FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 7 No. 4, August, 2023, pp 82 - 89
DOI: https://doi.org/10.33003/fjs-2023-0704-1777

EVALUATION OF CHEMICAL COMPOSITIONS OF RICE HUSK FROM LOCAL RICE SPECIES USING X-RAY FLUORESCENCE TECHNIQUE

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ABSTRACT

Rice husk is one of the major agricultural wastes in milling processes that is abundantly available in Nigeria. The research aim to evaluate the chemical composition of Bauchi State rice husk. The rice husk samples were collected in four Local Governments of Bauchi State during dry season and grounded into powder form and analyzed using X-Ray Fluorescence (XRF). Eleven compounds were reveals in all the samples which are as follows; SiO, RbO, K_2O, CaO, MnO, Fe_2O_3, NiO, CuO, ZnO, BrO and SrO. The major compounds having the trends SiO > K_2O > CaO > Fe_2O_3 > MnO and minor compound ZnO > NiO > BrO < SrO > CuO with their mean values (in %) 4.7508, 0.34406, 0.24784, 0.21368, 0.0214625 and 0.006532, 0.00514, 0.002858, 0.002325, 0.002138, 0.000303 respectively. The initiative implemented by Government within the region on rice production will give rise to rice husk utilization thereby reducing pollution. The high percentage of silica content in all the samples makes it of economic important in terms of industrial production. The toxic and hazardous compounds were absents which minimize it risk to health in terms of industrial application within the environs.

Keywords: Compounds, XRF, Rice Husk, Silica

INTRODUCTION

Tiamin Rice Mill and Umza International Limited have been allotted 15,000 hectares of land in Bauchi to promote self-sustaining yield in the state the companies will not only help transform the lives of local farmers but also provide employment opportunities (Omidiora, 2022). People can get fresh, quality rice from local markets, as well as improve business across the state. Investors will benefit from incentives such as free land for the installation of factories and manufacturing industries. The State Chairman Rice Farmer Association of Nigeria (RIFAN), disclosed this at the CBN fair for promoting financial stability and economic development in Bauchi. He said that 20,000 farmers benefited from farm inputs under the scheme as part of the empowerment program for farmers in the State. He also said that the inputs included assorted fertilizer, pesticides, high-yield seeds as well as technical know-how to operate in farms. With the Initiative of anchor borrowers' program, rice farmers have been encouraged to bridge the deficit in rice farming in the country. Rice farming received a boost across all the states in the country by supplying rice to milers in pyramids (Nwanisobi, 2021). The initiative by government lay more emphasis on rice and does not include how to utilize the rice husk composition for industrial development. The rice husk is the shell of the paddy grain that is obtained from the rice grains during the milling process. The chemical constituents of rice husk varies from one sample to another because of the difference in the variety of paddy (Chandrasekhar etal., 2003). A lot of researchers made a positive impact on how to utilize the rice husk which are as follows; as an alternative fuel for energy production (Assureira, 2002; Chungsangunsit etal., 2010) production of activated carbon Ba, as a raw material for manufacture of industrial chemicals based on silica and silicon compounds (Efeoma etal., 2023). Rice husks contain over 70 percent of silica by mass, with minor amounts of metallic elements, such as calcium, magnesium sodium and potassium and could be a very good alternative for the production of silica.

Rice husks were dumped in landfill sites and as such it exposed large amounts of methane gas in the atmosphere, resulting in depletion of the Earth's ozone layer (Gastaldini et al., 2009). Several other destinations of rice husk were reported, such as ingredient for substrates in floriculture and horticulture, livestock for the cattle, agricultural fertilizer, and simple fertilizer for plants (Sun and Gong, 2001). Plants absorb the necessary nutrients, such as N, P, and K, from fertilizer and the environment. However, they may also acquire heavy metals, such as Pb and Cd (Njinga etal., 2011). Rice have the tendency to accumulate high metal concentrations which also affect the husk.

The inhabitant of this area used these rice husk in feeding their cattle's since it is cheap and available within the environs. Also, discharging it to the rivers and burning it in an open air, these will lead to the increase in pollution. Burning rice husk produces high ash content, ranging from 13 to 29% depending on the geographical location, climate and rice variety. The rice husk ash contain heavy metals which can be hazardous to the environs and humans (Adefta and Tefera, 2020). Heavy metal induced is associated with toxicity as such its complications have become a main issue in the medical field. Heavy metal accumulation in the environment and its associated health hazards should be extensively studied. These come from a variety of sources, including fertilizers, sewage sludge, waste water irrigation, pesticides, rice husk burning residues, domestic and industrial effluent, and petrochemicals (Ponnusamy, 2022).

