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VOLUME 13 ISSUE 4 VERSION 1.0

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# Diurnal and Seasonal Flight Activity of the Honeybee, *Apis mellifera* L, and its Relationship with Temperature, Light Intensity and Relative Humidity in the Savanna of Northern Nigeria

By Usman H Dukku, Zecarias Russom & Albert G Domo
*Abubakar Tafawa Balewa University, Nigeria*

*Abstract -* This study was carried out at Bauchi (10°19'N; 09°50'E; Elevation 520 m), Nigeria, and it was the first of its kind in the country. Number of foraging bees returning to the hive was recorded for five minutes, at intervals of 30 minutes, and used as an indicator of flight activity. Temperature, light intensity and relative humidity were recorded concurrently. Two peaks of flight activity (one just before sunrise and the other just before sunset), separated by a period of very low activity, were observed in the dry season. However, in the rainy season flight activity was high throughout the day, declining progressively towards sunset. Though there was no significant correlation ($P>0.05$) between flight activity and temperature at 25°C, an inverse and highly significant correlation ($r=-0.75$; $P<0.01$) was found between them at 35°C. Similarly, an inverse and highly significant correlation ($r=-0.87$; $P<0.001$) was observed between flight activity and light intensity.

*Keywords :* *savanna, flight activity, foraging activity, apis mellifera, honeybee, temperature, light intensity, relative humidity, nigeria.*

*GJSFR-C Classification :* *FOR Code: 070799*


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# Diurnal and Seasonal Flight Activity of the Honeybee, *Apis mellifera* L, and its Relationship with Temperature, Light Intensity and Relative Humidity in the Savanna of Northern Nigeria

Usman H Dukku [α], Zecarias Russom [σ] & Albert G Domo [ρ]

*Abstract* - This study was carried out at Bauchi (10°19'N; 09°50'E; Elevation 520 m), Nigeria, and it was the first of its kind in the country. Number of foraging bees returning to the hive was recorded for five minutes, at intervals of 30 minutes, and used as an indicator of flight activity. Temperature, light intensity and relative humidity were recorded concurrently. Two peaks of flight activity (one just before sunrise and the other just before sunset), separated by a period of very low activity, were observed in the dry season. However, in the rainy season flight activity was high throughout the day, declining progressively towards sunset. Though there was no significant correlation (P>0.05) between flight activity and temperature at 25°C, an inverse and highly significant correlation (r=-0.75; P<0.01) was found between them at 35°C. Similarly, an inverse and highly significant correlation (r=-0.87; P<0.001) was observed between flight activity and light intensity. No correlation (r = 0.275; P = 0.441) was found between flight activity and relative humidity. The observed differences in flight activity appeared to be due to environmental factors such as temperature, light intensity and, most importantly, availability of forage rather than the genetic characteristics of the bee.

*Keywords : savanna, flight activity, foraging activity, apis mellifera, honeybee, temperature, light intensity, relative humidity, nigeria.*

## I. Introduction

The honeybee, *A. mellifera*, depends wholly on plants for food. Honeybee workers make thousands of visits to flowers in order to collect nectar and pollen. They also collect propolis from plants, which they use, among other things, in plastering the interior of their nests. Water is collected to dilute honey and to cool the nest during hot weather. Thus, a honeybee colony necessarily lives a busy life. However, the level of activity depends on a number of factors, such as weather, availability of forage and size of the colony. People who work with bees, such as beekeepers and researchers, need to know the pattern of activity of their bees so that they can work at the appropriate time. In the same vein, this knowledge can be used to advise farmers on the appropriate time to spray their crops to avoid killing these beneficial insects while they pollinate these crops.

Investigations into the pattern of activity of various races of *A. mellifera,* in different parts of the world, reveal a lot of variation. For example, Woyke (1992) reported a single peak (in the morning) and two peaks (one after sunrise and one before sunset) of foraging activity for, *A.m. adansonii*, in the rainy and dry seasons, respectively, in Ghana. Similarly Fletcher (1978) reported one peak of activity for *A.m.scutellata* before sunrise in S Africa. On the other hand, Silva and de Jong (1990) reported three peaks (at 7.00, 14.00 and 16.00 h) of activity for Africanized bees in Brazil. Gary (1967) associated the U-shaped pattern of foraging activity he obtained to the high temperature and low humidity conditions of the desert environment. Danka and Beaman (2007), working in the U.S.A., found that Russian and Italian bees had similar flight activity at any given colony size, temperature, or time of day. Flight increased linearly with rising emperatures and larger colony sizes.

The objective of the study was to determine, for the first time, the pattern of diurnal flight activity of different colonies of the indigenous honeybee, *A. mellifera*, and its relationship with seasons, temperature, light intensity and relative humidity, in the Sudan savanna vegetation zone of northern Nigeria.

## II. Materials and Methods

### a) The Study Area

The study was carried out at Bauchi (9°50 E; 10°19 N; 620 m Above Sea Level) in northern Nigeria in the Sudan (dry) savanna, a belt of vegetation that extends from Senegal to Sudan (Hepburn and Radloff, 1998). The average annual temperature and rainfall are

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25.4°C and 981 mm, respectively. There are two main seasons: a rainy season from May to October and a dry season from November to April (Dukku, 2003).

*b) Diurnal Flight Activity*

In order to determine the daily flight (or foraging) activity, foraging bees, returning within five minutes, were counted manually, with a tally counter, at the hive entrance, at intervals of 30 minutes, from dawn to dusk. The mean of the two counts within each hour was then used as a measure of flight activity of the colony for that hour. Temperature, light intensity and relative humidity were measured concurrently. In order to obtain seasonal foraging patterns, observations were made on five randomly-picked days for each of the rainy and dry seasons.

*c) Data Analysis*

Correlation analysis, t-test and one-way analysis of variance (ANOVA) were carried out on the generated data, as appropriate, using the statistical software, MINITAB 15 (Anonymous 2007).

## III. Results

*a) General Observations*

Foraging commenced at dawn, and continued throughout the day, although at varying levels of intensity, irrespective of the honeybee colony or the season, and ended at dusk. Foraging ceased between 15 and 25 minutes after sunset when the intensity of light was 3 or 4 lx. Returning foragers flew straight into the hive or, occasionally, hovered for a while before entering: In either case the landing board was not used. Sometimes they missed the entrance and struck the hive or its support and then crawled in. Thin clouds did not prevent foraging but thick ones did. Bees were observed foraging during light rainfall.

*b) Diurnal Flight Activity of Honeybee Colonies within Seasons*

Figures 1 and 2 show the pattern of flight activity of two honeybee colonies (#Y1H and Y3H) located at the same site in the dry and rainy seasons, respectively. As could be seen from these figures, the colonies had a similar pattern within each season, though the patterns of the same colony differed between seasons.

*c) Diurnal Flight Activity of Honeybee Colonies between Seasons*

Flight activity of *A. mellifera* in the dry and rainy seasons is presented in Figure 3. The mean number of returning foragers for the dry and rainy seasons was 258 ± s.e. 83 (n = 13) and 450 ± s.e. 58 (n = 13) per hour, respectively. The difference between these two means was not significant (P>0.05). However, the activity of the bees in the dry season was more variable, with a coefficient of variation (CV) of 115.5%, than in the rainy season which had a CV of 83.6%. By contrast, the rainy season had high flight activity at 08.00 h (mean number or foragers = 715) and 9.00 h (mean number or foragers = 709) with a steady decline thereafter towards the evening.

*d) Effect of Temperature on Flight Activity*

There was no significant correlation (r = +0.311; P = 0.30) between temperature and number of returning foragers on 24th October, 1999 when temperature averaged 24.7±s.e.0.8°C (n=13) and ranged from 19 to 28°C. On 5th February, 2000 there was a significant, albeit weak, inverse correlation (r = -0.575; P = 0.04) between these two variables at an average temperature of 23.1±s.e.1.3°C (n=13; range= 14 - 29°C). However, on 3rd April, 2011, there was a strong inverse correlation (r = -0.748; P= 0.003) between temperature and number of foragers at an average temperature of 34.7±s.e.1.6°C (n=13; range= 21 - 41°C). A one way analysis of variance (ANOVA) revealed a highly significant (P < 0.001) difference between these three mean temperatures and Tukey's range test further revealed that the means for 24th October (24.7°C) and 5th February (23.1°C) were the same, while that of 3rd April (34.7°C) was different from either of them. Therefore we concluded that at about 25°C, temperature had no effect on foraging activity of *A. mellifera*, but at about 35°C, it had a negative one (Figure 4).

*e) Effect of Light Intensity on Flight Activity*

There was a very highly significant and inverse relationship (r = -0.87; P < 0.001) between flight activity and intensity of light. The point of determination (r2 x 100) was 75.5%, meaning that about 76% of the variation in flight activity could be explained by light intensity. Moreover, the scatter diagram for this relationship (Figure 5) shows that the relationship was continuous and biologically meaningful.

*f) Effect of Relative Humidity on Flight Activity*

There was no significant correlation (r = 0.275; P = 0.441) between flight activity and relative humidity.

## IV. Discussion

As can be seen in Figures 1 and 2, while the pattern of foraging of *A. mellifera* in the study area does not differ among colonies in the same season, it differs between seasons even for the same colony. In a similar study on *A.m. adansonii* in Ghana, Woyke (1992) found that the pattern of activity, in different zones, did not differ much within each season but the pattern of activity, in different zones, differed much between seasons. This suggests that the pattern is influenced by the environment rather than the genetic makeup of the honeybee colonies. Woyke *et al* (2003) in their study on *A. mellifera, A. laboriosa* and *A. dorsata*, in India, concluded that the environmental conditions in which

the bees were living for longer period influence their behavior more than their phylogenic relationship. Similarly, Danka and Beaman (2007), working in the U.S.A., found that Russian and Italian bees had a similar flight activity at any given colony size, temperature, or time of day.

The most important environmental factor influencing the pattern of activity of *A. mellifera* appears to be the availability of forage. The dry season pattern, reported in this study, is explained by the dominance of one or a few plants that release nectar and/or pollen at night. Honeybees, being diurnal, exploit these resources near sunrise and sunset times vigorously. In the morning, when they deplete the resources, they fall back on the scanty resources that may be available or they collect water to cool their nests. In the rainy season, on the other hand, forage is usually available throughout the day from a variety of annuals, including crops. For example, the graphs in Figure 1 follow, very closely, the pattern of foraging on *Vitellaria paradoxa*, during whose bloom they were recorded. As reported by Dukku (2010a), honeybees forage on this plant in large numbers from sunset to well into dusk and again from dawn to well after sunrise. Similarly, the pattern in Figure 2 follows, very closely, the pattern of foraging of *A. mellifera* on two dominant plants blooming at the time of the study: *Acacia ataxacantha* and *Guiera senegalensis.* Dukku (2003; 2010b) reported that *A. mellifera* forages on these two plants throughout the day. Furthermore, our finding in this study that flight activity was less variable in the rainy season than in the dry season suggests that the activity of *A. mellifera* is controlled by the availability of forage. Similarly, Pierrot and Schlindwein (2003) concluded that resource availability of the surrounding vegetation seems to be the major factor in defining the forager activities of the stingless bee, *Melipona scutellaris* on a given day.

Our finding that at about 25°C, temperature had no effect on foraging activity of *A. mellifera* agrees with earlier findings. For example, Woyke *et al* (2003) found no correlation between temperature and number of foragers at 18 - 21°C though there was a highly positive correlation at 10 - 16°C. The inverse correlation between temperature and flight activity at about 35°C, reported in this study, agrees with Woyke's (1992) report that at temperatures above 30°C, the number of foragers decreases with the increase in temperature. According to Roman and Weryszko (2006) a temperature of 16-26°C is optimal for foraging by *A. mellifera.*

The inverse correlation between intensity of light and flight activity of *A. mellifera* reported in this study may be indirect or due to the effect of a third factor such as temperature.

## V. Conclusion

In conclusion, while recognizing the need for further investigation into this subject, we believe that the availability of forage is the main factor deciding the daily pattern of flight activity of *A. mellifera* in our area of study.

## VI. Acknowledgements

We wish to acknowledge, with thanks, the assistance given to us during our many field trips by Mr. Babayo K Musa of the Biological Sciences Programme, Abubakar Tafawa Balewa University.

