Global Journal of Science Frontier Research: A
Physics and Space Science
Volume 18 Issue 4 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

# External and Internal Radiation Doses from Chemical Fertilizers used in Ibadan, Oyo State, Nigeria

By B. U., Nwaka & N. N., Jibiri
*Alvan Ikoku Federal College of Education Owerri*

*Absract-* The knowledge of external and internal doses of radiation emitted from radionuclides contained in different chemical fertilizers sold in Ibadan, Nigeria is very important. Therefore, activity concentrations of 40K, 226Ra and 232Th radionuclides in Urea, NPK (15 – 15 – 15), NPK (16 – 16 – 16) and Single Super Phosphate (SSP) fertilizer brands sold in the area for agricultural purposes were determined using gamma–ray spectroscopy. Radium equivalent activity (Raeq), gamma radiation or representative index ($I_\gamma$), alpha index ($I_\alpha$), annual gonadal dose equivalent (AGDE), external exposure ($D_{ext}$) to gamma radiation as well as internal exposure ($D_{int}$) to doses of radiation to the marketers and users of the products were calculated. The calculated $Ra_{eq}$ for the four brands of chemical fertilizers were 80.90 $Bqkg^{-1}$, 295.95 $Bqkg^{-1}$, 293.93 $Bqkg^{-1}$ and 706.17 $Bqkg^{-1}$ respectively. External gamma doses were 0.60 $mSvy^{-1}$, 6.73 $mSvy^{-1}$, 6.65 $mSvy^{-1}$ and 13.00 $mSvy^{-1}$ while the sum of the internal doses due to inhalation and ingestion were found as 3.93 $\mu Svy^{-1}$, 4.51 $\mu Svy^{-1}$, 3.61 $\mu Svy^{-1}$ and 8.97 $\mu Svy^{-1}$ respectively. More external and internal doses of radiation were calculated for marketers of the products than farmers.

*Keywords: chemical fertilizers, ionizing radiation, external exposure, somatic effects, radium equivalent activity.*

GJSFR-A Classification: *FOR Code: 250604*

EXTERNALANDINTERNALRADIATIONDOSESFROMCHEMICAL FERTILIZERSUSEDINIBADANOYOSTATENIGERIA

*Strictly as per the compliance and regulations of:*

# External and Internal Radiation Doses from Chemical Fertilizers used in Ibadan, Oyo State, Nigeria

B. U., Nwaka [α] & N. N., Jibiri [σ]

*Abstract-* The knowledge of external and internal doses of radiation emitted from radionuclides contained in different chemical fertilizers sold in Ibadan, Nigeria is very important. Therefore, activity concentrations of $^{40}$K, $^{226}$Ra and $^{232}$Th radionuclides in Urea, NPK (15 – 15 – 15), NPK (16 – 16 – 16) and Single Super Phosphate (SSP) fertilizer brands sold in the area for agricultural purposes were determined using gamma–ray spectroscopy. Radium equivalent activity ($Ra_{eq}$), gamma radiation or representative index ($\boldsymbol{I_\gamma}$), alpha index ($\boldsymbol{I_\alpha}$), annual gonadal dose equivalent (AGDE), external exposure ($D_{ext}$) to gamma radiation as well as internal exposure ($D_{int}$) to doses of radiation to the marketers and users of the products were calculated. The calculated $Ra_{eq}$ for the four brands of chemical fertilizers were 80.90 $\boldsymbol{Bq\,kg^{-1}}$, 295.95 $\boldsymbol{Bq\,kg^{-1}}$, 293.93 $\boldsymbol{Bq\,kg^{-1}}$ and 706.17 $\boldsymbol{Bq\,kg^{-1}}$ respectively. External gamma doses were 0.60 $\boldsymbol{mSv\,y^{-1}}$, 6.73 $\boldsymbol{mSv\,y^{-1}}$, 6.65 $\boldsymbol{mSv\,y^{-1}}$ and 13.00 $\boldsymbol{mSv\,y^{-1}}$ while the sum of the internal doses due to inhalation and ingestion were found as 3.93 $\boldsymbol{\mu Sv\,y^{-1}}$, 4.51 $\boldsymbol{\mu Sv\,y^{-1}}$, 3.61 $\boldsymbol{\mu Sv\,y^{-1}}$ and 8.97 $\boldsymbol{\mu Sv\,y^{-1}}$ respectively. More external and internal doses of radiation were calculated for marketers of the products than farmers. The order of SSP > NPKs > Urea fertilizers was observed for external exposure to gamma radiation. The results could serve as important radiometric data and information upon which future environmental monitoring of external and internal exposure to gamma radiation and alpha particles associated with chemical fertilizers could be based.

*Keywords: chemical fertilizers, ionizing radiation, external exposure, somatic effects, radium equivalent activity.*

## I. Introduction

Fertilizers, whether chemical (inorganic) or animal manure (organics) are used to replenish micro and macro elements lost by crops through leaching, erosion and continuous cropping in farm soil. The widespread inorganic fertilizers in use in Nigeria are Nitrogen Phosphorus and Potassium (NPK) fertilizers, Urea fertilizer and Single Supper Phosphate fertilizer (SSP). NPK fertilizers are of different formulations including NPK (15 – 15 – 15), NPK (20 – 10 – 10) and NPK (16 – 16 – 16). Using x–ray fluorescence spectrometric technique, heavy metals of silicon, vanadium, chromium, nickel, zinc, iron, titanium and copper were identified in inorganic fertilizers sold in Samaru, Zaria, Nigeria (Elisha, 2014).

The phosphorus content of chemical fertilizers originates from phosphate rocks which contain varying levels of natural radionuclides Uranium ($^{238}$U), Thorium ($^{232}$Th) and Potassium ($^{40}$K) (Hassan *et al.,* 2016) that emit alpha particles, beta particles, and gamma radiations. According to Sahu *et al.* 2014 rock phosphate ore and phosphogypsum contributes to enhanced concentrations of natural radionuclides in the environment. High activity concentrations of radionuclides in fertilizers may result to increase in redistribution of radionuclides in farm soil, and via plant tissues, are deposited in steam, leaves, and fruits. Moreover, the health status of factory workers, marketers or dealers of the product as well as farmers may be at risk due to handling and packing in bags, inhalation and accidental ingestion which are the possible pathways of exposure.

The study of gamma radiation and alpha particles emitted from the radionuclides $^{226}$Ra, $^{232}$Th and $^{40}$K present in fertilizers is very important in environmental radioactivity. This is because high doses of radiation deposited directly on tissues and lunges could cause cancerous growth. External gamma radiation exposure occurs directly by the handling of fertilizer which could cause skin cancer if the gamma doses are higher than safe limit recommended by radiation protection and measurement agencies. Whereas, internal exposure to alpha particles arises from the inhalation of radon gas and its progenies as well as ingestion of doses of radiation either intentionally or accidentally. During radioactive decay, $^{226}$Ra and $^{232}$Th radionuclides release short–lived decay products of radon gas ($t_{1/2} = 3.8\ \text{days}$) and thoron ($t_{1/2} = 55.6\ \text{seconds}$) in the air which deposit their alpha particle energies in tissues and lungs. Radionuclide $^{226}$Ra has high potential, due to continuous irradiation, causing biological damages once it is deposited in tissues.