The chemical composition were obtained using Thermo Fisher Scientific X-Ray Fluorescence (XRF) Technique. Analysis was done via the standard method with 80% accuracy as compared with standard less method of 50% accuracy the standard method is fully depended on calibration curve of each oxide. The result will be accurate once if the calibration curve of the compound is good, the standard method were established by standard Reference material obtained from International atomic Energy IAEA (Adamu etal., 2021). The emission of X-ray associated with XRF

technique is simple, relatively independent of the chemical state, systematic and with uniform excitation and absorption dependent on an atomic number. Also, distortion in the line of X-ray radiation can be easily adjusted thereby enabling high accuracy and precision to be easily attained (Oyedotuna, 2018).

Herein, all the four samples reveals uniform result with high percentage of silica. The amorphous silica has vast applications in different industries such as; pharmaceuticals, ceramics, refractory and semiconducting materials, glass making, steel production, , rubber, plastic, cement, paints, soaps, polymer composites, refining of vegetable oils and many more (Pode, 2016). This finding focuses on the proper channeling of Bauchi rice husk for industrial utilization, to minimize environmental pollution. The initiative of rice farming by Government will definitely increases the amount of rice husk produce within the region. With a view to increase in rice husk production there is need to determine it chemical composition for production purposes which is far better than the way it is presently utilized.

MATERIALS AND METHOD

Study Area

The study area Bauchi State is a state in North East geopolitical zone of Nigeria, it sheared boundaries with Jigawa and Kano to the north, Plateau and Taraba to the south, Yobe and Gombe to the east, and Kaduna to the west. The sample collection were randomly selected within four Local Government which are; Alkaleri, Gaide, Ningi and Toro. The selection is based on the nature of the terrain which is good for rice farming. The annual rainfall range from 1000 to 1300 mm; wet season last for five months and dry season for seven months (Hamidu and Joseph, 2021). The climate is tropical and temperature ranges between 12°C and 30°C with relative humidity between 10-43 %. Farming, livestock rearing, and trading are the primary occupations of the inhabitants (Bauchi State, 2021).

Table 1: Sampling Points

S/N	Location	Code	Longitude	Latitude
1	Alkaleri	BAD 01	10° 16’ 35”	10° 19’ 27”
2	Gaide	BAD 02	11° 23’ 17”	10° 11’ 36”
3	Ningi	BAD 03	11° 04’ 54”	09° 33’ 29”
4	Toro	BAD 04	10° 03’ 31”	09° 04’ 32”

Table 1 shows the code of each sample, denoted by alphanumeric the letter B for Bauchi where the samples were obtained with the addition of two letters AD and serial number from 01 to 04 with their respective coordinate.

Sample Collection

The samples were collected during dry season between the period of 12th January 2021 to 20th January 2021. All the samples were collected in milling site not too far from the farm land where they are cultivated. Global Positioning System was used in taking the sampling points. The collection were carefully done to prevent

Contamination of the natural concentrations of the compounds in the material by using robber container.

Sample Preparation

The rice husk samples were grounded to powdered form with the help of mortar and pestle. 2 g of each sample were weighed and transferred to sample holder and covered with cotton wool to prevent it from scattering. The bottom of the samples holder is made of polypropylene which is a thermoplastic. The sample holder containing the sample which were run in a vacuum for ten minutes and were inserted into XRF machine for the analysis proper.

Data Analysis

With a view to compare the results obtained in elemental form with existing studies in oxide form. The EDXRF concentration values of the elements obtained in parts per million (ppm) were converted to oxide using the oxide multiplier.

Table 2: Multiplier for Element to Oxide (Adamu etal., 2022)

Elements	Si	Rb	K	Ca	Mn	Fe	Ni	Cu	Zn	Br	Sr	P	S
Multiplier	2.14	1.09	1.21	1.39	1.29	1.43	1.27	1.25	1.25	2.77	1.18	2.29	2.5
Oxide	SiO2	Rb2O	K2O	CaO	MnO	Fe2O3	NiO	CuO	ZnO	BrO	SrO	P2O3	SO3

RESULTS AND DISCUSSION

In Table 3, it shows equal number of compounds present, with similarities of almost equal percentage of oxide in two samples. Samples BAD 01 and BAD 04 shows some significance in terms of major compounds and minor, all the two are close to the mean. Lastly, the four results reveals high percentage of silica.