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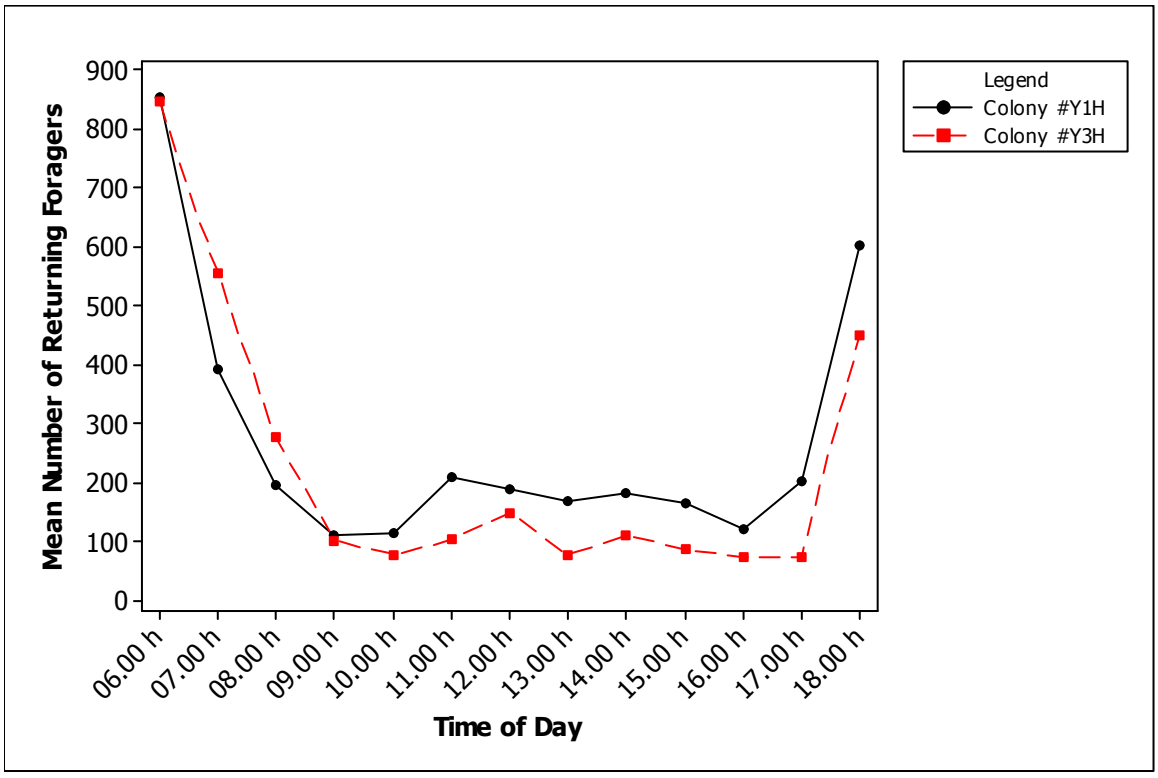


*Figure1 :* Diurnal flight activity of two honeybee colonies on 5th February 2000 (dry season). The mean number of returning foragers for every hour was obtained by taking the average of two counts taken, during a period of 5 minutes, at the beginning of the hour and 30 minutes later

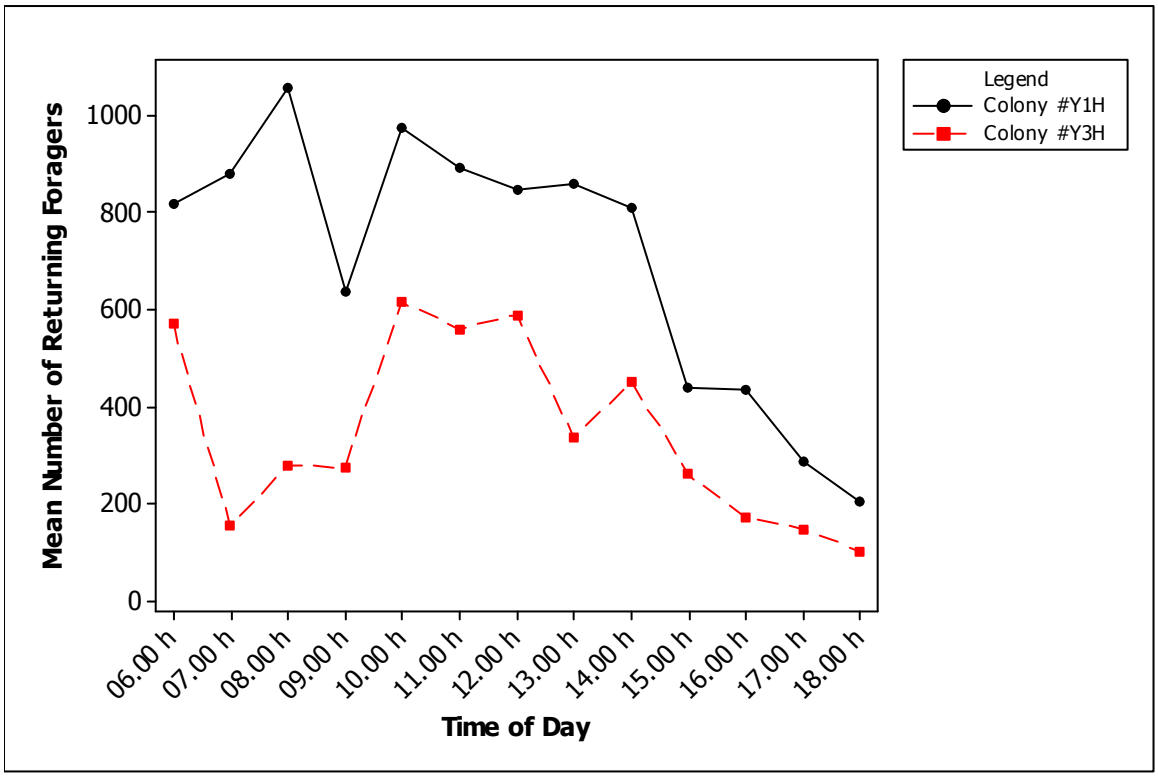


*Figure 2 :* Diurnal flight activity of two honeybee colonies on 20th August 2000(rainy season). The mean number of returning foragers for every hour was obtained by taking the average of two counts taken, during a period of 5 minutes, at the beginning of the hour and 30 minutes later

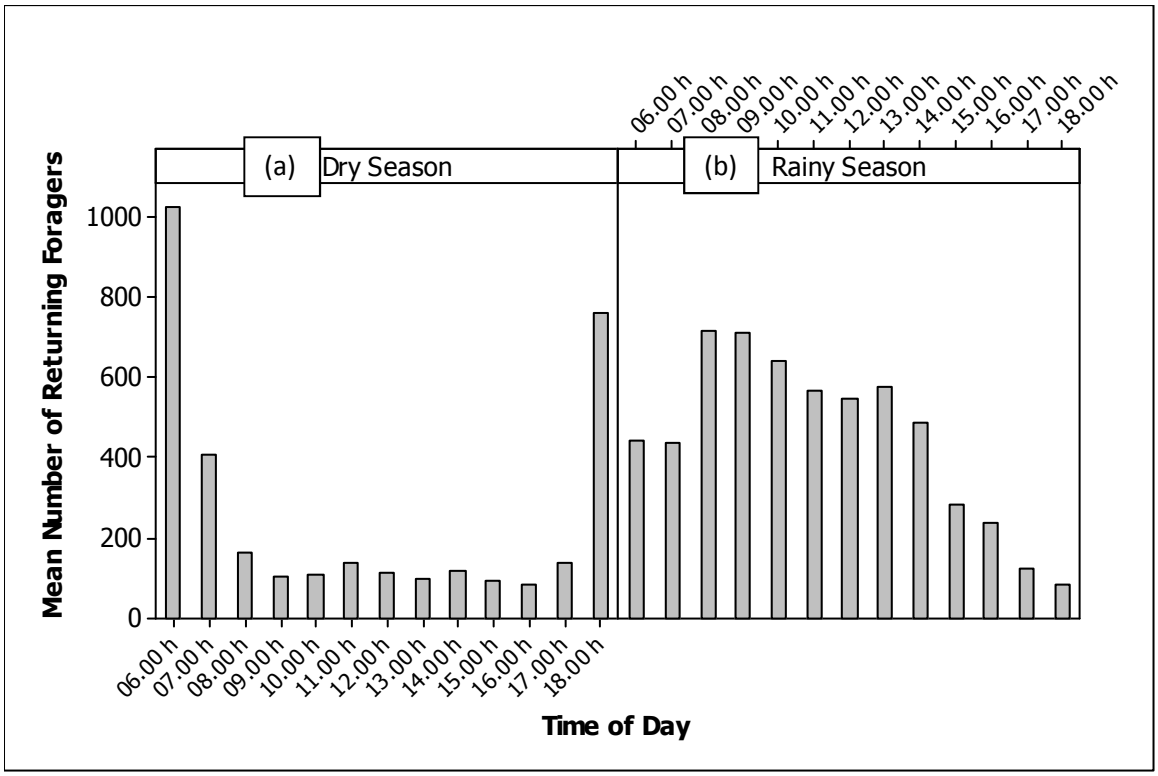


*Figure 3 :* Diurnal flight activity of honeybee colonies in (a) dry and (b) rainy seasons. The mean number of returning foragers for every hour was obtained by taking the average of two counts taken, during a period of 5 minutes, at the beginning of the hour and 30 minutes later. For each season data of hourly observations taken on five different days were used

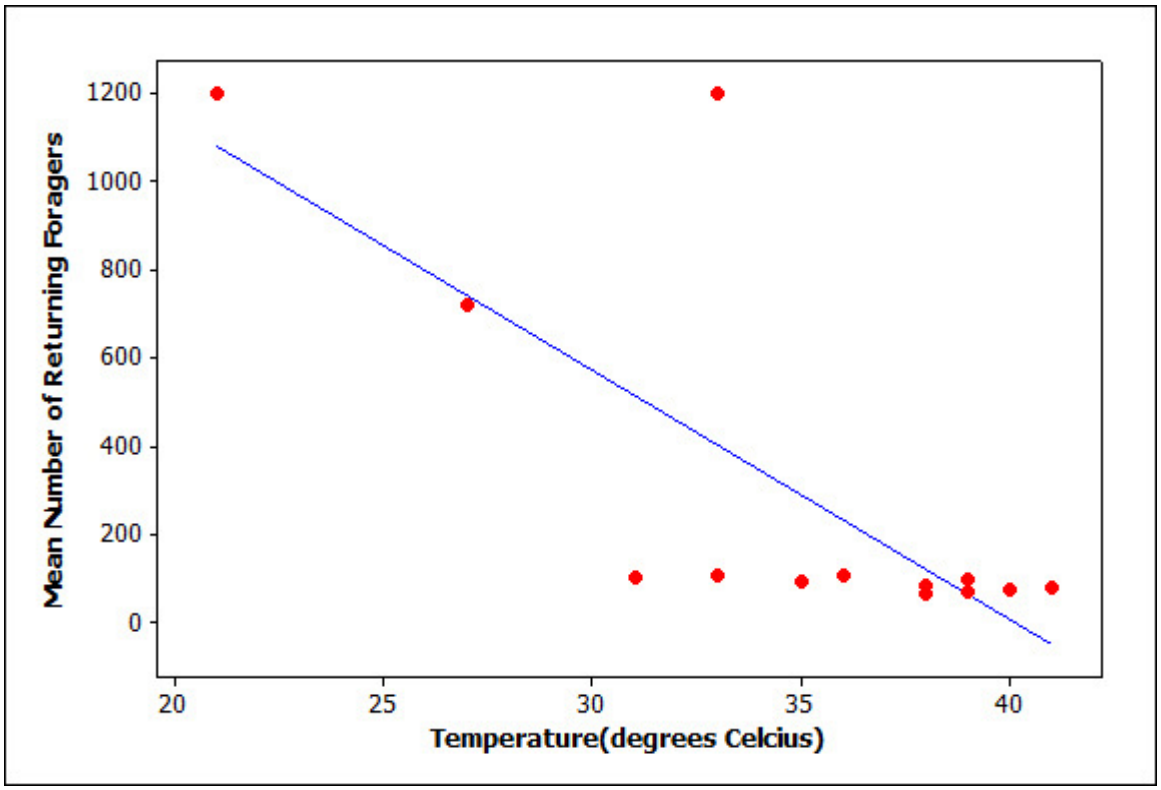


*Figure 4 :* Relationship between temperature and flight activity of honeybees on 3rd April 2011(mean temperature = 34.7˚C)