Hassan *et al.* (2017) had established that the average value of $^{226}$Ra ($^{238}$U), $^{232}$Th and $^{40}$K in Japanese fertilizers were less than their corresponding values in Egyptian fertilizers. Jabbar and Abdul (2014) in Basrah Governorate, Iraq found the mean specific activity

*Author α: Department of Physics, Alvan Ikoku Federal College of Education, Owerri, PMB 1033, Imo state, Nigeria.*
*e-mails: ben_de_req@yahoo.com; nwakabenjaminu@gmail.com;*
*Author σ: Radiation and Health Physics Research Laboratory, Department of Physics, University of Ibadan, Nigeria.*
*e-mail: jibirinn@yahoo.com*

concentrations 107.0±8.7 $Bq\ kg^{-1}$, 108.0±7.6 $Bq\ kg^{-1}$ and 1207.0±9.8 $Bq\ kg^{-1}$ respectively for $^{226}$Ra, $^{232}$Th and $^{40}$K. Though not too recently, activity concentrations of radionuclides $^{226}$Ra, $^{232}$Th and $^{40}$K present in chemical fertilizers in Nigeria were reported (Ibeanu *et al.,* 2009; Jibiri and Fasae, 2012) but the results did not consider at the time the radiation dose contribution of the various brand of fertilizers investigated. External and internal radiation dose contributions due to chemical fertilizers had not been given attention in Nigeria, therefore, the need to have current data and information on gamma radiation doses from external exposure as well as inhalation and accidental ingestion of doses of radiation due to alpha and possibly beta particles and the health implication. These were carried out by determining the activity concentrations of $^{226}$Ra, $^{232}$Th and $^{40}$K radionuclides, radium equivalent activity ($Ra_{eq}$), the gamma radiation or representative hazard index ($I_\gamma$) and the alpha index ($I_\alpha$) contained in NPK (15 – 15 – 15), NPK (16 – 16 – 16), SSP, and Urea fertilizers used in Ibadan, Nigeria for different purposes.

## II. Materials and Method

### a) *Sample preparation*

The four (4) brands of chemical fertilizers commonly in use in Ibadan were purchased from local marketers in the locality which comprises of NPK (15 – 15 – 15), NPK (16 – 16 – 16), Urea, and SSP fertilizers. Thirty – six (36) samples comprising of nine (9) samples from each brand were purposively selected and collected for the study, put in polythene bags, labeled and transported to the laboratory for preparation and analysis. They were pulverized in agate mortar to fine grain size and sieved through ~ 1.5 mm mesh sieve to be more homogeneous. The samples were then dried in a temperature controlled oven at 100°C to completely remove the moisture content until they attained constant weight. They were cooled in a desiccator, weighted (200±1g) and transferred in plastic containers, sealed using adhesives masking tape with each lid fastened on each container to prevent radon escape. The 36 sealed containers were stored for 30 days to establish radioactive secular equilibrium between long–lived $^{238}$U and $^{232}$Th and its daughters. Thereafter, an empty plastic container of the same geometry as the prepared homogeneous fertilizer samples was sealed and kept for 30 days to measure the background radiation of the laboratory environment.

### b) *Gamma–ray spectroscopy detector and characteristics*

Measurement of $^{226}$Ra, $^{232}$Th and $^{40}$K radionuclides was done using a 6 cm lead – shielded 7.6 cm by 7.6 cm sodium iodide activated with thallium, NaI(Tl), gamma ray spectrometer detector (Model number 802 series CANBERRA Inc.). The detector is lead shielded to minimize the effect of background radiation in the laboratory. The measuring instrument was coupled to a CANBERRA series 10 plus Multichannel Analyser (Model number 1104) through a preamplifier base and a photomultiplier tube which converts the visible light photons produced in the crystal into amplified electrical pulses, and then an amplifier. It has a modest resolution of 8% full–width at half maximum (FWHM) at $^{137}$Cs energy of 0.662 $MeV$ (Jibiri *et al.,* 2011), which suggests the choice of its use for measurement, which is capable of distinguishing the gamma–ray energies of the radionuclide of interest. The detector was connected to a personal computer (PC) with data acquisition system. A software programme was used to collect and analyse the data to compute the radionuclide concentrations in the samples. The procedure used in this study was similar to that followed by Isinkaye and Emelue (2015).

### c) *Energy and efficiency calibration of the detector*

To ensure the radiation parameters in the samples could be expressed in physical radiometric units, the detector was calibrated before it was used for analyses. Since the performance of a gamma–ray spectroscopy depends on the high resolving power and high value of efficiency, the calibration was done in two stages: energy calibration and efficiency calibration. Energy calibration converts channel numbers in the spectrum to gamma–ray energies in MeV by placing different gamma sources of known energy in the detector volume after a preset counting time so as to identify channels of various photopeaks corresponding to the different gamma energies. $^{137}$Cs (0.662 $MeV$), $^{60}$Co (1.173 $MeV$), $^{22}$Na (1.274 $MeV$), $^{60}$Co (1.333), $^{40}$K (1.460 $MeV$) $^{214}$Bi (1.765 $MeV$) and $^{208}$Ti (2.615 $MeV$) sources were used for energy calibration. A linear graph with empirical relation between the channel number and energies was obtained as the reliability of the measuring instrument, which was very strong enough (with correlation coefficient, $R = 0.99$) as shown in Figure 1. The efficiency calibration of the detector was done in other to determine the gamma–ray counting efficiencies over energy range of 0.662 – 2.615 $MeV$ covering all gamma energies of radionuclide of interest in the study. This was carried out by converting the count per seconds under the photopeaks to activity concentrations in $Bq\ kg^{-1}$ of certified reference standard samples. The counting time for accumulating the spectral line for both background and each fertilizer sample was set for 36, 000 seconds which was good enough for the detector to analyse the spectrum with the peaks of interest clearly shown and well distinguished (Isinkaye and Emelue, 2015).