Table 3: Shows the chemical constituents of rice husk in oxide, for the four selected samples obtained from Bauchi State

Compounds (in %)	BAD 01	BAD 02	BAD 03	BAD 04	Mean
SiO	4.7294	4.815	4.387	5.0718	4.7508
RbO	0.00037	0.00246	0.00307	0.00265	0.002138
K_2O	0.34250	0.3433	0.34213	0.3483	0.34406
CaO	0.26060	0.2383	0.26566	0.2268	0.24784
MnO	0.02069	0.02159	0.02216	0.02103	0.021368
Fe_2O_3	0.21959	0.19096	0.22844	0.21951	0.214625
NiO	0.00520	0.00445	0.00542	0.000549	0.00514
CuO	0.00027	0.00029	0.000364	0.000288	0.000303
ZnO	0.00640	0.00624	0.00683	0.006656	0.006532

BrO	0.00340	0.00269	0.00293	0.00241	0.002858
SrO	0.00280	0.002	0.002	0.001978	0.002325
Solutions	5.59122	5.62728	5.266004	5.901971	5.597989

According to the report of committee on substances, (Federal Environmental Protection Agency, Nigeria 1998), it was observed that the elements classified as toxic element As, Cr, Pb and Se while Cd classified as hazardous were not found in the entire samples of rice husk analyzed.

Table 4: Permissible criteria of substances to human health.

S/N	Substance	Substance Permissible criteria (ppm)	Desirable criteria (ppm)
1	Calcium (Ca)	20	
2	Copper (Cu)	1.5	Virtually absent
3	Iron	Less than 0.3	Virtually absent
4	Lead (Pb)	Less than 0.5	Absent
5	Manganese (Mn)	Less than 0.5	Absent
6	Zinc (Zn)	15	5
7	Arsenic (As)	0.05	Absent
8	Cadmium (Cd)	0.01	Absent
9	Chromium (Cr) (hexavalent)	0.05	Absent

Source: Report of the committee on substances, Federal Environmental Protection Agency, Nigeria (1998).

Figures 1-4 show the Energy Dispersive X-Ray Fluorescence spectral of rice husk samples with x-ray energy at x-axis and number of x-rays observed at each energy level.