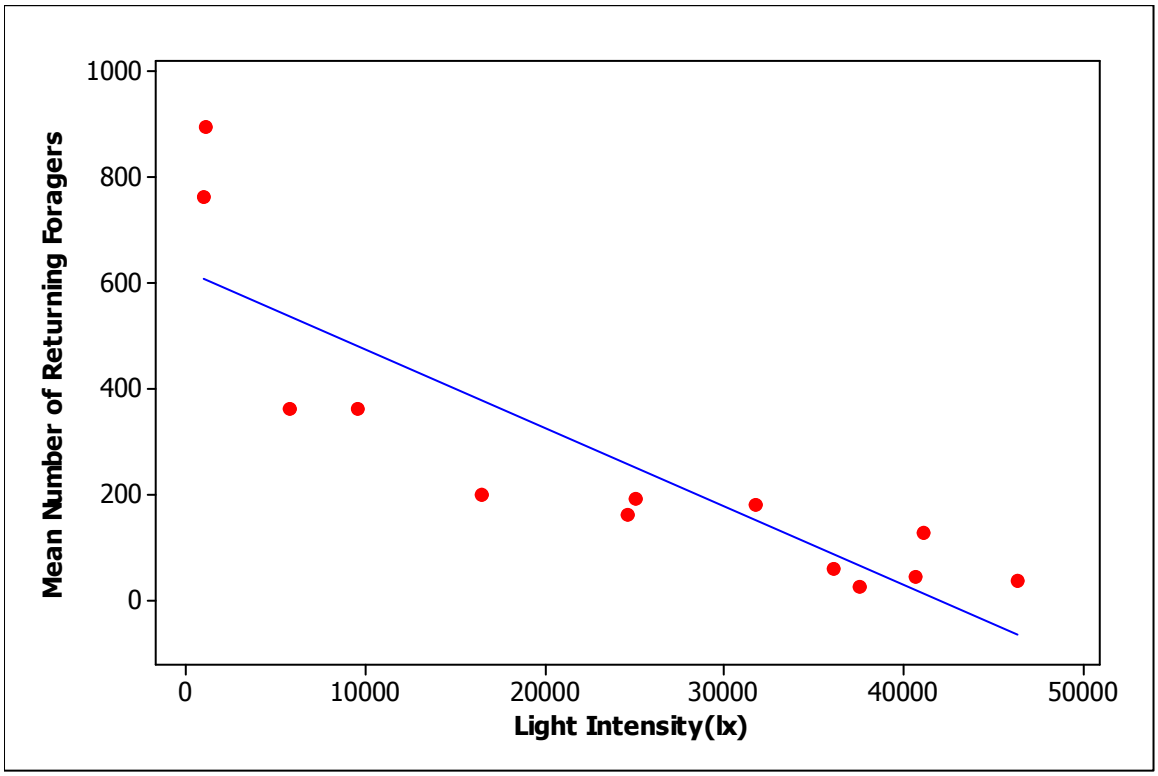


*Figure 5 :* Relationship between intensity of light and flight activity of honeybees

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# Investigations on the Physic-Chemical Parameters and Bacterial Occurrence in Four Water Bodies of Bhopal, India

By Najeeb Parvez, MS. A. Mudarris, Ishrat Mohi-ud-din & T. A. Qureshi
*King Abdul-Aziz University, Saudi Arabia*

*Abstract -* This study was carried out in four water bodies of Bhopal for a period of 2 years. Monthly changes in physicchemical parameters such as air temperature, water temperature, total dissolved solids, hydrogen-ion concentration, dissolved oxygen, free carbon dioxide, phenolphthalein alkalinity, total alkalinity, chloride, calcium hardness and total hardness along with bacterial occurrence were studied. The results indicated changes in physicchemical parameters and occurrence of bacteria depending on the different seasons of the year.

*Keywords :* *physic-chemical parameters, water bodies, monthly changes.*

*GJSFR-C Classification :* *FOR Code: 250499, 091101*


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# Investigations on the Physic-Chemical Parameters and Bacterial Occurrence in Four Water Bodies of Bhopal, India

Najeeb Parvez [α], MS. A. Mudarris [σ], Ishrat Mohi-ud-din [ρ] & T. A. Qureshi [ω]

*Abstract* - This study was carried out in four water bodies of Bhopal for a period of 2 years. Monthly changes in physic-chemical parameters such as air temperature, water temperature, total dissolved solids, hydrogen-ion concentration, dissolved oxygen, free carbon dioxide, phenolphthalein alkalinity, total alkalinity, chloride, calcium hardness and total hardness along with bacterial occurrence were studied. The results indicated changes in physic-chemical parameters and occurrence of bacteria depending on the different seasons of the year.

*Keywords : physic-chemical parameters, water bodies, monthly changes.*

## I. Introduction

The physic-chemical parameters are of paramount importance for all the organisms living in water. Many researchers have carried out studies on these parameters in different places in India (Pant and Sharma, 1985; Pataki, 1990; Agawam, 1993; Katarina, *et al.*, 1994; Katarina and Irbil, 1995; Magarey *et al.*, 2006).

Bhopal, the city of lakes, is situated at 23°16' N latitude and 77°26' E longitude. It possesses a number of small and large water bodies including Hate knead reservoir, Lower Lake, Sapura Lake and Larrup reservoir. Hate knead reservoir is situated at 26°16' N latitude and 77°30' E longitude above 460m MSL. Lower lake is situated at 23°16' N latitude and 72°25' E longitude and is one of the twin lakes of Bhopal. Shah pure lake has a surface area of 0.96 sq km. This lake is situated at 23°12' 00" N latitude and 77°25' 30" E longitude. Larrup reservoir is situated at about 10 km away from Bhopal city and lies at 23°11' 45" N latitude and 77°28' 50" E longitude.

Aquatic environment is inhabited with numerous species of bacteria, many of which are responsible for causing dreaded diseases in fishes. Eutrophic water provides favorable habitat for their growth and proliferation because of the availability of nutrients and organic materials (Plumb, 1994). (Koyama and Taming, 1967; Chen, 1968; Fonder, 1969 and Jones, 1970) observed the decline in number and growth of bacteria during summer months which they considered due to high temperature and low concentration of nutrients. (Plumb, 1994) reported that moderate level of temperature is suitable for the growth and development of bacteria.

The present study was, therefore, conducted to investigate the physic-chemical parameters and bacterial occurrence keeping in view the different seasons of the year.

## II. Materials and Methods

Important physic-chemical parameters like temperature, total dissolved solids, hydrogen-ion concentration, dissolved oxygen, free carbon dioxide, alkalinity, chloride and hardness of these water bodies were analyzed by the procedures of (APHA, 1995; Goblet roman, 1978 and Wetzel, 1979). Wherever necessary, the DREL / 2000 spectrophotometer, USA was also used for the purpose of water analysis.

For the purpose of isolation of bacteria from water, the samples were collected in sterilized bottles, once every month throughout the study period from five different locations of each water body. The isolation of bacteria from water samples was done following the methods of (Speck, 1976 and Collins and Lynne, 1985). The samples collected were serially diluted and each diluted sample was inoculated in the plates having different media by surface spread method (Speck, 1976). Upton 10 typical colonies selected from each duplicate set of plates were purified, confirmed and differentiated to the genus level.

## III. Results and Discussion

During the study period, marked changes were observed in the temperature of all the four water bodies under investigation. Atmospheric temperature ranged between 18.0 to 35.0 °o near Hate knead reservoir, 17.0 to 35.0 °o near Lower lake, 18.0 to 35.0°C near Sapura lake and 18.0 to 35.0°C near Larrup reservoir. The water temperature of Hate knead reservoir, Lower lake, Sapura lake and Larrup reservoir ranged between 20.0 to 30.0°C, 20.0 to 31.0°C, 20.0 to 30.0°C and 20.0 to 30.0°C, respectively. The occurrence of bacterial

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species showed negative relationship with atmospheric and water temperature in all the water bodies except Larrup reservoir where it showed positive relationship. It has been observed that the moderate temperature was more conducive for the occurrence of aquatic bacteria. This finding gets support from the work of (Plumb, 1994; Rodgers and Burke, 1981; Roberts *et al*., 1986 and Virginal, 1992).

Total dissolved solids ranged between 86.0 to 135.0 mg/l in Hate iced reservoir, 104.0 to 198.0 mg/l in Lower Lake, 86.0 to 135.0 mg/l in Sapura lake and 103.0 to 172.0 mg/l in Larrup reservoir. The occurrence of bacterial species indicated negative relationship with total dissolved solids in Lower lake and Larrup reservoir and positive relationship in Hate iced reservoir and Sapura lake.

pH ranged between 7.5 to 9.0 in Hate knead reservoir, 7.3 to 9.0 in Lower lake, 7.5 to 9.0 in Sapura lake and 7.0 to 8.4 in Larrup reservoir. The occurrence of bacterial species indicated negative relationship with pH in all the water bodies except Hate iced reservoir where it showed positive relationship.

Dissolved oxygen was found to range between 6.4 to 9.1 mg/l in Hate knead reservoir, 5.0 to 9.4 mg/l in Lower lake, 6.4 to 9.1 mg/l in Sapura lake and 5.4 to 10.0 mg/l in Larrup reservoir. Higher dissolved oxygen values observed during winter were due to low temperature and during summer due to the photosynthetic activities. The same have also been the observations of (Sir invasion, 1996; Sashay and Sinhala, 1969; Agawam *et al*., 1976 and Ray, 1978) in this regard. (Roberts *et al*., 1986) have reported occasional low oxygen concentrations in several organically enriched environments. The occurrence of bacterial species indicated positive relationship with dissolved oxygen in all the water bodies except Larrup reservoir where it showed negative relationship.

Free carbon dioxide was present in Hate iced only in July, 2004 and 2005. It ranged between 4.6 to 14.9 mg/l in Lower Lake, 9.5 to 19.2 mg/l in Sapura lake and 9.2 to 19.3 mg/l in Larrup reservoir. The occurrence of bacterial species showed positive relationship with free carbon dioxide in Sapura Lake and Larrup reservoir; negative relationship in Lower Lake and no relationship at all in Hate knead reservoir. Phenolphthalein alkalinity ranged between 6.3 to 15.3 mg/l in Hate iced reservoir, 6.5 to 18.2 mg/l in Lower Lake and 6.4 to 10.2 mg/l in Larrup reservoir. The occurrence of bacterial species showed positive relationship with phenolphthalein alkalinity in Lower lake and Larrup reservoir; negative relationship in Hate knead reservoir and no relationship at all in Sapura Lake.

Total alkalinity ranged between 60.0 to 186.0 mg/l in Hate iced reservoir, 110.0 to 262.0 mg/l in Lower Lake, 60.0 to 186.0 mg/l in Sapura Lake and 124.0 to 210.0 mg/l in Larrup reservoir. The occurrence of bacterial species showed negative relationship with total alkalinity in all the four water bodies.

Chloride values ranged between 14.0 to 35.0 mg/l in Hate knead reservoir, 18.5 to 56.0 mg/l in Lower Lake, and 14.0 to 35.0 mg/l in Sapura Lake and 25.0 to 38.0 mg/l in Larrup reservoir. Higher chloride values were observed in Lower Lake as compared to those of Hate iced reservoir, Sapura Lake and Larrup reservoir. Comparatively, lower values were obtained during monsoon and higher during summer months. Similar seasonal trend of fluctuation in chloride values is also reported by (Paha and Mohr okra, 1966; Mathew, 1969 and Agawam *et al*., 1976). Higher concentration of chloride is an indicator of pollution due to high organic waste of animals (Thresh *et al*., 1944). The occurrence of bacterial species exhibited negative relationship with chloride in all the four water bodies.