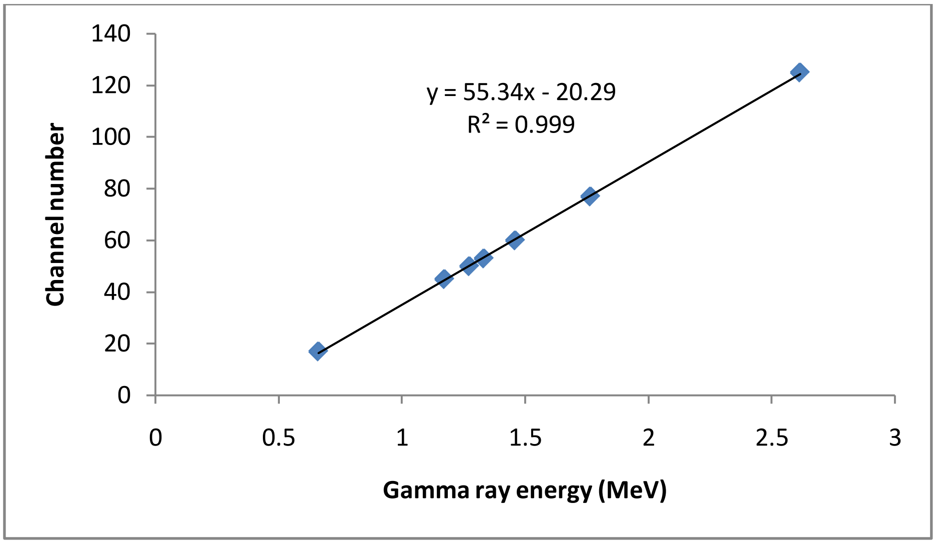



*Figure 1:* Energy Calibration Line of the Detector Systems

*d) Calculation of activity concentration of radionuclide of interest in chemical fertilizers*

The activity concentrations of $^{226}$Ra in each chemical fertilizer sample was estimated from gamma–ray peak energy of 1.760 $MeV$ associated with the decay of $^{214}$Bi, while that of $^{232}$Th was determined from gamma–ray peak energy of 2.615 $MeV$ associated with the decay of $^{208}$Ti. The activity concentration of $^{40}$K was estimated from gamma–ray peak energy of 1.460 $MeV$ from the decay of $^{40}$K itself. The net area under the corresponding photopeak in the energy spectrum was calculated by subtracting count due to Compton scattering of the background source from the total (gross) area of the photopeak. The count rate under the photopeak of each of the $^{226}$Ra, $^{232}$Th, and $^{40}$K radionuclides is related to activity concentrations using equation1 (Farai and Isinkaye, 2009; Jibiri and Okeyode, 2012). The mean values were presented in Tables 2 - 5 for the four (4) different chemical fertilizers.

$$C_i(Bq\ kg^{-1}) = KC_n = \frac{C_n}{\varepsilon\ P_\gamma\ M_s} \quad (1)$$

Where $C_i$ is the activity concentration of radionuclide, $i$ in the fertilizer samples measured in $Bq\ kg^{-1}$, $C_n$ is the count rate under the corresponding photopeak which is the net count above the background over the time taken (36,000 seconds), $\varepsilon$ is absolute detector efficiency at specific gamma–ray energy, $P_\gamma$ is the absolute transition or emission probability of the specific gamma–ray, and $M_s$ is the mass of each sample in the container in $kg$. The detection limit (DL) of a measuring system was needed to provide the minimum detectable activity concentrations in a sample measured in $Bq\ kg^{-1}$calculated for the study using equation 2 (Jibiri *et al.,* 2011).

$$DL\ (Bq\ kg^{-1}) = 4.65\frac{\sqrt{C_b}}{t_b}K \quad (2)$$

Where $C_b$ represents net background count in the corresponding peak, $t_b$ is the background counting time (in seconds), and $K$ is the factor that converts count per seconds (cps) to activity concentration in $Bq\ kg^{-1}$. Detection limits were obtained for each radionuclides$^{226}$Ra, $^{232}$Th and $^{40}$K of interest, however, values above the detection limits were recorded in the study.

## III. Evaluation of Radiological Hazard Indices

*a) Radium equivalent activity $Ra_{eq}$*

Variation in the distribution of radionuclides of $^{226}$Ra, $^{232}$Th and $^{40}$K in phosphate rock deposits and inorganic fertilizer requires that radium equivalent activity is determined in materials. The radium equivalent activity has been defined as single radiological parameters that compare the specific activity of materials containing varying concentrations of $^{226}$Ra, $^{232}$Th and $^{40}$K radionuclides (Berekta and Mathew, 1985). Regarding the radiological health safety assessment, the maximum safety limit of $Ra_{eq} \leq 370\ Bq\ kg^{-1}$ had been set for materials to keep gamma–ray dose below $1.5\ mSv\ y^{-1}$. Equation 3 was used to compute the $Ra_{eq}$ and results presented in Table 6.

$$Ra_{eq} = C_{Ra} + 1.430C_{Th} + 0.077C_K \quad (3)$$

Where $C_{Ra}$, $C_{Th}$ and, $C_K$ are the concentrations of $^{226}$Ra, $^{232}$Th and $^{40}$K in $Bq\ kg^{-1}$ in the fertilizer samples.

*b) Annual gonadal doses equivalent $AGDE$*

The annual gonadal dose equivalent ($AGDE$) is a measure of the genetic significance of the yearly dose received by the population reproductive organs (Ravisankar *et al.* 2014). The gonads, bone marrow and the bone surface cell are sensitive to ionizing radiations and are considered as of interest (UNSCEAR, 2000). Increase in $AGDE$ has been reported to affect the bones marrow, causing the destruction of the red blood cells which are then replaced by white blood cells. The $AGDE$ for the different inorganic fertilizers were calculated using equations 4 (Ravisankar *et al.,* 2014) and the results presented in **Table 6.** Equation 4 was used to compute $AGDE$ in $\mu Svy^{-1}$.

$$AGDE\ (\mu Svy^{-1}) = 3.09\ C_{Ra} + 4.18\ C_{Th} + 0.314\ C_K \quad (4)$$

Where $C_{Ra}$, $C_{Th}$, and $C_K$ are the concentrations of $^{226}$Ra, $^{232}$Th and $^{40}$K in $Bq\,kg^{-1}$ in the fertilizer samples.

*c) Radioactivity hazard Index ($I_\gamma$)*

Gamma radiation hazards associated with $^{226}$Ra, $^{232}$Th and $^{40}$K radionuclides in the chemical fertilizer brands were assessed using the radioactivity hazard index. According to European Commission guidelines, $I_\gamma$ should be greater than two (2) but less than 6 (2< $I_\gamma$ < 6) for radiation dosed of $1\,mSv\,y^{-1}$ (Khan *et al.,* 1998). Furthermore, the value $I_\gamma \leq 0.5$ corresponds to a dose rate criterion of $0.3\,mSv\,y^{-1}$ whereas $0.5 \leq I_\gamma$ corresponds to a criterion of $1\,mSv\,y^{-1}$ (European Commission Report, 1999; Turhan *et al.,* 2008). Equation 5 defines $I_\gamma$ as

$$I_\gamma = \frac{C_{Ra}}{300} + \frac{C_{Th}}{200} + \frac{C_K}{3000} \quad (5)$$

Where $C_{Ra}$, $C_{Th}$, and $C_K$ are the concentrations of $^{226}$Ra, $^{232}$Th and $^{40}$K in $Bq\,kg^{-1}$ in the fertilizer samples.