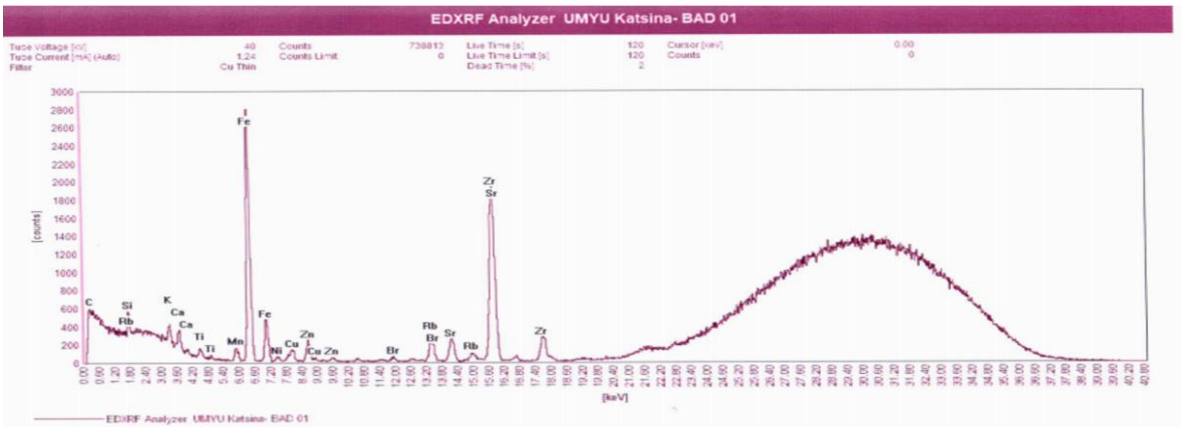

Figure 1: BAD 01

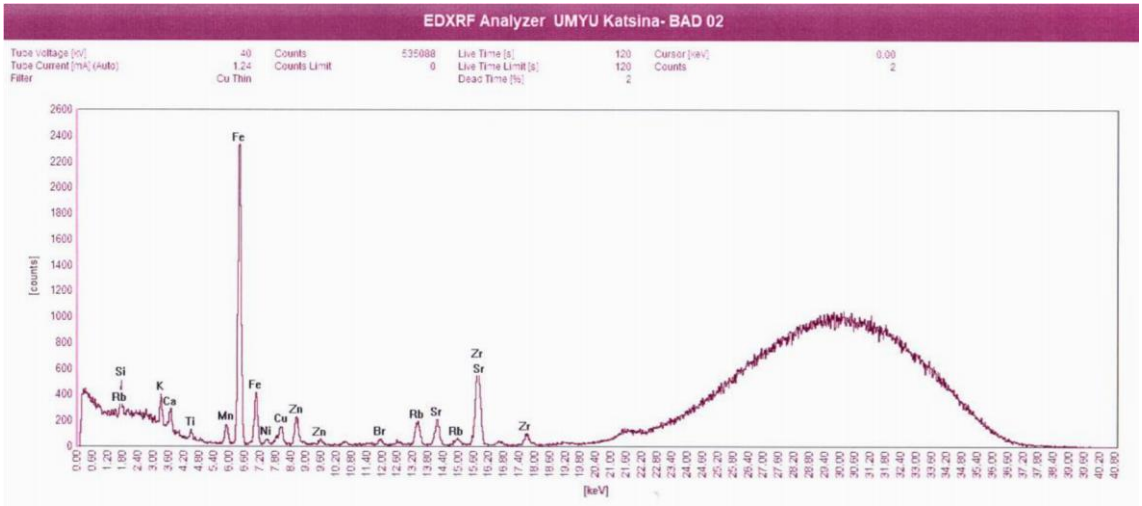

Figure 2: BAD 02

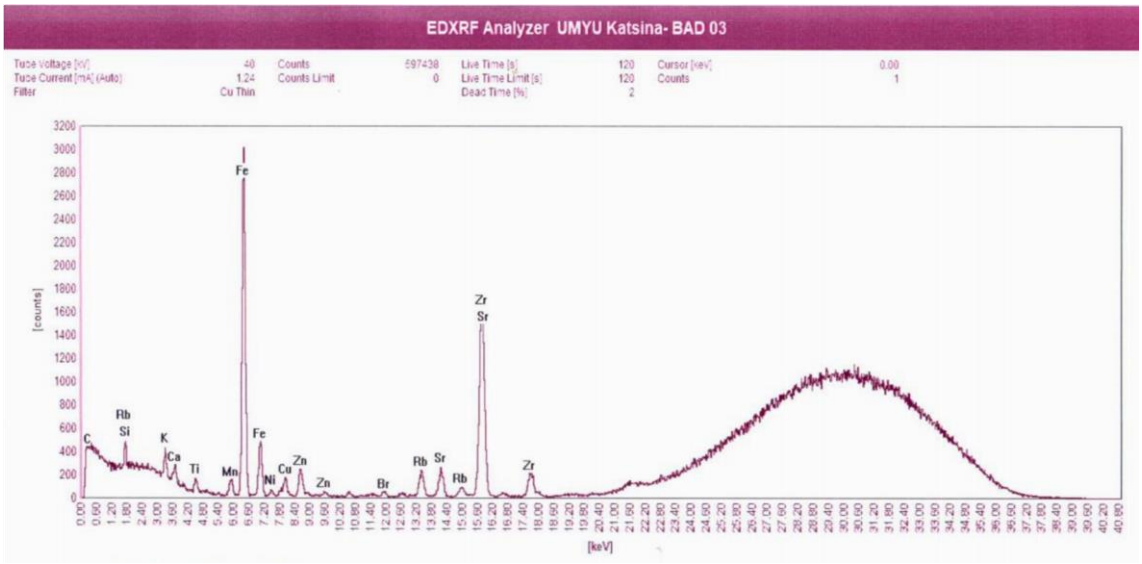

Figure 3: BAD 03

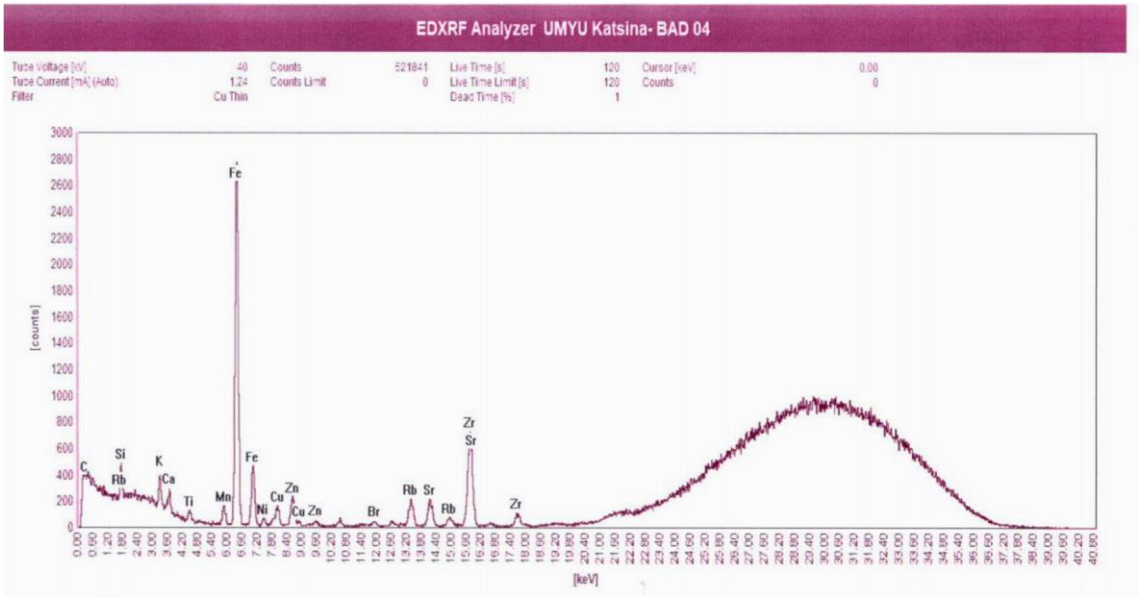

Figure 4: BAD 04