Calcium hardness ranged between 85.0 to 138.0 mg/l in Hate kneads reservoir, 71.0 to 167.0 mg/l in Lower Lake, and 85.0 to 139.0 mg/l in Sapura Lake and 69.0 to 174.0 mg/l in Larrup reservoir. The occurrence of bacterial species showed negative relationship with calcium hardness in all the water bodies except Lower Lake where it showed positive relationship.

Total hardness ranged between 110.0 to 240.0 mg/l in Hate kneads reservoir, 101.0 to 240.0 mg/l in Lower Lake, 154.0 to 243.0 mg/l in Sapura lake and 115.0 to 298.0 mg/l in Larrup reservoir. The occurrence of bacterial species showed negative relationship with calcium hardness in Hate iced reservoir and Sapura lake while it showed positive relationship in Lower lake and Larrup reservoir.

It was observed that the occurrence and abundance of aquatic bacteria varied from time to time depending on the availability of nutrients and prevailing physico-chemical parameters. The bacteria isolated represented mainly the families *Bacillaceae, Cytophagaceae, Enterobacteriaceae, Micrococcaceae, Pseudomonadaceae* and *Streptococcaceae*. Of the total bacteria isolated, *Aeromonas, Acinetobacter*, Bacillus, *Cytophaga, Escherichia, Flexibacter*, Micrococcus, Pseudomonas, Staphylococcus and Streptococcus were the common genera found in all the water bodies.

Abundant occurrence of bacteria was recorded during and after rainy season in all the four water bodies. It might be due to the influx of large volume of sewage loaded with bacteria and other organic material. This finding gets support from the observations of (Fred et al., 1924; Taylor, 1949 and Collins, 1963). Decrease in the number of bacteria is noticed during summer months which might be due to high temperature and low nutrient level. Similar findings are reported by (Koyama and Domino, 1967; Chen, 1968; Fonder, 1969 and Jones, 1970).

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*Table 1 :* Physic-chemical parameters of Hate iced reservoir (August 2003-July 2005)

| Month | AT °C | WT °C | TDS (mg/l) | pH | DO (mg/l) | Free $CO_2$ (mg/l) | PA (mg/l) | TA (mg/l) | Chloride (mg/l) | CH (mg/l) | TH (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug | 27 | 28 | 101 | 7.5 | 7.1 | 0 | 4.2 | 110 | 26 | 1.5 | 188 |
| Sep | 29 | 27 | 113 | 7.6 | 6.9 | 0 | 6.3 | 82 | 24 | 111 | 199 |
| Oct | 27 | 26 | 127 | 7.9 | 7.4 | 0 | 8.7 | 62 | 22 | 119 | 210 |
| Nov | 24 | 23 | 130 | 8.0 | 7.7 | 0 | 9.5 | 83 | 20 | 133 | 299 |
| Dec | 22 | 24 | 119 | 8.4 | 7.9 | 0 | 11.8 | 105 | 16 | 138 | 240 |
| Jan | 19 | 21 | 98 | 8.6 | 8.5 | 0 | 8.4 | 111 | 17 | 108 | 191 |
| Feb | 21 | 22 | 88 | 8.8 | 9.1 | 0 | 12.5 | 123 | 19 | 103 | 172 |
| Mar | 25 | 23 | 94 | 8.3 | 6.7 | 0 | 9.7 | 131 | 23 | 117 | 201 |
| Apr | 30 | 27 | 101 | 8.1 | 6.9 | 0 | 12.8 | 145 | 33 | 123 | 213 |
| May | 35 | 29 | 115 | 7.9 | 7.2 | 0 | 14.7 | 179 | 31 | 109 | 194 |
| Jun | 31 | 28 | 121 | 7.6 | 7.5 | 0 | 11.3 | 147 | 29 | 96 | 142 |
| Jul | 29 | 27 | 130 | 7.9 | 7.1 | 6.4 | 0 | 122 | 28 | 87 | 119 |
| Aug | 26 | 25 | 96 | 7.6 | 7.2 | 0 | 4.9 | 116 | 27 | 102 | 182 |
| Sep | 28 | 26 | 120 | 7.8 | 7.0 | 0 | 6.8 | 84 | 22 | 108 | 193 |
| Oct | 28 | 27 | 131 | 8.2 | 7.6 | 0 | 9.3 | 60 | 19 | 122 | 218 |
| Nov | 25 | 24 | 128 | 8.4 | 7.9 | 0 | 102 | 85 | 17 | 129 | 221 |
| Dec | 21 | 23 | 114 | 8.7 | 8.2 | 0 | 12.5 | 109 | 14 | 132 | 237 |
| Jan | 18 | 20 | 102 | 8.8 | 8.6 | 0 | 8.3 | 116 | 18 | 105 | 117 |
| Feb | 20 | 21 | 86 | 9.0 | 9.0 | 0 | 12.7 | 130 | 21 | 101 | 157 |
| Mar | 25 | 23 | 96 | 8.6 | 6.4 | 0 | 9.0 | 139 | 29 | 112 | 204 |
| Apr | 29 | 25 | 105 | 8.4 | 6.8 | 0 | 13.1 | 148 | 35 | 128 | 221 |
| May | 34 | 28 | 118 | 8.2 | 7.0 | 0 | 15.3 | 186 | 33 | 106 | 181 |
| Jun | 31 | 27 | 123 | 7.8 | 7.8 | 0 | 12.9 | 156 | 30 | 98 | 149 |
| Jul | 29 | 26 | 135 | 8.2 | 7.4 | 4.0 | 0 | 130 | 25 | 85 | 110 |

AT=Atmospheric temperature, WT=Water temperature, TDS=Total Dissolved Solids, DO=Dissolved Oxygen, PA=Phenolphthalein Alkalinity, TA=Total Alkalinity, CH=Calcium Hardness, TH=Total Hardness

*Table 2 :* Physic-chemical parameters of Lower lake (August 2003-July 2005)

| Month | AT °o | WT °o | TDS (mg/l) | pH | DO (mg/l) | Free $CO_2$ (mg/l) | PA (mg/l) | TA (mg/l) | Chloride (mg/l) | CH (mg/l) | TH (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug | 27 | 25 | 115 | 7.3 | 5.8 | 5.2 | 0 | 168 | 52.3 | 158 | 208 |
| Sep | 28 | 26 | 119 | 7.4 | 5.4 | 6.0 | 0 | 148 | 42.4 | 167 | 280 |
| Oct | 30 | 27 | 132 | 7.7 | 5.0 | 0 | 12.0 | 115 | 33.8 | 122 | 194 |
| Nov | 26 | 24 | 124 | 8.1 | 6.4 | 0 | 7.8 | 128 | 28.2 | 111 | 167 |
| Dec | 22 | 24 | 113 | 8.2 | 8.2 | 8.4 | 0 | 137 | 21.5 | 102 | 143 |
| Jan | 18 | 21 | 109 | 7.4 | 8.8 | 10.1 | 0 | 143 | 19.2 | 88 | 127 |
| Feb | 22 | 23 | 104 | 7.7 | 9.4 | 12.8 | 0 | 162 | 23.2 | 75 | 109 |
| Mar | 28 | 26 | 148 | 8.1 | 7.2 | 14.9 | 0 | 194 | 28.8 | 93 | 138 |
| Apr | 31 | 28 | 162 | 8.5 | 6.7 | 0 | 6.5 | 235 | 36.7 | 106 | 157 |
| May | 35 | 30 | 194 | 8.8 | 6.1 | 0 | 10.2 | 262 | 55.6 | 117 | 173 |
| Jun | 31 | 27 | 171 | 8.3 | 7.3 | 0 | 17.8 | 213 | 45.0 | 132 | 198 |
| Jul | 29 | 26 | 138 | 8.0 | 6.5 | 8.6 | 0 | 192 | 51.8 | 145 | 201 |
| Aug | 26 | 23 | 118 | 7.3 | 5.9 | 4.6 | 0 | 175 | 54.0 | 160 | 271 |
| Sep | 28 | 26 | 125 | 7.6 | 5.5 | 6.2 | 0 | 154 | 44.2 | 155 | 204 |
| Oct | 29 | 25 | 136 | 7.9 | 5.2 | 0 | 12.2 | 110 | 38.0 | 134 | 199 |
| Nov | 25 | 22 | 122 | 8.2 | 6.4 | 0 | 8.0 | 121 | 31.5 | 115 | 181 |
| Dec | 21 | 23 | 116 | 8.0 | 8.0 | 8.5 | 0 | 128 | 24.6 | 100 | 134 |
| Jan | 17 | 20 | 112 | 7.4 | 8.4 | 10.4 | 0 | 140 | 18.5 | 83 | 121 |
| Feb | 21 | 24 | 106 | 7.6 | 8.8 | 12.5 | 0 | 166 | 20.0 | 71 | 101 |
| Mar | 27 | 25 | 156 | 8.0 | 6.4 | 14.6 | 0 | 197 | 27.2 | 89 | 130 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Apr | 30 | 28 | 164 | 8.8 | 6.3 | 0 | 7.0 | 232 | 38.0 | 105 | 159 |
| May | 34 | 29 | 198 | 9.0 | 6.2 | 0 | 10.4 | 246 | 56.0 | 120 | 182 |
| Jun | 32 | 28 | 178 | 8.5 | 6.8 | 0 | 18.2 | 210 | 48.2 | 137 | 203 |
| Jul | 30 | 27 | 142 | 8.2 | 6.0 | 8.5 | 0 | 196 | 52.2 | 149 | 211 |

AT=Atmospheric temperature, WT=Water temperature, TDS=Total Dissolved Solids, DO=Dissolved Oxygen, PA=Phenolphthalein Alkalinity, TA=Total Alkalinity, CH=Calcium Hardness, TH=Total Hardness

*Table 3 :* Physic-chemical parameters of Sapura lake (August 2003-July 2005)

| Month | AT °C | WT °C | TDS (mg/l) | pH | DO (mg/l) | Free $CO_2$ (mg/l) | PA (mg/l) | TA (mg/l) | Chloride (mg/l) | CH (mg/l) | TH (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug | 27 | 26 | 92 | 7.6 | 7.2 | 14.9 | 0 | 116 | 27 | 102 | 182 |
| Sep | 29 | 27 | 120 | 7.8 | 7.0 | 16.8 | 0 | 84 | 22 | 108 | 193 |
| Oct | 27 | 25 | 131 | 8.2 | 7.6 | 19.2 | 0 | 60 | 19 | 122 | 208 |
| Nov | 26 | 24 | 128 | 8.4 | 7.9 | 10.3 | 0 | 85 | 17 | 139 | 221 |
| Dec | 22 | 24 | 114 | 8.7 | 8.2 | 11.7 | 0 | 109 | 14 | 132 | 215 |
| Jan | 19 | 22 | 102 | 8.8 | 8.6 | 12.1 | 0 | 116 | 18 | 105 | 189 |
| Feb | 22 | 24 | 86 | 9.0 | 9.0 | 12.6 | 0 | 130 | 21 | 101 | 176 |
| Mar | 25 | 23 | 96 | 8.6 | 6.4 | 13.0 | 0 | 139 | 25 | 112 | 201 |
| Apr | 29 | 27 | 105 | 8.4 | 6.8 | 13.9 | 0 | 148 | 35 | 128 | 216 |
| May | 35 | 30 | 118 | 8.2 | 7.0 | 15.2 | 0 | 186 | 33 | 106 | 193 |
| Jun | 31 | 28 | 123 | 7.8 | 7.8 | 12.5 | 0 | 156 | 30 | 98 | 178 |
| Jul | 29 | 27 | 135 | 8.2 | 7.4 | 11.4 | 0 | 130 | 29 | 85 | 154 |
| Aug | 28 | 26 | 101 | 7.5 | 7.1 | 14.2 | 0 | 110 | 26 | 105 | 188 |
| Sep | 30 | 27 | 113 | 7.6 | 6.4 | 16.3 | 0 | 82 | 24 | 111 | 199 |
| Oct | 28 | 24 | 127 | 7.9 | 7.1 | 18.7 | 0 | 62 | 22 | 119 | 210 |
| Nov | 25 | 23 | 130 | 8.0 | 7.7 | 9.5 | 0 | 83 | 20 | 133 | 220 |
| Dec | 21 | 23 | 119 | 8.4 | 7.9 | 11.3 | 0 | 105 | 16 | 138 | 243 |
| Jan | 18 | 20 | 98 | 8.6 | 8.5 | 11.8 | 0 | 111 | 17 | 108 | 195 |
| Feb | 20 | 22 | 89 | 8.8 | 9.1 | 12.2 | 0 | 123 | 19 | 103 | 187 |
| Mar | 25 | 23 | 94 | 8.3 | 6.7 | 12.7 | 0 | 131 | 23 | 117 | 205 |
| Apr | 28 | 26 | 101 | 8.1 | 6.9 | 13.4 | 0 | 145 | 33 | 123 | 212 |
| May | 34 | 29 | 115 | 7.9 | 7.2 | 14.7 | 0 | 179 | 31 | 109 | 199 |
| Jun | 32 | 28 | 121 | 7.6 | 7.5 | 11.6 | 0 | 147 | 29 | 96 | 164 |
| Jul | 30 | 27 | 132 | 7.9 | 7.1 | 10.2 | 0 | 122 | 28 | 87 | 157 |