*d) Alpha index ($I_\alpha$)*

Emission of alpha radiation from alpha particles due to the release of radon gas from the samples is called alpha index represented by $I_\alpha$ which was calculated using equation 6 (Khan *et al.,* 1998; Tufail *et al.,* 2007; Hassan *et al.,* 2016).

$$I_\alpha = \frac{C_{Ra}}{200} \quad (6)$$

$C_{Ra}$ represents the concentrations of $^{226}$Ra in $Bq\,kg^{-1}$ in the fertilizer samples.

*e) Estimation of external gamma doses and internal exposures to radiation doses*

Factory workers, marketers or dealers of chemical fertilizers, as well as farmers, are exposed to ionizing radiation doses present in the material through three major pathways: external exposure to gamma–ray during the packing in bags and handling of the materials, internal exposure from inhalation of dust and contaminated air due to the practice and possible internal exposure from any accidental ingestion of the materials. The computed doses due to inhalation and accidental ingestion were summed up to get the total internal doses delivered by $^{226}$Ra, $^{232}$Th, and $^{40}$K radionuclides to the tissues and organs. This was carried out by applying conversion coefficient doses, relevant for this study, supplied by the International Commission on Radiological Protection (ICRP). External exposure to gamma radiation was estimated using equation 7 (Mustapha *et al.,* 2007 Jibiri *et al.,* 2011; Ademola and Oyema, 2014):

$$D_{Ext} = \sum_i A_i\ C_{Ext,\ i}\, T_{ext} \quad (7)$$

Where $A_i$ is the activity concentrations of nuclide, $i$ measured in $(Bq\,kg^{-1})$, $C_{Ext,\ i}$ is the effective dose coefficient for nuclides $i$ as presented in Table 1, $T_{ext}$ is the duration of exposure in a year. For factory workers and markers who work for eight (8) hours per day in twenty (20) working days per month, the duration of exposure per year was calculated as 20 × 8 × 12 which equals 1920 hours per year $(h\,y^{-1})$. Also for this study, we assume that for a farmer working for eight (8) hours per day for three (3) days per a week, which gives a total of twelve (12) days per month. The duration of exposure for such farmer per year was calculated as 12 × 8 × 12 which equals 1152 hours per year $(h\,y^{-1})$ as presented in Table 1.

Internal exposure from inhalation of poultry/manure dust and contaminated air due to the practice was calculated using equation 8 (Mustapha *et al.,* 2007)

$$D_{Inhal} = \sum_i A_i\ C_{Inhal,\ i}\,\eta_{Inhal}\, D_f\ T_{ext} \quad (8)$$

where $A_i$ is the activity concentrations of nuclide, $i$ measured in $Bq\,kg^{-1}$, $T_{ext}$ is the duration of exposure in number of years (which for the purpose of this work has been corrected for 1920 for poultry feeds exposure and 1152 for poultry manure exposure), $C_{Inhal,\ i}$ is the dose coefficient for inhalation of nuclide $i$ measured in $Sv\,Bq^{-1}$, $\eta_{Inhal}$ is the breathing rate measured in m$^3$/h with coefficient of 1.69 (Mustapha *et al.,* 2007) and $D_f$ is the dust loading factor measured in g/m$^{-3}$ with coefficient of $1.0 \times 10^{-3}$ $[1.0 \times 10^{-6}\ kg\,m^{-3}]$ (Degrand and Lepicard, 2005).

Internal dose from accidental ingestion of radionuclides was calculated from equation 9 (Kolo *et al.,* 2016)

$$D_{Ingest} = \sum_i A_I C_{Ingest,\ i}\,\eta_{ingest}\ T_{ext} \quad (9)$$

Where $A_i$ is the activity concentrations of nuclide $i$ $(Bq\,kg^{-1})$, $C_{Ingest,\ i}$ is the dose coefficient for ingestion of nuclide, $i$, measured in $Sv\,Bq^{-1}$, $\eta_{ingest}$ is the ingestion rate for adults, measured in $kg\,h^{-1}$ whose value is 5.0×10$^{-6}$ (Mustapha *et al.,* 2007) and $T_{ext}$ is the duration of exposure in a year, which for this study was corrected as 1920 for poultry feeds exposure and 1152 for poultry manure exposure.

Global Journal of Science Frontier Research ( A ) Volume XVIII Issue IV Version I Year 2018

*Table 1:* Dose coefficient and some risk parameters for radionuclide of interest adopted in this work

| Dose coefficient parameters | $^{40}$K $(Bq\,kg^{-1})$ | $^{226}$Ra $(Bq\,kg^{-1})$ | $^{232}$Th $(Bq\,kg^{-1})$ | $T_{ext}$ $(h\,y^{-1})$ | References |
|---|---|---|---|---|---|
| Effective dose coefficient, $C_{ext}$ $(\eta Sv\,h^{-1}/Bq\,kg^{-1})$ | 1.175 | 9.929 | 0.003 | | Mustapha *et al.* (2007) |
| Dose coefficient for inhalation, $C_{Inhal}$ $(Sv\,Bq^{-1})$ | 3.0 E-09 | 2.2 E-06 | 2.9 E-05 | | 1CRP 119 (2012) |
| Dose coefficient for ingestion $C_{Ingest}$ $(Sv\,Bq^{-1})$ | 6.2 E-09 | 2.8 E-07 | 2.2 E-07 | | 1CRP 119 (2012) |
| Duration of exposure for marketers/dealers of fertilizer products | | | | 1920* | |
| Duration of exposure for commercial farmers | | | | 1152** | |

*Source: Kolo et al. (2016), except for 1920* and 1152** which were computed for this study.*

## IV. Results and Discussion

### a) *Activity concentration of $^{40}$K, $^{226}$Ra, and $^{232}$Th radionuclides in different fertilizers*

Tables 2, 3, 4, and 5 presented the activity concentrations of $^{40}$K, $^{226}$Ra and $^{232}$Th radionuclides for Urea, NPK (15 – 15 – 15), NPK (16 – 16 – 16) and SSP fertilizers used in Ibadan, Nigeria. Observation from Tables 2 to 5 showed that NPK (16 – 16 – 16) recorded the highest mean activity concentration 2929.33±180.47 $Bq\,kg^{-1}$ for $^{40}$K while the lowest value 171.70±16.15 $Bq\,kg^{-1}$ was found in Urea. The mean results obtained for NPK (15 – 15 – 15) and NPK (16 – 16 – 16) fertilizer were relatively close and showed exceptional values of concentration among the four fertilizer brands. For $^{226}$Ra radionuclides, the highest mean activity concentration 631.17±14.04 $Bq\,kg^{-1}$ was found in SSP fertilizer while the lowest mean activity concentration 9.58±7.08 $Bq\,kg^{-1}$ was found in NPK (15 – 15 – 15) fertilizer samples. While for $^{232}$Th radionuclides, it was found that NPK (15 – 15 – 15) fertilizer had the highest mean activity concentration 44.04±6.07 $Bq\,kg^{-1}$ whereas SSP fertilizer had the lowest value 28.53±4.16 $Bq\,kg^{-1}$. The coefficient of variation (CV) calculated in this study show that some data set was relatively high while others were relatively low. Relatively high values of CV indicated that the distributions were widely dispersed (heterogeneous distribution of data set), while relatively lower values of CV indicated closely dispersed distributions (homogenous distribution of data set).