Figures 5-9 Show the percentage concentration of major compounds having $SiO > K_2O > CaO > Fe_2O_3$ with mean summarizing the all samples results.

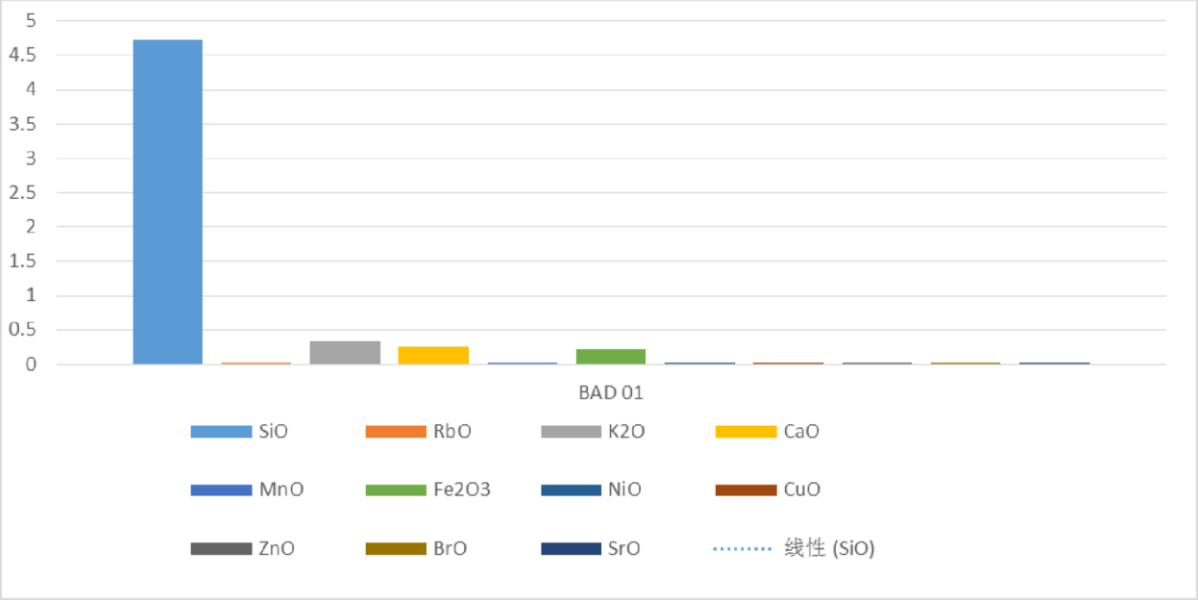

Figure 5: Percentage Concentration of Compound in Alkaleri Rice Husk.