AT=Atmospheric temperature, WT=Water temperature, TDS=Total Dissolved Solids, DO=Dissolved Oxygen, PA=Phenolphthalein Alkalinity, TA=Total Alkalinity, CH=Calcium Hardness, TH=Total Hardness

*Table 4 :* Physic-chemical parameters of Larrup reservoir (August 2003-July 2005)

| Month | AT °C | WT °C | TDS (mg/l) | pH | DO (mg/l) | Free $CO_2$ (mg/l) | PA (mg/l) | TA (mg/l) | Chloride (mg/l) | CH (mg/l) | TH (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug | 29 | 26 | 131 | 7.1 | 7.4 | 14.2 | 0 | 139 | 33 | 147 | 276 |
| Sep | 30 | 28 | 157 | 7.2 | 6.9 | 13.5 | 0 | 124 | 29 | 172 | 294 |
| Oct | 28 | 26 | 159 | 7.5 | 6.3 | 16.7 | 0 | 146 | 25 | 109 | 183 |
| Nov | 25 | 22 | 132 | 7.6 | 7.9 | 18.2 | 0 | 141 | 28 | 99 | 165 |
| Dec | 22 | 23 | 119 | 7.8 | 7.2 | 19.3 | 0 | 133 | 30 | 93 | 133 |
| Jan | 18 | 20 | 103 | 7.5 | 7.1 | 15.8 | 0 | 147 | 37 | 69 | 115 |
| Feb | 21 | 22 | 111 | 7.3 | 6.9 | 13.0 | 0 | 159 | 29 | 102 | 178 |
| Mar | 26 | 24 | 116 | 8.1 | 6.5 | 11.5 | 0 | 173 | 33 | 114 | 185 |
| Apr | 30 | 27 | 143 | 8.4 | 9.2 | 0 | 7.2 | 182 | 35 | 120 | 215 |
| May | 34 | 29 | 157 | 8.3 | 5.8 | 0 | 8.9 | 163 | 37 | 141 | 254 |
| Jun | 32 | 29 | 128 | 7.9 | 5.4 | 0 | 9.7 | 201 | 34 | 156 | 273 |
| Jul | 30 | 26 | 117 | 7.5 | 6.2 | 0 | 7.7 | 158 | 35 | 170 | 289 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug | 28 | 25 | 124 | 7.0 | 7.2 | 12.7 | 0 | 150 | 28 | 152 | 282 |
| Sep | 30 | 26 | 172 | 7.3 | 6.6 | 10.8 | 0 | 130 | 26 | 174 | 298 |
| Oct | 27 | 25 | 166 | 7.7 | 6.4 | 18.5 | 0 | 148 | 27 | 118 | 202 |
| Nov | 24 | 23 | 148 | 7.9 | 8.2 | 14.9 | 0 | 142 | 28 | 110 | 188 |
| Dec | 20 | 22 | 140 | 7.5 | 8.0 | 16.3 | 0 | 130 | 29 | 102 | 175 |
| Jan | 19 | 21 | 110 | 7.2 | 7.6 | 12.8 | 0 | 151 | 38 | 75 | 122 |
| Feb | 22 | 23 | 122 | 7.4 | 7.2 | 10.0 | 0 | 165 | 27 | 106 | 186 |
| Mar | 27 | 25 | 130 | 8.3 | 7.0 | 9.2 | 0 | 180 | 34 | 120 | 219 |
| Apr | 31 | 27 | 160 | 8.1 | 10.0 | 0 | 6.4 | 194 | 33 | 124 | 227 |
| May | 35 | 30 | 170 | 8.6 | 6.0 | 0 | 9.8 | 178 | 37 | 140 | 251 |
| Jun | 33 | 29 | 140 | 8.2 | 5.6 | 0 | 10.2 | 210 | 30 | 159 | 282 |
| Jul | 31 | 28 | 115 | 7.2 | 6.8 | 0 | 8.5 | 170 | 32 | 163 | 291 |

AT=Atmospheric temperature, WT=Water temperature, TDS=Total Dissolved Solids, DO=Dissolved Oxygen, PA=Phenolphthalein Alkalinity, TA=Total Alkalinity, CH=Calcium Hardness, TH=Total Hardness

*Table 5 :* Mean and Standard Deviation of various ecological parameters and bacterial species

| Parameters | Hate iced reservoir | Lower lake | Sapura lake | Larrup reservoir |
|---|---|---|---|---|
| Atmospheric temperature | 26.38 ± 4.4517 | 26.96 ± 4.64 | 26.67 ± 4.459 | 27.17 ± 4.749 |
| Water temperature | 25.0 ± 2.5 | 25.29± 2.474 | 25.21 ± 2.449 | 25.29 ± 2.776 |
| Conductivity | 206.5 ± 29.67 | 278.71± 52.106 | 210.5 ± 33.29 | 283.03 ± 27.788 |
| Total dissolved solids | 112.17 ± 14.45 | 137.58 ± 27.28 | 112.08 ± 14.76 | 136.25 ± 20.33 |
| Hydrogen-ion concentration | 8.18 ± 0.4231 | 8.0 ± 0.4822 | 8.18 ± 0.4213 | 7.69 ± 0.4499 |
| Dissolved oxygen | 7.54 ± 0.7076 | 6.78 ± 1.2024 | 7.54 ± 0.7076 | 7.05 ± 1.04008 |
| Free carbon dioxide | - | 9.38 ± 3.225 | 13.34 ± 2.475 | 14.21 ± 2.97 |
| Phenolphthalein alkalinity | 10.22 ± 2.95 | 11.01 ± 3.962 | - | 8.55 ± 1.269 |
| Total alkalinity | 119.13 ± 32.14 | 173.83 ± 42.81 | 119.13 ± 32.14 | 158.92 ± 22.79 |
| Chloride | 24.08 ± 5.88 | 37.12 ± 12.52 | 24.08 ± 5.88 | 31.42 ± 3.817 |
| Calcium hardness | 111.54 ± 13.89 | 118.08 ± 27.58 | 111.96 ± 14.55 | 126. 46 ± 29.78 |
| Total hardness | 189.5 ± 33.81 | 174.63 ± 44.84 | 196.04 ± 20.74 | 220.13 ± 56.75 |
| Bacteria | 6.96 ± 1.6951 | 7.17 ± 1.95 | 7.46 ± 4.45 | 7.04 ± 1.989 |

*Table 6 :* Coefficient of Correlation between the occurrence of bacterial species and various ecological parameters

| Parameters | Hate iced reservoir | Lower lake | Sapura lake | Larrup reservoir |
|---|---|---|---|---|
| Air temperature | - 0.23 (1.135) | -0.2247(1.081) | - 0.294 (1.445) | 0.1227 (0.5801) |
| Water temperature | - 0.137 (0.651) | - 0.2603 (1.26) | -0.2191 (1.053) | 0.12607 (0.5961) |
| Conductivity (µmhos/cm) | 0.1313 (0.621) | - 0.3135 (1.548) | - 0.0849 (0.399) | -0.0518 (0.2436) |
| TDS (mg/l) | 0.326 (1.622) | -0.4769 (2.545)* | 0.0872 (0.410) | - 0.0661 (0.3111) |
| pH | 0.0396 (0.186) | -0.5271(2.90)* | -0.1342 (0.6355) | - 0.3348 (1.666) |
| Dissolved oxygen (mg/l) | 0.338 (1.68) | 0.0902 (0.425) | 0.389 (1.98) | - 0.5263 (2.90)* |
| Free $CO_2$ (mg/l) | - | - 0.285 (1.030) | 0.129 (0.6101) | 0.2980 (1.16) |
| Phenolphthalein alkalinity (mg/l) | - 0.3009 (1.411) | 0.484 (1.56) | - | 0.684 (2.30) |
| Total alkalinity (mg/l) | - 0.425 (2.20)* | - 0.4795 (2.56)* | - 0.576 (3.31)* | - 0.1396 (0.6614) |
| Chloride (mg/l) | - 0.2922 (1.433) | - 0.064 (0.3036) | - 0.392 (1.99) | - 0.3095 (1.52) |
| Calcium hardness (mg/l) | - 0.3032 (1.49) | 0.2165 (1.04) | - 0.2042 (0.978) | 0.2725 (1.328) |
| Total Hardness (mg/l) | - 0.3442 (1.719) | 0. 1797 (0.857) | - 0.1874 (0.894) | 0.2435 (1.177) |

*Values are significant at 5 % level

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*Abstract -* *Background and Objective :* A number of studies have previously described elevated levels of homocysteine as an independent coronary heart disease and stroke risk factor. The results of above studies show different data for the methylenetetrahydrofolate reductase (MTHFR) genetic polymorphism and hyperhomocysteinemia, which is the cause of cerebrovascular accident. Purpose of the study was to determine whether there is a link between hyperhomocysteinemia and A1298CC, C677 genotype associated with acute cerebral infarction.

*Methods :* The prospective study included patients (n=102) with acute cerebral infarction, regardless of its genesis or transient ischemic attack, and patients with a history of cerebral infarction of any age, that correlates with the imaging techniques.

*Keywords :* *cerebrovascular disease; homocysteine; mutation; risk factor; stroke.*

*GJSFR-C Classification :* *FOR Code: 030401*


*Strictly as per the compliance and regulations of :*

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Pauls Auce [α], Anželika Gudreniece [σ], Viktorija Ķēniņa [ρ], Daina Pastare [ω], Gundega Berģe [¥], Linda Piekuse [§] & Andrejs Millers [χ]

*Summary - Background and Objective :* A number of studies have previously described elevated levels of homocysteine as an independent coronary heart disease and stroke risk factor. The results of above studies show different data for the methylenetetrahydrofolate reductase (MTHFR) genetic polymorphism and hyperhomocysteinemia, which is the cause of cerebrovascular accident. Purpose of the study was to determine whether there is a link between hyperhomocysteinemia and A1298CC, C677 genotype associated with acute cerebral infarction.

*Methods :* The prospective study included patients (n=102) with acute cerebral infarction, regardless of its genesis or transient ischemic attack, and patients with a history of cerebral infarction of any age, that correlates with the imaging techniques. The control group (n = 34) consisted of patients without a history of cerebrovascular disease, showing no indication of previous strokes according to imaging techniques. Homocysteine was determined using IMMULITE 2000 testing system.

*Results :* Comparing the both groups, increased homocysteine level association with the cerebrovascular event was not observed (p=0.4). By studying the genetic polymorphism of MTHFR, a statistically significant relationship of elevated homocysteine with C677TT (p=0.15), C677CT (p=0.61) and C677CC (p=0.90) was not detected. Similar results were obtained for A1298 genetic polymorphism.

*Conclusion :* This study showed that there is no link between hyperhomocysteinemia and MTHFR genetic polymorphism in the investigated population associated with risk of acute cerebral infarction. Taking into consideration the relationship of homocysteine with folic acid and vitamin B12 levels, the next phase of study will include the determination of these two parameters in addition.

*Keywords : cerebrovascular disease; homocysteine; mutation; risk factor; stroke.*

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## I. Introduction

In Latvia mortality rate from ischemic and hemorrhagic stroke is 230/100 000 annually for people aged from 35 to 74 years (1); cerebrovascular diseases is the leading cause of severe disability (2). Healthcare costs due to cerebrovascular diseases in the year 2003 accounted for 21 billion euros in all 25 European Union countries alone (3).