It is interesting to compare the radionuclide activity concentrations of the present study to similar reported study in different countries of the world. The $^{40}$K, $^{226}$Ra, and $^{232}$Th results obtained in SSP fertilizer were higher than the corresponding values for PhF2 (SSP) fertilizers reported in Egypt (Hassan *et al.,* 2016). The $^{226}$Ra concentrations obtained for Urea, NPK (15 – 15 – 15) and NPK (16 – 16 – 16) fertilizers were lower than the 571±20 $Bq\,kg^{-1}$, and 325±2 $Bq\,kg^{-1}$ established in Egyptian and Japanese fertilizers (Hassan *et al.,* 2017 b). Furthermore, the mean values of $^{232}$Th radionuclides obtained in this study for Urea, NPK (15 – 15 – 15), NPK (16 – 16 – 16) and SSP fertilizers were higher than the results reported for Egyptian and Japanese fertilizers (Hassan *et al.,* 2017). $^{226}$Ra and $^{232}$Th activity concentrations (except the values obtained for $^{40}$K) for both NPK fertilizers of the study were found lower than the corresponding results obtained by Jabbar and Abdul (2014) in Basrah Governorate, Iraq. Variation of the results with literature could be due to chemical compositions of materials used during the manufacturing process.

Except the mean results recorded for Urea, $^{40}$K concentrations in NPKs and SSP were found higher than the results reported for Egyptian fertilizers, whereas the entire four fertilizer brands were found lower than the reported results in Japanese fertilizers (Hassan *et al.,* 2017). Moreover, $^{226}$Ra concentration in Urea fertilizer of the present study was found lower than the mean value 15.38±2.94 $Bq\,kg^{-1}$ obtained in Urea fertilizer Tarakandi in Jamalpur, Bangladesh (Samad *et al.,* 2011), however, the $^{232}$Th concentration was found higher than the mean value 17.16±6.73 $Bq\,kg^{-1}$ in Urea fertilizer Tarakandi in Jamalpur, Bangladesh (Samad *et al.,* 2011).

As observed from **Table 6,** mean value obtained for radium equivalent activity for the four brands of chemical fertilizers, except that of SSP which recorded 706.17 $Bq\,kg^{-1}$, were lower than 613±33 $Bq\,kg^{-1}$ and 454±5 $Bq\,kg^{-1}$ reported in Egyptian and Japanese fertilizers (Hassan *et al.,* 2017). Except for SSP brand, Urea and NPKs recorded $Ra_{eq}$ lower than the recommended worldwide mean value 370 $Bq\,kg^{-1}$, an indication that SSP fertilizer should be handled by marketers and farmers with precautions. All the chemical fertilizer brands investigated, except Urea, had $I_{\gamma} < 1$ which should be avoided since they will deliver effective dose rate higher than one $(1)\,mSv\,y^{-1}$ to marketers of the products, factory workers, and farmers. The recommended maximum concentration of $^{226}$Ra is 200 $Bq\,kg^{-1}$ which represents $I_{\alpha} = 1$. The values of $I_{\alpha}$

obtained in Urea, NPKs, except for SSP fertilizers, were less than one ($I_\alpha < 1$) which implied that the Urea and NPKs samples had $^{226}$Ra concentrations less than 200 $Bq\,kg^{-1}$ while $^{226}$Ra concentrations for SSP fertilizer was three (3) times higher than 200 $Bq\,kg^{-1}$. It, therefore, can be said about SSP fertilizer investigated in this study that possible radon inhalation could be so enormous that the samples warrant restriction. Comparing the activity concentrations of the radionuclides of interest, radium equivalent activity, external and internal doses gamma doses in the brands of chemical fertilizers investigated in this study with the worldwide safety standards for soil samples in $Bq\,kg^{-1}$ would not be necessary since chemical fertilizers are the man–made, manufactured from local industries.

Observation from Table 6 showed that factory workers and marketers of chemical fertilizers investigated in this study would appear to be more exposed to external than internal doses of radiation. This situation was likewise with farmers. Since factory workers and dealers or marketers of the products spend more days than farmers as observed from Table 1, it is expected that the mean values obtained for marketers of the products should be greater than that of farmers who were calculated and recorded in this study. For both marketers and farmers, the highest external exposure to gamma doses of radiation (in $mSv\,y^{-1}$) as observed from Table 6 were found in SSP fertilizers, while the lowest (in $mSv\,y^{-1}$) were found in Urea fertilizers respectively. Likewise, results (in $\mu Sv\,y^{-1}$) were found for internal doses due to accidental ingestion. In general, the most significant exposure to radiation doses was external (in $mSv\,y^{-1}$) followed by inhalation (in $\mu Sv\,y^{-1}$) and then accidental ingestion (in $\mu Sv\,y^{-1}$). Total internal exposure to doses of radiation due to the sum of inhalation and ingestion doses were found lower than that of external exposure doses of radiation. Precaution should be taken by factory workers, marketers of the products and farmers in staying around radiation field from NPKs, and SSP fertilizers to avoid serious radiobiological health challenges.

*Table 2:* Activity Concentration of Urea Fertilizer Samples

| Sample code | $^{40}$K ($Bq\,kg^{-1}$) | $^{226}$Ra ($Bq\,kg^{-1}$) | $^{232}$Th ($Bq\,kg^{-1}$) |
|---|---|---|---|
| Urea 01 | 168.89±6.63 | 6.49±5.53 | 37.12±0.54 |
| Urea 02 | 155.39±7.95 | 10.49±4.58 | 31.45±0.53 |
| Urea 03 | 172.50±8.81 | 9.10±4.82 | 44.53±0.57 |
| Urea 04 | 168.59±8.46 | 16.50±3.83 | 37.59±0.54 |
| Urea 05 | 165.59±8.46 | 14.74±3.97 | 34.45±0.52 |
| Urea 06 | 187.35±9.56 | 7.52±5.21 | 37.12±0.54 |
| Urea 07 | 154.26±7.87 | 12.31±4.29 | 41.91±0.55 |
| Urea 08 | 206.18±10.51 | 11.59±4.42 | 48.61±0.60 |
| Urea 09 | 166.57±8.51 | 9.89±4.68 | 44.26±0.57 |
| Mean±Std. Dev. | 171.70±16.15 | 10.95±3.23 | 39.67±5.49 |
| CV | 0.09 | 0.19 | 0.14 |

