluctuation constantly getting higher from morning to evening. The highest value was found at Noon (1.00 PM) and the lowest value was found at Night (1.00 AM).

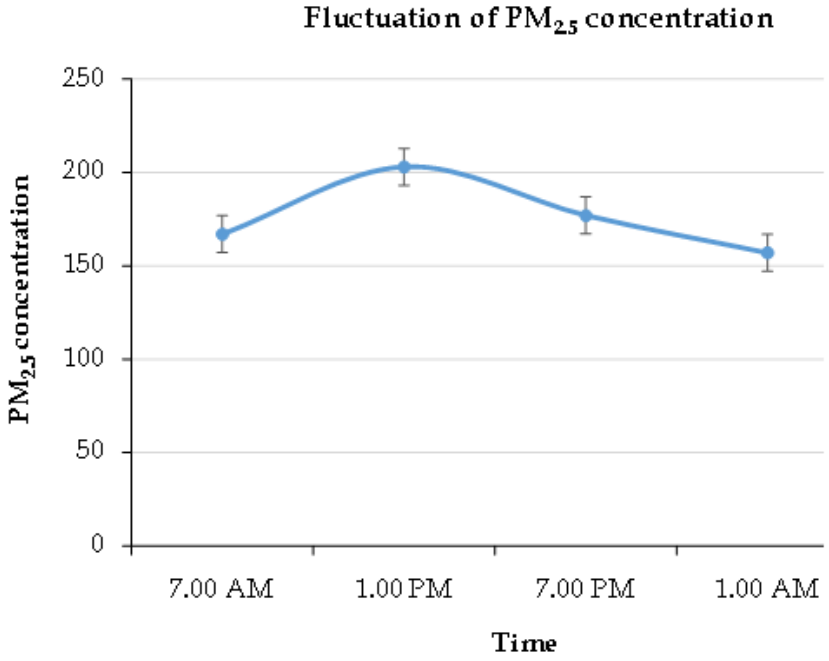

Figure4. *Fluctuation of $PM_{2.5}$ concentration in Gazipur city-corporation area.*

Fluctuation $PM_{2.5}$ concentration in Mymensingh City-corporation area: Twenty-four hours fluctuation of $PM_{2.5}$ Concentration were presented in the Figure 5. Considering the sampling period the daily fluctuation constantly getting higher from morning to evening. the highest value was found at Evening (7.00 PM) and the lowest value was found at Night (1.00 AM).

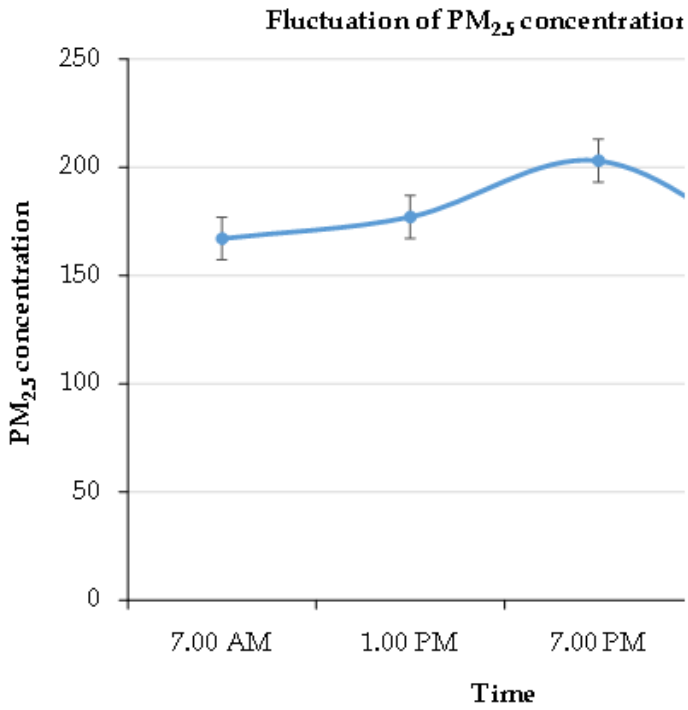

Figure5. *Fluctuation of $PM_{2.5}$ concentration in Mymensingh city-corporation area.*

Concentration of $PM_{2.5}$ between two study areas: After statistical analysis it was found that (Table 1) the total concentration of $PM_{2.5}$ in Gazipur city ranged from 137.25 - 341.44 µg m^{-3} with a mean value of 203.68 µg m^{-3}.

In Mymensingh city the total concentration of $PM_{2.5}$ was found that (Table 2) ranged from 120.67-268.67 µg m^{-3} with a mean value of 172.73 µg m^{-3}.