The results of sample BAD 01 reveals ten compounds with SiO having 85% (i.e. 4.7294 out of 5.59122) weight almost equal with that of the mean followed by K2O > CaO > Fe2O3 which are represented by ash, yellow and green respectively. The result is in line with Iskandar Shahrim and others (Iskandar etal., 2015; Golmohammadi, 2020; Larbi, 2010). Having same type of sample, same technique, equal number of compounds presents with slight difference in minor compound but high SiO2 in both the findings. Likewise Mohamed R. M (Mohamed etal., 2010) used different technique but equal compounds and the same sample.

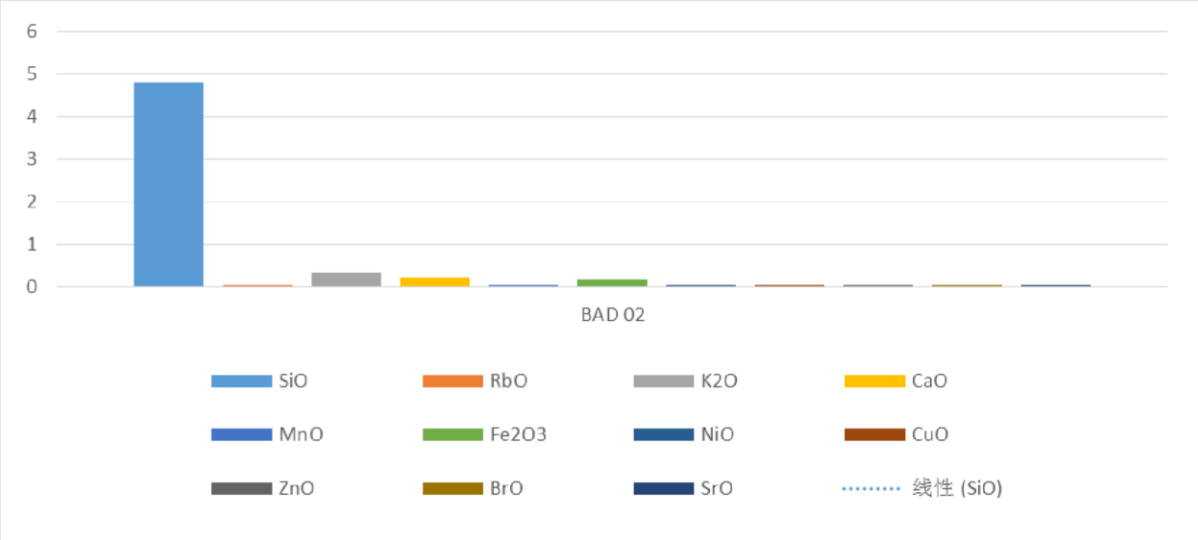

Figure 6: Percentage Concentration of Compound in Gaide Rice Husk.

In the case BAD 02, ten compound were found with high percentage SiO having 74% (i.e. 4.815 out of 5.62728), with decrease in silica compare to the first sample. It experience slight decrease in major compound like CaO and Fe2O3 but maintain the trend Fe2O3 < CaO < K2O. The percentage silica can be affected by the impurities and the temperature expose to rice husk as confirmed by Krishnarao etal., (2001) and Olawale, (2012). With high silica content and low thermal conductivity makes it a suitable option for a variety of industrial applications as suggested by Ana Riva etal., (2016).