Due to the trend of aging of the European Union's population the topicality of the problem is growing. Solution could be targeted identification of the ischemic stroke risk factors and their following modification. Multiple etiological moments of the cerebral infarction make the solution of these problems difficult. Atherothrombosis and atherosclerosis are important causes of stroke, the most common in the younger age group (4). Atherosclerosis is also indirectly involved in other stroke etiology and pathogenesis stages, for example, like coronary heart disease. A number of studies have previously described elevated level of homocysteine as an independent coronary heart disease (5) and stroke (6) risk factor, and there are indications of its possible special connection with cerebral infarction due to the large blood vessel atherothrombosis (7). However, the situation is not so unequivocal as there are also studies that do not detect such a relationship to cardiovascular diseases (8), (9). Moreover, taking into account the heterogeneity of etiology and pathogenesis of stroke, it is not completely clear how this relates to its sub-types. The situation is further complicated by the fact that right now most studies have not demonstrated the efficacy of folic acid in cerebrovascular and cardiovascular event reduction (10), (11), (12), there is only one meta - analysis, which indicates the contrary (13). Similar is the situation in the B group vitamins combination use in the cardio-and cerebrovascular disease risk reduction - several studies showed no reduction (14), (15), while others showed a positive effect (16), (17), but, for example, one study

showed that folic acid in combination with B vitamins possibly increases the risk of revascularization following percutaneous coronary intervention (18).

## II. Materials and Methods

The research was done in VSIA „Pauls Stradins Clinical Hospital" during the period from 01/01/2011 to 15/12/2011. The study was prospective in nature. The case study group included patients with acute cerebral infarction regardless of its genesis, or transient ischemic attack, as well as patients with a history of cerebral infarction of any age that correlated with the imaging techniques data. The control group consisted of patients without a history of cerebrovascular disease, or episode, excluding patients showing indications of prior cerebrovascular diseases according to the imaging techniques.

The work was received the Ethics Committee of Riga Stradiņš university approval.

Demographic, clinical and paraclinical data were taken from routine questionnaires, which are used in the stroke registry. For the control group was used in the same questionnairy as for the case group, only it was was completed in the modified scale.

Homocysteine was determined using IMMULITE 2000 testing system, which uses solid phase hemiluminiscence enzyme immunoassay test for L-homocysteine quantitativedetermination in plasma and serum. It is based on two cycles – release of the bound homocysteine, and its subsequent conversion to S-adenosyl-L-homocysteine (SAH) and the immune response. Antibodies used in the test system are specific for homocysteine. Elevated homocysteine value was considered to be more than 14.25 mmol / l according to the American Stroke Association Guidelines (19). DNA was isolated from venous blood using standard phenol - chloroform method. Genotyping of C677T and A1298C polymorphisms was done by PCR and RFLP analysis (restrictases HinfI, MboII). The study database was created in EpiData software. For statistically processing the STATA StataCorp (2007) Statistical Software was used: Release 11. College Station, TX: StataCorp. Both descriptive and analytical statistical methods were applied.

## III. Results

*a) Demographic Data*

Among 137 of the study subjects 43, 1% (59/137) were men and 56, 9% (78/137) women. Distribution by sex between cases and controls was not statistically significant ($p = 0.512$). In the control group, the age ranged between 45 and 87 years with median of 67 years and quartile boundaries between 59 and 72 years. In the cases group age ranged between 39 and 88 years with a median of 71 years and the quartile limits between 65 and 78 years. The both groups were statistically significantly different by age, $p < 0.01$; the cases group was statistically significantly older.

*b) MTHFR Genetic Polymorphism*

C677 genetic polymorphism results for the cases and control groups are summarized in the 1th table.

A1298 genetic polymorphism represents the 2nd table, where A1298CC - homozygote, which is due to the labile form of MTHFR, A1298AA – a „normal" homozygote.

Homocysteine levels have been measured in 136 individuals, the average rate was 13.2 μmol / l, with a standard deviation of 4.7. In the cases group (102 persons), it ranged from 4.7 to 32.3 μmol / l, and the average level was 13.2 μmol / l with a standard deviation of 4.85. In the control group (34 persons) homocysteine level ranged from 8.2 to 25.2 μmol / l, and the average rate was 13.4 μmol / l with a standard deviation of 4.2. Between the two groups a statistically significant difference was not observed, $p = 0.4$. Relationship of an elevated homocysteine level with cerebrovascular event was not established, OR = 1.04, 95% confidence interval 0.42 to 2.66; $p = 0.9$.

*c) MTHFR and Hyperhomocysteinaemia*

Analyzing the association of an elevated homocysteine level with MTHFR genetic polymorphism no statistically significant relationship with C677TT mutations was observed, $p = 0.15$, such relationship was not found also with the C677CT genotypes, $p = 0.61$ and also with the C677CC – normal homozygote, $p = 0.90$. The 3rd table illustrates the tested relation of C677 genetic polymorphism to elevated serum homocysteine level.

Similar analysis was also done for A1298 genetic polymorphism, where there were found the same results, no statistically significant relationship between hyperhomocysteinemia and A1298CC genotype, $p = 0.09$, heterozygous variant, $p = 0.21$ and the normal homozygote, $p = 0.94$ was detected, that represent 4th table.

## IV. Discussion

The paper's findings have already been extensively studied and described before. From our neighbors in the north of Poland: their study has already found no link between the two investigated MTHFR polymorphism variants, in addition the genotype C677TT in the target group was found in 8% cases and A1298CC in 14% cases, which is close to our results, only in this study there was found the link of a variant of C677TT polymorphism with increased level of homocysteine in the serum (20). The study of our other neighbours in Sweden also found no relationship between the C677TT mutation, hyperhomocysteinemia,

acute cerebrovascular event, internal carotid artery stenosis and folic acid level (22). In this study the TT genotype was present in 10% of both control and cases groups. Another study from a country from our region - Denmark also did not show a direct relation of C677TT genotype with stroke, but did show relation of C677TT genotype with elevated homocysteine level; C677TT genotype was found in the 10.6% and 8.3% persons of the cases and control groups correspondingly (23). Another study, in which target group consisted of younger people with an acute stroke from Poland, also found no relationship between C677TT genotype in this age group, the TT genotype occurred in 12% persons in the stroke group and 10.9% in the control group (24). In Russia the genotype C677TT according to literature occurs in 8.4% of healthy population (25). Without taking into account the small size of the control group, but only considering the genotype frequencies of the target group, it can be concluded that there are no significant differences comparing with our neighbouring countries.

After the last great meta-analysis, at which was assessed the relationship between MTHFR genetic polymorphism, hyperhomocysteinaemia and dietary folic acid quantity, it was concluded that in areas with increased use of folic acid or permanent food enrichment there is no benefit from reducing homocysteine with a purpose to prevent stroke. MTHFR 677C→T polymorphism association with stroke should be investigated in areas with a low folate level (21). In this phase of the study, neither vitamin $B_{12}$, nor folic acid were measured, this is planned to do in the next phase. The author failed to find large and high-quality population data on the vitamin $B_{12}$ and folic acid levels in the blood of Latvia's population as well; hopefully, we will be able to successfully reply to this question in our next study. In view of the above facts it is not possible to speak certainly on the lack of association between the two investigated genotypes and homocysteine level.

## V. Conclusion

The incidence of MTHFR C677 T and C alleles was established, which will be used to calculate the size of the control and cases groups of the next phase of the study. The identical work was done with A1298 A and C alleles. It was found that there is no relationship between the hyperhomocysteinaemia and the studied MTHFR genetic polymorphism in the incorporated population.

## VI. Conflicts of Interest

The autors declare no conflicts of interests.

*Table 1 :* C677 genetic polymorphism in the control and cases groups. C677TT - homozigote that is associated with the MTHFR thermolabile form, C677CC - "normal" heterozigote

| | Genotype | | | |
|---|---|---|---|---|
| Group | **C677TT**; N=13, 10.2 % | **C677CT**; N=47, 36.7 % | **C677CC**; N=68, 53.1 % | **Total** |
| **Cases** | 10 (10.1) | 33 (33.3) | 56 (56.6) | 99 (100.0) |
| **Controls** | 3 (10.3) | 14 (48.3) | 12 (41.4) | 29 (100.0) |

*Table 2 :* A1298 genetic polymorphism in the cases and control groups

| | Genotype | | | |
|---|---|---|---|---|
| Group | **A1298CC**; N=23, 17,4% | **A1298AC**; N=50, 37,8 % | **A1298AA**; N=59, 44,7 % | Total |
| **Cases** | 17 (17.0) | 40 (40.0) | 43 (43.0) | 100 (100,0) |
| **Controls** | 6 (18.8) | 10 (31.3) | 16 (50.0) | 32 (100.0) |

*Table 3 :* C667 genetic polymorphism in relation to the serum elevated homocysteine level

| Homocysteine level | | | | |
|---|---|---|---|---|
| Genotype | **Elevated, N (%)** | **Normal, N (%)** | OR; 95% confidence interval | p value |
| **C677TT** (N=13, 10.1%) | 11 (12.8) | 2 (4.8) | 0.33; [0.03 – 1.65] | 0.15 |
| **C677CT** (N=47, 36.7%) | 17 (40.5) | 30 (34.9) | 1.22; [0.53 – 2.77] | 0.61 |
| **C677CC** (N=68, 53.1%) | 23 (54.8) | 45 (52.3) | 1.05; [0.47 – 2.33] | 0.90 |
| **Total** (N=128, 100%) | 42 (100%) | 86 (100%) | | |

*Table 4 :* Relation of the A1298 genetic polymorphism to elevated serum homocysteine level.

| Genotype | Homocysteine level | | OR; 95% confidence interval | p value |
|---|---|---|---|---|
| | Elevated, N (%) | Normal, N (%) | | |
| A1298CC (N=23, 17.4%) | 11 (25.6) | 12 (13.5) | 2,21; [0.79 – 6.07] | 0.09 |
| A1298AC (N=50, 37.9%) | 13 (30.2) | 37 (41.6) | 0.61; [0,26 – 1,40] | 0.21 |
| A1298AA; (N=59; 44.7%) | 19 (44.2) | 40 (44.9) | 0.97; [0,44 – 2,15] | 0.94 |
| Total (N=132; 100%) | 43 (100%) | 89 (100%) | | |



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# Using of Semi-Empirical Models and Fick's Second Low for Mathematical Modeling of Mass Transfer in Thin Layer Drying of Carrot Slice

By Isa Hazbavi, Seyed Hashem Samadi & Hamid Khafajeh
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*Abstract -* Drying behavior of carrot slices were studied at 200, 300, 400 and 500 W for constant sample thickness (5mm) in a microwave dryer. By increasing the microwave output powers (200-500 W), the drying time decreased from 17.5 to 9.5 min. The drying process took place in the falling rate period. Six mathematical models for describing the thinlayer drying behavior of carrot slices were investigated. The models were compared based on their coefficient of determination (R2), root mean square error (RMSE) and reduced chi-square ($\chi 2$) values between experimental and predicted moisture ratios. The results show that the Midilli model is the most appropriate model for drying behaviour of thin layer carrot slices. Moisture transfer from carrot slices was described by applying the Fick's diffusion model, and effective moisture diffusion coefficients were calculated. A third order polynomial relationship was found to correlate the effective moisture diffusivity ($D_{eff}$) with moisture content. The effective moisture diffusivity increased with decrease in moisture content of carrot slices. Average effective moisture diffusivity increased from $6.33\times10^{-9}$ to $1.14\times10^{-8}$ $m^2/s$ with increasing the microwave power.