*Table 3:* Activity Concentration of NPK (15 – 15 – 15) Fertilizer Samples

| Sample code | $^{40}$K ($Bq\,kg^{-1}$) | $^{226}$Ra ($Bq\,kg^{-1}$) | $^{232}$Th ($Bq\,kg^{-1}$) |
|---|---|---|---|
| NPK1501 | 3722.56±189.36 | 4.00±5.25 | 48.96±0.61 |
| NPK1502 | 2429.89±123.30 | 12.19±4.55 | 38.97±0.56 |
| NPK1503 | 1587.64±80.76 | 5.70±6.19 | 21.78±0.62 |
| NPK1504 | 2806.73±142.77 | 6.37±5.78 | 42.53±0.57 |
| NPK1505 | 3114.89±158.45 | 17.20±3.90 | 51.79±0.63 |
| NPK1506 | 3410.21±173.47 | 2.97±2.48 | 53.11±0.63 |
| NPK1507 | 2707.09±137.70 | 22.14±3.47 | 42.76±0.63 |
| NPK1508 | 3302.92±168.01 | 9.04±5.08 | 49.70±0.61 |
| NPK1509 | 3029.13±154.09 | 4.61±6.46 | 46.76±0.60 |
| Mean±Std. Dev. | 2901.23±627.62 | 9.58±7.08 | 44.04±9.55 |
| CV | 0.22 | 0.74 | 0.22 |

*Table 4:* Activity Concentration of NPK (16 – 16 – 16) Fertilizer Samples

| Sample code | $^{40}$K $(Bq\ kg^{-1})$ | $^{226}$Ra $(Bq\ kg^{-1})$ | $^{232}$Th $(Bq\ kg^{-1})$ |
|---|---|---|---|
| NPK1601 | 2923.94±148.73 | 14.26±4.10 | 41.37±0.55 |
| NPK1602 | 2946.37±149.88 | 0.49±42.99 | 37.27±0.54 |
| NPK1603 | 2694.12±137.04 | 39.85±2.17 | 28.19±0.54 |
| NPK1604 | 3217.68±163.63 | 23.90±4.71 | 32.09±0.49 |
| NPK1605 | 2803.14±142.49 | 22.93±4.63 | 43.76±0.57 |
| NPK1606 | 2696.24±137.15 | 22.38±4.60 | 30.33±0.52 |
| NPK1607 | 2923.19±148.70 | 19.71±4.59 | 31.98±0.56 |
| NPK1608 | 3023.50±153.80 | 16.99±4.46 | 29.83±0.53 |
| NPK1609 | 3135.75±159.51 | 24.81±4.74 | 25.89±0.54 |
| Mean±Std. Dev. | 2929.33±180.47 | 20.59±10.40 | 33.41±6.07 |
| CV | 0.06 | 0.51 | 0.18 |

*Table 5:* Activity Concentration of SSP Fertilizer Samples

| Sample code | $^{40}$K $(Bq\ kg^{-1})$ | $^{226}$Ra $(Bq\ kg^{-1})$ | $^{232}$Th $(Bq\ kg^{-1})$ |
|---|---|---|---|
| SSP01 | 397.21±20.22 | 492.88±9.02 | 27.36±0.53 |
| SSP02 | 496.25±25.25 | 549.71±9.97 | 28.19±0.54 |
| SSP03 | 401.86±20.45 | 613.76±11.06 | 32.74±0.60 |
| SSP04 | 558.68±28.43 | 923.07±16.37 | 34.86±0.61 |
| SSP05 | 416.04±21.17 | 676.43±12.13 | 28.22±0.54 |
| SSP06 | 412.74±21.01 | 22.38±4.60 | 30.33±0.52 |
| SSP07 | 479.67±24.41 | 743.88±13.28 | 23.01±0.43 |
| SSP08 | 342.29±17.43 | 500.51±9.14 | 32.48±0.59 |
| SSP09 | 493.18±25.10 | 497.30±9.09 | 23.01±0.43 |
| Mean±Std. Dev. | 444.21±66.74 | 631.17±14.04 | 28.53±4.16 |
| CV | 0.15 | 0.02 | 0.15 |

*Table 6:* Radiological indices associated with the Chemical Fertilizers

| Radiological Indices | Urea fertilizer | NPK(15-15-15) | NPK(16-16-16) | SSP |
|---|---|---|---|---|
| $Ra_{eq}\ (Bq\ kg^{-1})$ | 80.90 | 295.95 | 293.93 | 706.17 |
| $I_{\gamma}$ | 0.29 | 1.22 | 1.21 | 2.40 |
| $I_{\alpha}$ | 0.05 | 0.05 | 0.10 | 3.16 |
| $D_{Ext}\ M\ (mSv\ y^{-1})$ | 0.60 | 6.73 | 6.65 | 13.00 |
| $D_{Ext}\ F\ (mSv\ y^{-1})$ | 0.35 | 4.04 | 3.99 | 7.80 |
| $D_{inhal}\ M\ (\mu Sv\ y^{-1})$ | 3.81 | 4.24 | 3.31 | 7.19 |
| $D_{inhal}\ F\ (\mu Sv\ y^{-1})$ | 2.29 | 2.60 | 1.99 | 4.31 |
| $D_{ingest}\ M\ (\mu Sv\ y^{-1})$ | 0.12 | 0.27 | 0.30 | 1.78 |
| $D_{ingest}\ F\ (\mu Sv\ y^{-1})$ | 0.02 | 0.16 | 0.18 | 1.07 |
| $D_{Tot\ inter}\ M\ (\mu Sv\ y^{-1})$ | 3.93 | 4.51 | 3.61 | 11.50 |
| $D_{Tot\ inter}\ F\ (\mu Sv\ y^{-1})$ | 2.31 | 2.76 | 1.17 | 5.38 |

*M: Marketers, F: Farmers, $D_{Tot\ inter}$ : Total internal exposure to doses of radiation due to the sum of inhalation and ingestion doses*

## V. Conclusion and Recommendations

Radiological indices due to activity concentrations of $^{40}$K, $^{226}$Ra and $^{232}$Th radionuclides for Urea, NPK (15 – 15 – 15), NPK (16 – 16 – 16), and SSP fertilizers used in Ibadan, Nigeria were determined and recorded to ascertain if marketers and farmers could be exposed to doses of radiation and also to compare their radiological indices. The values of $I_{\gamma}$ for NPKs and SSP showed that samples investigated should be avoided if health risk should be minimized. Also, the value of $I_{\alpha}$ for SSP revealed that health risk should be expected. Findings further showed that total internal exposure to doses of radiation due to the sum of inhalation and ingestion doses were found lower than that of external exposure to radiation doses. Marketers appeared to be more exposed both to external and internal doses of radiation than farmers. Samples of SSP fertilizers investigated had the greatest potentials among the four chemical fertilizer brands to cause radiobiological effects and should be handled with caution. The study did not compare the gamma dose rates/exposures from the radionuclides of $^{40}$K, $^{226}$Ra and $^{232}$Th contained in the chemical fertilizers with their corresponding permissible safety limits for soil and sediment as reported by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Investigation of more samples of chemical fertilizers for an average of ten (10) years in the study area will give a better result, however, preliminary data and information is provided as a prelude to investigations of radiological study of chemical and organic fertilizers in other states in Nigeria and countries of the world. The study recommends monitoring and placing serious restriction to chemical fertilizers rich in $^{40}K$, $^{226}Ra$ and $^{232}Th$ radionuclides so as to minimize possible health hazards they may pose to users and marketers of the products. It also suggests the need to have local safety radiological standards in Nigeria.