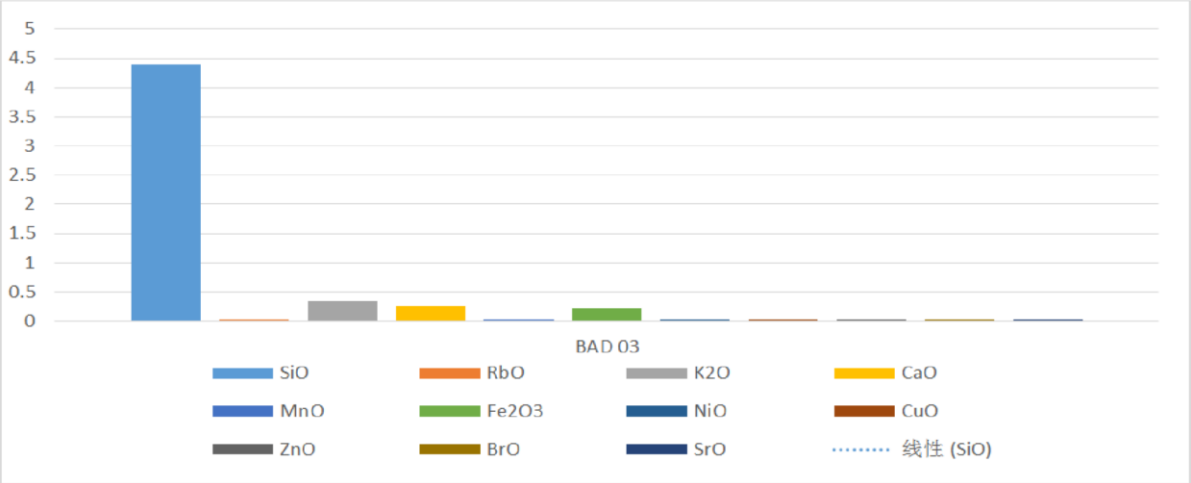

Figure 7: Percentage Concentration of Compound in Ningi Rice Husk.

The BAD 03 sample shows some significant change with SiO having 83% (4.387 out of 5.266004) weight greater than sample BAD 02 and less than sample BAD 01. The results of BAD 03 have some slight difference in terms of major compounds with that of BAD 01 and the same order of decrease. Herein, the percentage silica obtained is greater than the one obtained using Atomic Absorption Spectroscopy which shows percentage of silicon within the range of 81.01% and 79.12%. In the other hand same sample using XRay Fluorescence Technique reveals percentage of silica 95.45% and 94.85% which was confirmed by Jonathan, (2020). Indicating the advantage of the X-Ray Fluorescence technique over others in terms of determination of silica in rice husk and or rice husk ash.

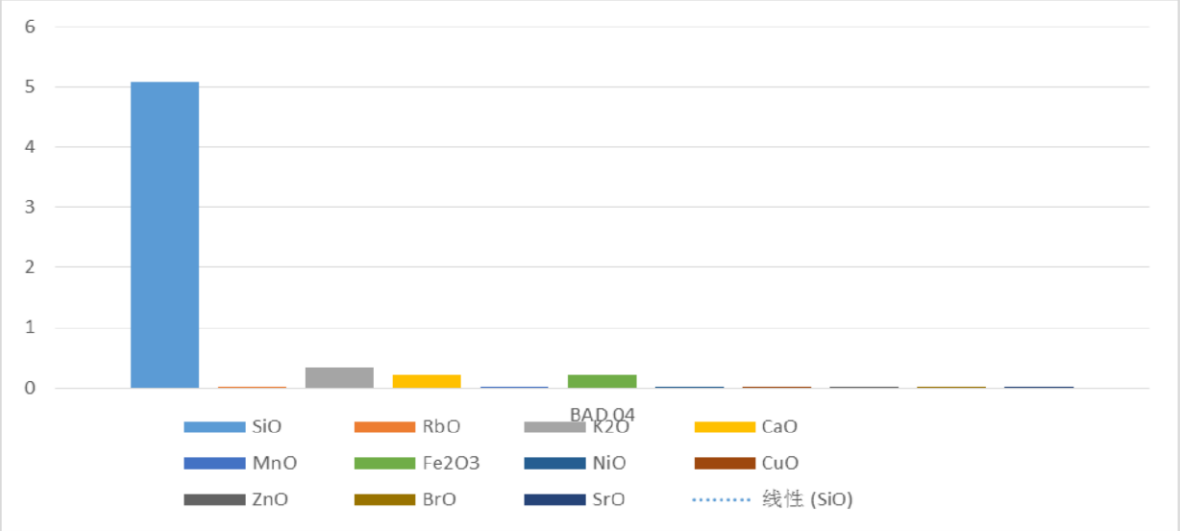

Figure 8: Percentage Concentration of Compound in Toro Rice Husk

In last sample BAD 04, it is the replication of sample BAD 01 having 85% (5.0718 out of 5.901971) silica content with unique, it varies depending on paddy type and source, soil almost equal of K_2O and Fe_2O_3 with changes in CaO which is fertilizers, climate conditions and sample preparation, among in fraction. In all the four samples they have uniform number of compound present with slight changes both in major and minor compounds. The chemical content of rice husk is not the same, it varies depending on source and paddy type, nature of soil fertility, climate conditions and sample preparation, among others as part of Iyenagbe and Mamat, (2012) contribution.