*Keywords :* *drying; modeling; moisture diffusivity; carrot slices, microwave power.*

*GJSFR-C Classification :* *FOR Code: 100505, 861401*


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# Using of Semi-Empirical Models and Fick's Second Low for Mathematical Modeling of Mass Transfer in Thin Layer Drying of Carrot Slice

Isa Hazbavi [α], Seyed Hashem Samadi [σ] & Hamid Khafajeh [ρ]

*Abstract* - Drying behavior of carrot slices were studied at 200, 300, 400 and 500 W for constant sample thickness (5 mm) in a microwave dryer. By increasing the microwave output powers (200-500 W), the drying time decreased from 17.5 to 9.5 min. The drying process took place in the falling rate period. Six mathematical models for describing the thin-layer drying behavior of carrot slices were investigated. The models were compared based on their coefficient of determination (R2), root mean square error (RMSE) and reduced chi-square (X2) v alues between ex perimental and predicted moisture ratios. The results show that the Midilli model is the most appropriate model for drying behaviour of thin layer carrot slices. Moisture transfer from carrot slices was described by applying the Fick's diffusion model, and effective moisture diffusion coefficients were calculated. A third order polynomial relationship was found to correlate the effective moisture diffusivity ($D_{eff}$) with moisture content. The effective moisture diffusivity increased with decrease in moisture content of carrot slices. Average effective moisture diffusivity increased from $6.33\times10^{-9}$ to $1.14\times10^{-8}$ $m^2/s$ with increasing the microwave power.

*Keywords : drying; modeling; moisture diffusivity; carrot slices, microwave power.*

## I. Introduction

Drying of moist materials is a complicated process involving simultaneous heat and mass transfer. Mathematical modeling and simulation of drying curves under different conditions is important to obtain a better control of this unit operation and an overall improvement of the quality of the final product [1, 2, 3]. Currently, there are three types of thin-layer drying models used to describe the drying phenomenon of agriculture product, namely, theoretical model, which considers only the internal resistance to moisture transfer between product and heating air, semi-theoretical and empirical models which consider only the external resistance.

The drying process takes place in two stages. The first stage happens at the surface of the drying material at a constant drying rate and is similar to the vaporization of water into the ambient. The second stage drying process takes place with decreasing drying rate [4].

When drying process is controlled by the internal mass transfer, mainly in the falling rate period, modeling of drying is carried out through diffusion equations based on Fick's second law [4, 5, 6, 7]. Molecular diffusion is the main water transport mechanism and to predict the water transfer in food materials diffusion models based on Fick's second law are used.

Effective moisture diffusivity describes all possible mechanisms of moisture movement within the foods, such as liquid diffusion, vapour diffusion, surface diffusion, capillary flow and hydrodynamic flow. A knowledge of effective moisture diffusivity is necessary for designing and modeling mass-transfer processes such as dehydration, adsorption and desorption of moisture during storage. Researchers reported that effective moisture diffusivity increased with moisture content up to a limit value and then decreased and eventually became constant at high moisture contents [8, 9].

The aim of this research was the study and modelling of the drying kinetics of mass transfer during the microwave drying process of carrot slices. The effect of drying powers and moisture content on the effective moisture diffusivity of the dried slices was also studied.

## II. Mateials and Methods

Carrot samples were procured from local vegetable market in Tehran, Iran. The samples were stored at 4±0.5 °C before they were used in experiments. The samples were removed from the refrigerator before experimentation and were allowed to attain room temperature. Carrots were washed under running water to remove the adhering impurities, and thinly sliced in thicknesses of 5 mm using a sharp stainless steel knife. The average initial moisture content of the samples were found to be 78.2 ± 0.7 % wet basis, as determined by using convective oven at 105 °C for 24h.

A domestic microwave oven (M945, Samsung Electronics Ins) with maximum output of 1000 W at 2450MHz was used for the drying experiments. The

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dimensions of the microwave cavity were 327×370×207 mm. The oven has a fan for air flow in drying chamber and cooling of magnetron. The moisture from drying chamber was removed with this fan by passing it through the openings on the right side of the oven wall to the outer atmosphere. The microwave dryer was operated by a control terminal which could control both microwave power level and emission time. Experiments were performed at four initial mass of 30 g at four microwave powers of 200, 300, 400 and 500 W. The moisture losses of samples were recorded at 15 s intervals during the drying process by a digital balance (GF-600, A & D, Japan) and an accuracy of ± 0.001 g.

For measuring the weight of the sample during experimentation, the tray with sample was taken out of the drying chamber, weighed on the digital top pan balance and placed back into the chamber. Drying was carried out until the final moisture content reaches to a level less than 10 % (w.b.).

The moisture ratio of samples during the thin layer drying experiments was calculated using the following equation:

$$MR = \frac{X_t - X_e}{X_0 - X_e} \quad (1)$$

where MR is the moisture ratio (dimensionless), Xt is the moisture content at drying time t (d.b.) and X0 is the initial moisture content (d.b.). The values of Xe are relatively small compared to Xt or X0. Thus, Eq. (1) can be reduced to MR=Xt/X0 [5].

The experimental sets of (MR, t) were fitted to six empirical models from the literature, using IBM SPSS Statistics 19. (SPSS, Inc.).

Newton model:

$$MR = \exp(-kt) \quad (2)$$

Henderson and Pabis model:

$$MR = a\exp(-kt) \quad (3)$$

Page's model:

$$MR = \exp(-kt^n) \quad (4)$$

Midilli model:

$$MR = a\exp(-kt^n) + bt \quad (5)$$

Wand and Singh model:

$$MR = 1 + bt + at^2 \quad (6)$$

Logarithmic model:

$$MR = a\exp(-kt) + b \quad (7)$$

Where k is the drying rate constant (1/min), and a, b and n are equation constants model.

The terms used to evaluate goodness of fit of the tested models to the experimental data were the coefficient of determination ($R^2$); root mean square error (RMSE) and the reduced chi-square ($\chi^2$) between the experimental and predicted moisture ratio values. Statistical values are defined as follows:

$$R^2 = 1 - \left( \frac{\sum_{i=1}^{N} (MR_{pre,i} - MR_{exp,i})^2}{\sum_{i=1}^{N} (MR_{pre,i} - \overline{MR}_{exp})^2} \right) \quad (8)$$

$$\chi^2 = \frac{\sum_{i=1}^{n} (MR_{exp,i} - MR_{pre,i})^2}{N - z} \quad (9)$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n} (MR_{exp,i} - MR_{pre,i})^2}{N}} \quad (10)$$

In these equations, N is the number of observations, z is the number of constants, MRexp and MRpre are the experimental and predicted moisture ratios, respectively.

The drying rate of samples was calculated by using Eq. (11):

$$DR = \frac{X_{t+\Delta t} - X_t}{\Delta t} \quad (11)$$

where $X_{t+\Delta t}$ is moisture content at time t+Δt (d.b.), t is the time (min) and DR is the drying rate (d.b./min).

Fick's second equation of diffusion was used to calculate the effective diffusivity, considering a constant moisture diffusivity, infinite slab geometry and uniform initial moisture distribution:

$$MR = \frac{8}{\pi^2} \sum_{n=o}^{\infty} \frac{1}{(2n+1)} \exp\left( -\frac{(2n+1)\pi^2}{L^2} D_{eff}\, t \right) \quad (12)$$

where $D_{eff}$ is the effective diffusivity ($m^2/s$), and L is the thickness (here half) of slab (m).

The Eq. (12) can be simplified by taking the first term of Eq. (13):

$$MR = \frac{8}{\pi^2} \exp\left( -\frac{\pi^2 D_{eff}\, t}{L^2} \right) \quad (13)$$

Eq. (13) is evaluated numerically for Fourier number, $F_0 = D_{eff} \times t/L^2$, for diffusion and can be rewritten as Eq. (14) can be rewritten as:

$$MR = \frac{8}{\pi^2} \exp(-\pi^2 F_0) \quad (14)$$

Thus:

$$F_0 = -0.101 \ln(MR) - 0.0213 \quad (15)$$

The effective moisture diffusivity was calculated using Eq. (16) as:

$$D_{eff} = \frac{F_0}{\left(\frac{t}{L^2}\right)} \quad (16)$$

## III. Results and Discussion

Fig. 1 shows the change in moisture ratio of carrot slices with time by microwave drying. A reduction in drying time occurred with increasing the microwave power level. On the other hand, mass transfer within the sample was more rapid during higher microwave power

heating because more heat was generated within the sample creating a large vapor pressure difference between the centre and the surface of the product due to characteristic microwave volumetric heating. The time required for the lowering of moisture content of carrot slices to 0.1 from 3.59 on dry basis varied between 9.5 and 17.5 min depending on the microwave power level.

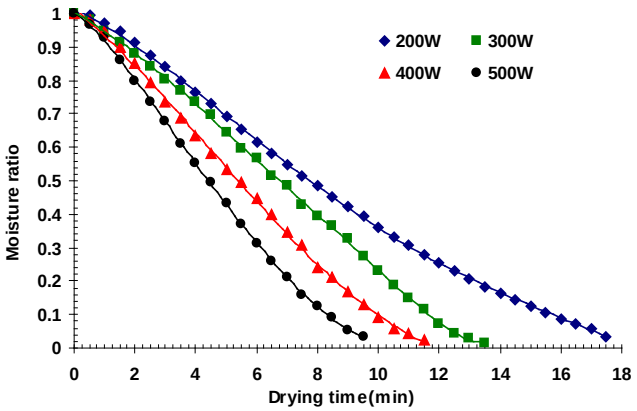


*Figure 1 :* Variation in moisture ratio as a function of drying time

The statistical results from models are summarized in Table 1. The values of mentioned tests were in the range of 0.7373–0.9999 for $R^2$, 0.00003–0.0665 for $\chi^2$, 0.0054–0.2486 for RMSE. Based on the criteria of the highest $R^2$ and the lowest RMSE, and $\chi^2$, the model of Midilli was selected as the most suitable model to represent the thin-layer drying behavior of carrot slices. Fig. 2 compares experimental data with those predicted with the Midilli model for carrot slices at 200, 300, 400 and 500W. The prediction using the model showed MR values banded along the straight line, which showed the suitability of these models in describing drying characteristics of carrot s lices.

*Table 1 :* Thin layer drying model constants and statistical parameters of sliced carrot

| Model | P(W) | Constants | $R^2$ | $\chi^2$ | RMSE |
|---|---|---|---|---|---|
| Newton | 200 | k=0.1313 | 0.8737 | 0.0125 | 0.1103 |
| | 300 | k=0.1848 | 0.7373 | 0.0285 | 0.1656 |
| | 400 | k=0.2153 | 0.8154 | 0.0211 | 0.1423 |
| | 500 | k=0.2505 | 0.8477 | 0.0177 | 0.1266 |
| Henderson and Pabis | 200 | k=0.1644; a=1.4794 | 0.9244 | 0.0182 | 0.1310 |
| | 300 | k=0.2505; a=1.8251 | 0.8131 | 0.0665 | 0.2486 |
| | 400 | k=0.2806; a=1.6672 | 0.8802 | 0.0428 | 0.1982 |
| | 500 | k=0.319; a=1.5604 | 0.9047 | 0.0327 | 0.1674 |
| Wang and Singh | 200 | a=0.0007; b=-0.0690 | 0.9945 | 0.0006 | 0.0228 |
| | 300 | a=-0.0005; b=-0.0698 | 0.9969 | 0.0082 | 0.0875 |
| | 400 | a=0.0005, b=-0.0951 | 0.9949 | 0.0006 | 0.0229 |
| | 500 | a=0.0013; b=-0.1182 | 0.9946 | 0.0006 | 0.0228 |
| Page | 200 | k=0.028; n=1.574 | 0.9980 | 0.0002 | 0.0145 |
| | 300 | k=0.023; n=1.813 | 0.9903 | 0.0012 | 0.0327 |
| | 400 | k=0.041; n=1.707 | 0.9940 | 0.0007 | 0.0248 |
| | 500 | k=0.060; n=1.680 | 0.9961 | 0.0004 | 0.0193 |
| Midilli | 200 | k=0.036; n=1.379; a=1.010; b=-0.007 | 0.9999 | 0.00003 | 0.0054 |
| | 300 | k=0.024; n=1.519; a=0.994; b= -0.022 | 0.9999 | 0.0001 | 0.0094 |
| | 400 | k=0.034; n=1.550; a=0.997; b=-0.020 | 0.9982 | 0.0007 | 0.0246 |
| | 500 | k=0.063; n=1.492; a=0.996; b=-0.015 | 0.9999 | 0.0001 | 0.0064 |
| Logarithmic | 200 | k=0.041; a=2.015; b=-0.961 | 0.9983 | 0.0002 | 0.0149 |
| | 300 | k=0.015; a=5.931; b=-4.885 | 0.9964 | 0.0007 | 0.0250 |
| | 400 | k=0.033; a=3.342; b=-2.298 | 0.9971 | 0.0003 | 0.0169 |
| | 500 | k=0.047; a=2.888; b=-1.847 | 0.9973 | 0.0004 | 0.0179 |