## References Références Referencias


1. Ademola, J.A. and Oyema, U.C. (2014). Assessment of natural radionuclides in fly ash produced at Orji River Thermal Power Station, Nigeria and the associated radiological impact. *Natural Science,* 6, 752 – 759.
2. Beretka, J. & Mathew, P.J. (1985).Natural radioactivity of Australian building materials industrial wastes and by–products. *Health physics,* 48(1), 87-95.
3. Degrange, J., Lepicard, S. (2005). Naturally occurring radioactive materials (NORM IV). Proceedings of an International Conference, Szezkyrk, 17 – 21 May, Pp. 230.
4. Elisha, J.J. and Elisha, M.J. (2012). Characterization of selected inorganic fertilizers by atomic absorption spectroscopy: possible carryover of heavy metals from phosphate rock. *International Journal of Science and Research,* 3(5), 94 – 96.
5. European Commission (EC) Report on Radiological Protection Principles concerning the natural radioactivity of building materials. Radiation Protection No. 112. Luxembourg: Directorate – General Environment, Nuclear Safety and Civil Protection; 1999, 6 – 9.
6. Farai, I.P., and Isinkaye, M.O. (2009). Radiological safety assessment of surface – water dam sediments used as building materials in southwestern Nigeria. Journal of Radiological Protection, 29, 85 – 93.
7. Hassan, N.M., Chang Byung – Uck, and Tokonami, S. (2017). Comparison of natural radioactivity of commonly used fertilizer materials in Egypt and Japan. *Journal of Chemistry,* Volume 2017, 8pages, https://doi.org/10.1155/2017/9182768
8. Hassan, N.M., Mansour, N.A., Fayez – Hassan, M., and Sedqy, E. (2016). Assessment of natural radioactivity in fertilizers and phosphate ores in Egypt. *Journal of Taibah Universityfor Science,* 10(2), 296 – 306.
9. Ibeanu, I.G.E., Akpan T.C., Mallam, S.P., Chatta, C. (2009). Evaluation of chemical fertilizer in Nigeria for NORMs Using NAI gamma spectrometry technique. *Nigerian Journal of Physics,* 21(1), 130 – 134.
10. Jabbar, H.J. and Abdul, R.H.S. (2014). Natural radioactivity of some local an d imported fertilizers in Basrah Governorate/Iraq. *Archives of Physics Research,* 5(5): 18 – 22.
11. International Commissinm on Radiological Protection. (2012). ICRP Publication 119: Compendium of dose coefficients based on ICRP Publication 60. Annals of the ICRP41 (Suppl).42(4); e1 – e130.
12. Isinkanye, M.O. and Emelue, H.U. (2015).Natural radioactivity measurements and evaluation of radiological hazards in sediments of Oguta Lake, South East Nigeria. *Journal of Radiation Research and Applied Sciences,* 8(3), 459 – 469.
13. Jibiri, N.N., Alausa, S.K., Owofolaju, A.E. and Adeniran, A.A. (2011).Terrestrial gamma dose rates and physicochemical properties of farm soils from ex – tin mining locations in Jos – Plateau, Nigeria. *African Journal of Environmental Science and Technology,* 5(12), 1039 – 1049.
14. Jibiri, N.N., and Fasae, K.P. (2012).Activity concentrations of $^{226}Ra$, $^{232}Th$ and $^{40}K$ in brands of fertilizers used in Nigeria. *Radiation Protection Dosimetry,* 148(1), 132 – 137.
15. Jibiri, N.N. and Okeyode, I.C. (2012). Evaluation of radiological hazards in the sediments of Ogun river, South – western Nigeria. *Radiation Physics and Chemistry,* 81, 1829 – 1835.
16. Khan, K., Khan, H.M., Tufail, M. Khatibeh, A.J.A.H., Ahmad, N. (1998). Radiometric analysis of Hazara phosphate rock and fertilizers in Pakistan. *Journal of Environmental Radioactivity,* 38, 77 – 84.
17. Kolo, M.T., Khandarker, M.U., Amin, Y.M., Abdullah, W.H.B. (2016). Quantification and radiological risk estimation due to the presence of natural radionuclides in Maiganga Coal, Nigeria. *Plos ONE,* 11(6): e0158100, doi: 10.1371/journal.pone. 0158100.
18. Mustapha, A., Mbuzukongira, P., Mangala, M. (2007).Occupational radiation exposure of artisans mining columbite – tantalite in Eastern Democratic Republic of Cogo. *Journal of Radiological Protection,* 27(2), 187: PMID: 17664663.
19. Ravisankar, R., Sivakumar, S., Chandrasekaran, A., Prince Prakash Jebakuma, J., Vijayalakshmi, I., Vijayagopal, P. *et al.,* (2014). Spatial distribution of gamma radioactivity levels and radiological hazard indices in the east coast sediment of Tamilnadu, India with statistical approach. *Radiation Physics Chemistry,* 103, 89 – 98.
20. Sahu, S.K., Ajmal, P.Y., Bhaangare, R.C., Tiwari, M., Pandit, G.G. (2014). Natural radioactivity assessment of a phosphate fertilizer plant area. *Journal of Radiological Research and Applied Sciences.* 7(1), 123 – 128.
21. Samad, M.A., Ali, M.I., Paul, D. and Islam, S.M.A. (2011). An environmental impact study of Jamuna Urea Fertilizer Factory at Tarakandi in Jamalpur with radiological indices. *Journal of Environmental Science & Natural Resources,* 4(2), 27 – 33.

22. Tufail, M., Akhtar, N., Javied, S., Hamid, T. (2007). Natural radioactivity hazards of building bricks fabricated available from saline soil of two districts of Pakistan. *Journal of Radiological Protection,* 27, 481 – 492.
23. Turhan, S., Baykan, U.N., Sen, K. (2008). Measurement of the natural radioactivity in building materials used in Ankara and assessment of external doses. *Journal of Radiological Protection,* 28, 83 – 91.
24. UNSCEAR, (2000). Sources and effects of ionizing radiation. United Nations Scientific Committee on the Effects of Atomic Radiation Report to the General Assembly with Scientific Annexes, New York.