NAAQS exposer standards were most recently revised in 2006 tighten the 24-hour $PM_{2.5}$ standard to 35 µg m^{-3}. Result showed that $PM_{2.5}$ concentration in Gazipur city was higher than NAAQS standard and $PM_{2.5}$ concentration in Mymensingh city was also higher than NAAQS standard.

The values were higher than the result conducted by Baitun *et al.* (2018) at Ashuiganj, Brahmanbaia, where the concentrations of $PM_{2.5}$ varied from 12.2-145 µg m^{-3} where mean value was 67.09 µgm^{-3}. The results were lower than the work conducted by Mondol *et al.* (2015) where the average concentrations of total suspended particulate matter in city ambient air were 413.02, 292.63, 671.65, 184.09 and 301.13 µg m^{-3} in Dhaka, Noakhali, Chittagong, Faridpur and Kustia, respectively.

The result were similar with the work conducted by Hoque *et al.* (2014) at Farmgate Dhaka and Joydebpur road Gazipur. the concentrations of $PM_{2.5}$ in the air of Joydebpur (Gazipur) has been found higher than that of Farmgate (Dhaka) during the sampling period and the daily average of $PM_{2.5}$ for both the cities always exceeded the Bangladesh National Ambient Air Quality Standard (BNAAQS, 65 µg m^{-3} for $PM_{2.5}$).

Concentration of $PM_{2.5}$ during February to April 2019 between two study areas: After statistical analysis it was found that (Table 3), PM concentration during February, range (89-427) µg m^{-3}, mean 230.30 µg m^{-3}, SD 116.95 µg m^{-3}, March, range (127-289) µg m^{-3}, mean 197.60 µgm^{-3}, SD 43.15 µg m^{-3}, April range (109-381) µg m^{-3}, mean 183.15 µg m^{-3}, SD 72.58 µg m^{-3} in Gazipur city.

In Mymensingh it was found that (Table 4) PM concentration February range (142-427) µg m^{-3}, mean 242.40 µg m^{-3}, SD 87.75 µg m^{-3}, March range (107-278) µg m^{-3}, mean 174.75 µg $m^{-3,}$ SD 47.48 µg m^{-3}, April range (45-167) µg m^{-3}, mean 101.05 µg m^{-3}, SD 30.64 µgm^{-3}.

The results were lower than the work conducted research by Rouf *et al.* (2012) observed that during April- October, 24 hour average concentration of $PM_{2.5}$ were high within the National Ambient Air Quality Standard (NAAQS) level but it increased occasionally by more than two and a half times during the whole non-monsoon period (November-March). The highest values found of $PM_{2.5}$ were

327 µg m^{-3} and 254.9 µg m^{-3} 24 hour average concentration in January 2007 and December 2008 respectively.

The values were higher with the conducted research by Hossain *et al*. (2012) showed the monthly average hourly PM concentrations in winter months (November to March). $PM_{2.5}$ annual average was found 95 μgm^{-3} exhibit levels exceeding World Health Organization (WHO) guidelines as well as exceed more than twice the national standards of annual $PM_{2.5}$ (15 µg m^{-3}) concentrations.

The results were higher to conduct research Rana *et al.* (2016) investigated temporal and directional variation in particulate matter (PM) concentration in Dhaka, Gazipur, and Narayanganj from October 2012 to march 2015 $PM_{2.5}$ concentration were six times greater than the national standards of Bangladesh. Dhaka and its vicinity experienced several air pollution episodes in dry season when $PM_{2.5}$ concentrations were 8-13 times greater than the World Health Organization (WHO, 2016) guideline value.

The results were higher to conduct research Begum *et al.* (2013 from January 2007 to February 2009. Result showed that PM concentration were much than the Bangladesh National Air Quality Standard (BNNAQS).

The results were similar to conduct research Begum *et al.* (2011) found that vehicular emissions and emission from brick kiln are the major contributors to air pollution in Dhaka especially in the dry seasons.

The result were similar to conduct research Begum *et al.* (2013) has been analyzed that the $PM_{2.5}$ concentrations were not varying so much between day and night time. This might be due to the rainfall and high humidity during these days.

4. CONCLUSION

Considering the concentrations of $PM_{2.5}$ in the ambient air of both study areas, it might be concluded that ambient air of traffic areas between two location were unhealthy and $PM_{2.5}$ values were highest in dry season this might be temperature, humidity, Vehicle emission, Brick kilns emission and Industrial smoke. Special attention is recommended to the respective authority to overcome the environmental problems and health risks caused by air pollution, particularly $PM_{2.5}$ pollution.

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