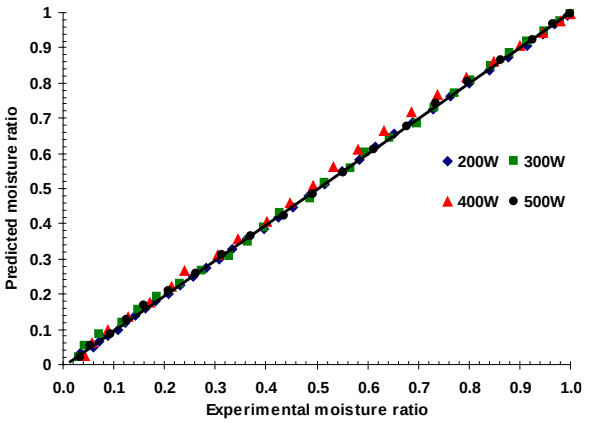


*Figure 2 :* Comparison of experimental moisture ratio with predicted moisture ratio from the Midilli model for carrot slices

Fig. 3 shows the changes in drying rate as a function of drying time at the different powers. It is clear that the moisture content and drying rate decrease continuously with drying time. The drying rate was rapid during the initial period but it became very slow at the last stages during the drying process. The moisture content of the material was very high during the initial phase of the drying which resulted in a higher absorption of microwave power and higher drying rates due to the higher moisture diffusion. As the drying progressed, the loss of moisture in the product caused a decrease in the absorption of microwave power and resulted in a fall in the drying rate. Similar results have been observed in the drying of different fruits and vegetables: kiwifruit [10]; hazelnut [11]; carrot pomace [12]; amelia mango [13]; pineapple, mango, guava and papaya [14] and apple [6]. Constant drying rate period was not observed during the drying of carrot slices. This shows that diffusion in dominant physical mechanism governing moisture movement in the samples.

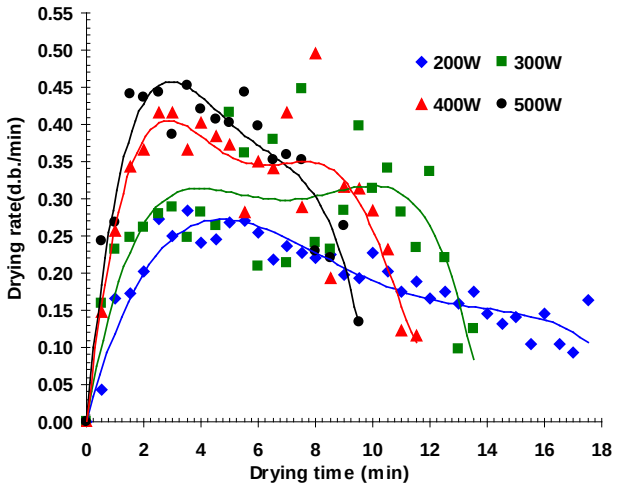


*Figure 3 :* Drying rates for carrot slices at different microwave powers

Variation in effective moisture diffusivity of carrot slices with moisture content at different microwave power levels is shown in Fig. 4. The effective moisture diffusivity increased with decrease in moisture content. However, the moisture diffusivity further was higher at any level of moisture content at higher microwave power level, resulting into shorter drying time. This may indicate that as moisture content decreased, the permeability to vapour increased, provided the pore structure remained open. The temperature of the product rises rapidly in the initial stages of drying, due to more absorption of microwave heat, as the product has a high loss factor at higher moisture content. This increases the water vapour pressure inside the pores and results in pressure induced opening of pores. In the first stage of drying, liquid diffusion of moisture could be the main mechanism of moisture transport. As drying progressed further, vapour diffusion could have been the dominant mode of moisture diffusion in the latter part of drying. Sharma and Prasad [8]; Sharma et al. [9] also reported similar trend in the variation in the moisture diffusivity with moisture content.

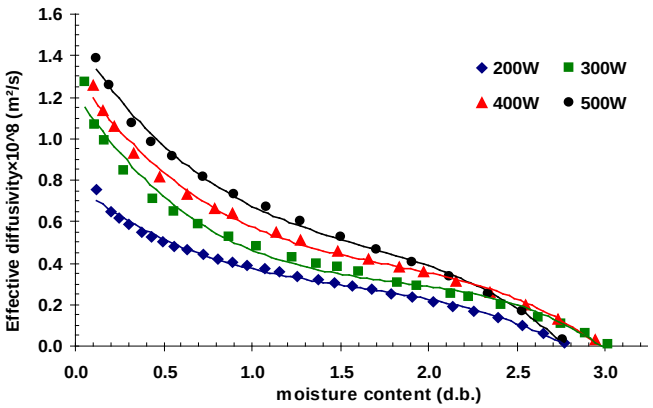


*Figure 4 :* Variation in effective moisture diffusivity with moisture content at different microwave powers

A third order polynomial relationship was found to correlate the effective moisture diffusivity with corresponding moisture content of carrot slices and is given by Eq. (17)

$$D_{eff} = (A + BX + CX^2 + DX^3) \times 10^{-8} \qquad (17)$$

where A, B, C, D is the constants of regression, and X is moisture content (d.b.)

Regression constants for microwave drying of carrot slices under different powers are presented in Table 2. The high values of $R^2$ are indicative of good fitness of empirical relationship to represent the variation in effective moisture diffusivity with moisture content of carrot slices.

*Table 2 :* Regression coefficients of effective moisture diffusivity for different microwave powers

| P(W) | A | B | C | D | $R^2$ |
|---|---|---|---|---|---|
| 500 | 1.4877 | -1.3507 | 0.6745 | -0.1372 | 0.9962 |
| 400 | 1.3081 | -1.2129 | 0.5893 | -0.1109 | 0.9955 |
| 300 | 1.2130 | -1.2750 | 0.6410 | -0.1174 | 0.9862 |
| 200 | 0.7791 | -0.6854 | 0.3530 | -0.0745 | 0.9944 |

The average effective moisture diffusivity was calculated by taking the arithmetic mean of the effective moisture diffusivities that were estimated at various levels of moisture contents during the course of drying, as shown in Fig 5. Average values of effective diffusivity for different microwave power are presented in Table 3. The $D_{eff}$ values of the carrot slices were within the general ranges of $10^{-9}$ to $10^{-11}$ $m^2/s$ for biological materials [6, 12, 15]. The values of $D_{eff}$ are comparable with the reported values of $1.0465\times10^{-8}$ to $9.1537\times10^{-8}$ $m^2/s$ mentioned for apple pomace microwave drying [6], $1.14\times10^{-6}$ to $6.09\times10^{-6}$ $m^2/s$ for tomato pomace microwave drying at 160-800W [16], $0.55\times10^{-7}$ to $3.5\times10^{-7}$ $m^2/s$ for Gundelia tournefortii microwave drying at 90-800W [7].

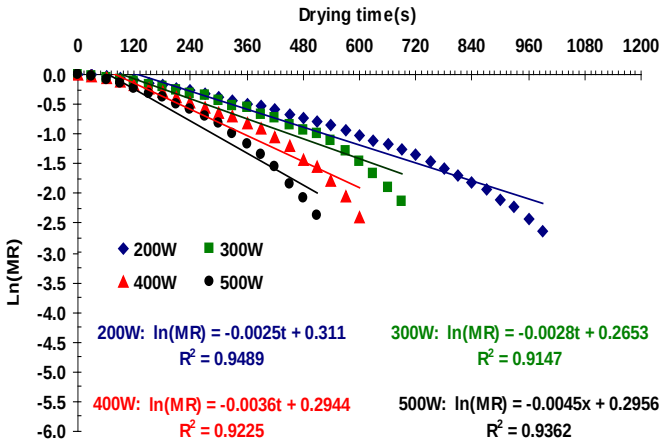


*Figure 5 :* Variation in ln (MR) and drying time (in seconds) for carrot slices dried at different microwave powers

*Table 3 :* Result of average effective diffusivity of carrot slices with different microwave power levels

| P(W) | Average effective diffusivity ($m^2/s$) |
|---|---|
| 500 | $1.14\times10^{-8}$ |
| 400 | $9.12\times10^{-9}$ |
| 300 | $7.09\times10^{-9}$ |
| 200 | $6.33\times10^{-9}$ |

A linear regression analysis on the average diffusion coefficient with microwave power resulted in the following relationships:

$$(D_{eff})_{average} = 4\times10^{-9}\exp(0.002P) \quad R^2 = 0.9788 \quad (18)$$

where P is the microwave power (W).

## IV. Conclusion

In this study, microwave drying characteristics of carrot slices were investigated. The drying curves of carrot slices did not show a constant rate drying period. The drying took place in the falling rate period during drying process. To explain the drying characteristics of strained yoghurt, nine drying models were applied; however, the model developed by Midilli model showed good agreement with the experimental data. The effective diffusivity was computed from Fick's second law, the values of which varied between $6.33\times10^{-9}$ to $1.14\times10^{-8}$ $m^2/s$, over the microwave power level range. The effective diffusivity increases microwave power level increases. The effective moisture diffusivity increased with decrease in moisture content of carrot slices. A third order polynomial relationship existed between effective moisture diffusivity and the moisture content of carrot slices.

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(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

**Format**

*Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.*

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

**Structure**

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

*Abstract, used in Original Papers and Reviews:*

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

*Acknowledgements: Please make these as concise as possible.*

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

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*Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.*

*Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.*

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Color Charges: It is the rule of the Global Journals Inc. (US) for authors to pay the full cost for the reproduction of their color artwork. Hence, please note that, if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a color work agreement form before your paper can be published.

*Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.*

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Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

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## TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

**1. Choosing the topic:** In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

**2. Evaluators are human:** First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

**3. Think Like Evaluators:** If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

**4. Make blueprints of paper:** The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

**5. Ask your Guides:** If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

**6. Use of computer is recommended:** As you are doing research in the field of Computer Science, then this point is quite obvious.

**7. Use right software:** Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

**8. Use the Internet for help:** An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

**9. Use and get big pictures:** Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

**10. Bookmarks are useful:** When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

**11. Revise what you wrote:** When you write anything, always read it, summarize it and then finalize it.

**12. Make all efforts:** Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

**13. Have backups:** When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

**14. Produce good diagrams of your own:** Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

**15. Use of direct quotes:** When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

**16. Use proper verb tense:** Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

**17. Never use online paper:** If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

**18. Pick a good study spot:** To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

**19. Know what you know:** Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

**20. Use good quality grammar:** Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

**21. Arrangement of information:** Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

**22. Never start in last minute:** Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

**23. Multitasking in research is not good:** Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

**24. Never copy others' work:** Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

**25. Take proper rest and food:** No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

**26. Go for seminars:** Attend seminars if the topic is relevant to your research area. Utilize all your resources.

**27. Refresh your mind after intervals:** Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

**28. Make colleagues:** Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

**29. Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

**30. Think and then print:** When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

**31. Adding unnecessary information:** Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

**32. Never oversimplify everything:** To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

**33. Report concluded results:** Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

**34. After conclusion:** Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

## Informal Guidelines of Research Paper Writing

**Key points to remember:**

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

**Final Points:**

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

**General style:**

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

**Title Page:**

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

**Abstract:**

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

**Introduction:**

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.



- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

**Procedures (Methods and Materials):**

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

**Results:**

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

**Discussion:**

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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- Do not give permission to anyone else to "PROOFREAD" your manuscript.

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|---|---|---|---|
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| ***Introduction*** | Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited | Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter | Out of place depth and content, hazy format |
| ***Methods and Procedures*** | Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads | Difficult to comprehend with embarrassed text, too much explanation but completed | Incorrect and unorganized structure with hazy meaning |
| ***Result*** | Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake | Complete and embarrassed text, difficult to comprehend | Irregular format with wrong facts and figures |
| ***Discussion*** | Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited | Wordy, unclear conclusion, spurious | Conclusion is not cited, unorganized, difficult to comprehend |
| ***References*** | Complete and correct format, well organized | Beside the point, Incomplete | Wrong format and structuring |

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