Global Journals Guidelines Handbook 2018

www.GlobalJournals.org

# Fellows

## FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (FARSS)

Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards "FARSS" title to individuals. The 'FARSS' title is accorded to a selected professional after the approval of the Editor-in-Chief/Editorial Board Members/Dean.

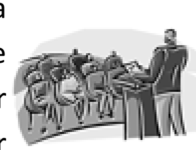
- The "FARSS" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSS or William Walldroff, M.S., FARSS.

FARSS accrediting is an honor. It authenticates your research activities. After recognition as FARSB, you can add 'FARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

*The following benefits can be availed by you only for next three years from the date of certification:*

FARSS designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSB title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA). The Fellow can also participate in conference/seminar/symposium organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent.

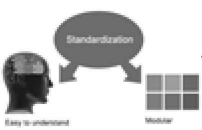


You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The FARSS can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

As FARSS, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.




The FARSS will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.


The FARSS member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A. Once you are designated as FARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

The FARSS members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.

The FARSS member also entitled to get the benefits of free research podcasting of their research documents through video clips. We can also streamline your conference videos and display your slides/ online slides and online research video clips at reasonable charges, on request.

The FARSS is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSS can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSS member can decide its price and we can help in making the right decision.

The FARSS member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

## MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (MARSS)

The ' MARSS ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

The “MARSS” is a dignified ornament which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., MARSS or William Walldroff, M.S., MARSS.

MARSS accrediting is an honor. It authenticates your research activities. After becoming MARSS, you can add 'MARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

*The following benefitscan be availed by you only for next three years from the date of certification.*

MARSS designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSS, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.


We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSS member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.


Once you are designated as MARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

# Auxiliary Memberships

## Institutional Fellow of Global Journals Incorporation (USA)-OARS (USA)

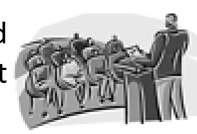
Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as “Institutional Fellow of Open Association of Research Society” (IFOARS).

The “FARSC” is a dignified title which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as “Institutional Board of Open Association of Research Society”-(IBOARS).

*The Institute will be entitled to following benefits:*

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA)
The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.
The author fees of such paper may be waived off up to 40%.



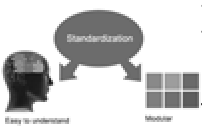
The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.


The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of “Open Association of Research Society, U.S.A (OARS)” so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.




After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

**The following entitlements are applicable to individual Fellows:**

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.


Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

**Other:**

**The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:**

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

**Note :**

"

- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

# Preferred Author Guidelines

**We accept the manuscript submissions in any standard (generic) format.**

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

## Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

**Declaration of Conflicts of Interest**

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

## Policy on Plagiarism

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

## Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

**Changes in Authorship**

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

**Copyright**

During submission of the manuscript, the author is confirming an exclusive license agreement with Global Journals which gives Global Journals the authority to reproduce, reuse, and republish authors' research. We also believe in flexible copyright terms where copyright may remain with authors/employers/institutions as well. Contact your editor after acceptance to choose your copyright policy. You may follow this form for copyright transfers.

**Appealing Decisions**

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

**Acknowledgments**

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

**Declaration of funding sources**

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

## Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

***Manuscript Style Instruction (Optional)***

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

***Structure and Format of Manuscript***

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

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

## Format Structure

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

All manuscripts submitted to Global Journals should include:

**Title**

The title page must carry an informative 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) where the work was carried out.

**Author details**

The full postal address of any related author(s) must be specified.

**Abstract**

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

**Keywords**

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

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

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning 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 a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

**Numerical Methods**

Numerical methods used should be transparent and, where appropriate, supported by references.

**Abbreviations**

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

**Formulas and equations**

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

**Tables, Figures, and Figure Legends**

Tables: Tables should be 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. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

**Figures**

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

## Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). 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: Authors are advised 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. Also, you can email your editor to remove the color fee after acceptance of the paper.

## Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

***1. Choosing the topic:*** In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

***2. Think like evaluators:*** If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. 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.

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

***4. Use of computer is recommended:*** As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

***5. Use the internet for help:*** An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

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

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

***8. Make every effort:*** Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

***9. Produce good diagrams of your own:*** Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

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

***11. Pick a good study spot:*** Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

***12. Know what you know:*** Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

***13. Use good grammar:*** Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

***14. 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 for your topic. You may also maintain your arguments with records.

***15. Never start at the last minute:*** Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

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

***17. Never copy others' work:*** Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

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

***19. Refresh your mind after intervals:*** Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

***20. Think technically:*** Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

***21. Adding unnecessary information:*** Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

***22. Report concluded results:*** Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

***23. Upon 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 for 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 of 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 criteria peer reviewers will use for grading the final paper.

**Final points:**

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

*The introduction:* This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

**The discussion section:**

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to 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 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 avoid:*

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

**Title page:**

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

**Abstract:** This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite 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 approaches 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. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a 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 limit the initial two items to no more than one line each.

*Reason for writing the article—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 for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

**Approach:**

  - Single section and succinct.
  - An outline of the job done is always written in past tense.
  - Concentrate on shortening results—limit background information to a verdict or two.
  - Exact spelling, clarity 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 of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

*The following approach can create a valuable beginning:*

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets 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 for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory 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 soundly written procedures segment allows a capable scientist to replicate 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 to give the least amount of information that would permit another capable scientist to replicate 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 section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show 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:**

*Materials may be reported in part of a section or else they may be recognized along with your measures.*

**Methods:**

- Report the method and not the 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—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

**Approach:**

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and 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 as 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. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

**Content:**

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give 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 manuscript.

**What to stay away from:**

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

**Approach:**

As always, use past tense when you submit 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 section.

**Figures and tables:**

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

**Discussion:**

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an 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 implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully 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 the prospect, and let it drop at that. Make a decision as to whether each premise is supported or 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.

- o You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- o Give details of all of your remarks as much as possible, focusing on mechanisms.
- o Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- o One piece of 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?
- o Recommendations for detailed papers will offer supplementary suggestions.

**Approach:**

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

## The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

*Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection*.

*Segment draft and final research paper:* You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

*Written material:* You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

## CRITERION FOR GRADING A RESEARCH PAPER (COMPILATION) BY GLOBAL JOURNALS

**Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.**

| Topics | Grades | | |
|---|---|---|---|
| | **A-B** | **C-D** | **E-F** |
| ***Abstract*** | Clear and concise with appropriate content, Correct format. 200 words or below | Unclear summary and no specific data, Incorrect form<br><br>Above 200 words | No specific data with ambiguous information<br><br>Above 250 words |
| ***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 |

# Index

save our planet

# Global Journal of Science Frontier Research

Visit us on the Web at www.GlobalJournals.org | www.JournalofScience.org
or email us at helpdesk@globaljournals.org

ISSN 9755896