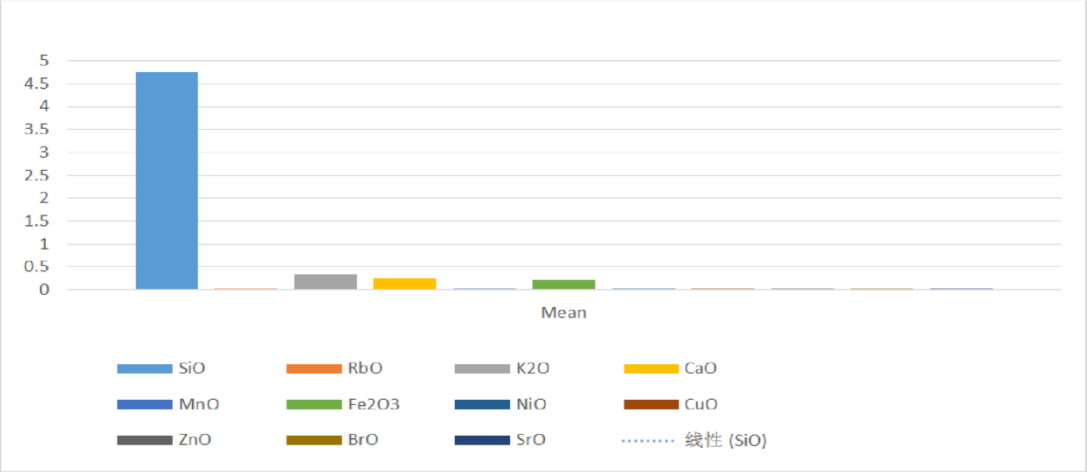

Figure 9: The Mean Percentage Concentration of the Four Samples.

The mean verified and summarized the four results indicating the four major compounds with blue, ash, yellow and green represents SiO, K_2O, CaO and Fe_2O_3. The percentage weight of SiO is one of uniqueness of the results obtained and it plays a vital role in industries and generation of energy. The whole process will now be cyclic, from farming to obtain rice and rice husk to obtain energy and raw materials for industrial application minimizing waste and pollution in the State. The results reveals high percentage silica, so there is need to enlighten the people of State to use it in modern way far better than it is utilized presently. For small scale farmers with less capital, it can be used as additive to soil which is a reality as in the case of Kumar, (2013) rich with enough amount of potassium and silicon, helps to activate the soil and add fertility according to Badar and Qureshi, (2014), Carbonized rice husk can be used as soil amendment, for processing fertilizer, and as activated carbon, Aquaculture, (2016). In case industrial application as fuel Hossain, (2018), as biofuel which usually undergoes combustion Sikarwar, (2016). With time if the production of rice initiated by Government in Bauchi increase it, can be used to generate electrical energy. Industries process the husk to produce energy in a place where they usually experience high production of rice yearly Pradhan, (2013). The husk's ability to produce electricity from biomass is based on gasification, the gases are subsequently exposed to high temperature to produce heat or steam that activates a gas turbine and produces electricity Iyenagbe and Mamat, (2012). Any meaningful development cannot be complete without considering it positive and negative impact. This research will back up the development of rice farming improvement made by RIFAN and CBN by utilize the rice husk for industrial purposes and minimize hazardous effect to the environ.

CONCLUSION

The rice husk samples were collected in four Local Governments of Bauchi State and analyzed using Energy Dispersive X-Ray Fluorescence. Ten compounds were reveals in all the samples which are as follows; SiO, RbO, K_2O, CaO, MnO, Fe_2O_3, NiO, CuO, ZnO, BrO and SrO. The major compounds having the trends SiO > K_2O > CaO > Fe_2O_3 with mean values (in%) 4.7508, 0.4406, 0.24784 and 0.214625 for SiO, K_2O, CaO and Fe_2O_3 respectively. Likewise, the minor compounds are in fractions which makes it invisible in the mean graphical representation. The minor compoud are; CuO, SrO, BrO, NiO, ZnO and MnO with their respective mean values (in%) 0.000303, 0.002325, 0.002858, 0.00514, 0.006532 and 0.021368 respectively. The high percentage of silica content in all the samples makes it of economic important in terms of energy and industrial application. It was observed that the elements classified as toxic elements As, Cr, Pb and Se while Cd classified as hazardous were not found in the entire samples of rice husk analyzed. At the point of samples collection the rice husk were not contaminated with toxic and are not hazardous as recommended by Federal Environmental Protection Agency, Nigeria (1998). Based on the fact obtained, it can be used for production with less effect to the environment.

ACKNOWLEDGEMENTS

The authors would like to thank Eng. Abdulrahman Abdullahi Central Laboratory Umaru Musa Yar'adua University Katsina State, Nigeria for time invested during analysis.

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