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Treatment effect on reactivity of Metakaolin using *Azadirachta indica* bark activated carbon

Ezekiel A. Adetoro [a,*], Rasheed Abdulwahab [b], Omolara D. Adetoro [c], Samson O. Ojoawo [d], Pushparaj Naik [e]

[a] Department of Civil Engineering, Adeleke University, Ede, Nigeria
[b] Department of Civil and Environmental Engineering, Kwara State University, Malete, Nigeria
[c] Department of Food Science,Ladoke Akintola University of Technology, Ogbomoso, Nigeria
[d] Department of Civil Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
[e] Department of Civil Engineering, NMAM Institute of Technology, Karnataka, India

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ABSTRACT

Metakaolin (MK) is a new family of mineral admixtures that can be utilized as supplemental cementitious materials in the construction industry. It has technical and environmental benefits and can be used as a partial substitute for cement in concrete mixtures when finely processed. The effect of *Azadirachta Indica* Bark Activated Carbon (AIBAC) on the reactivity of Metakaolin (MK) was investigated in this work. Hydrochloric acid was used to make chemically activated carbon from *Azadirachta indica* bark, and Metakaolin (MK) was made from Kaolin Clay (KC). AIBAC (5, 10, 15 and 20% proportioned according to MK weight) were measured into four conical flasks, 200 g of MK was added to each of them, mixed homogeneously and 125 mL of distilled water was added to encourage reaction between AIBAC and MK samples. The mixtures were oven dried at 110 °C after 24 h. The aforementioned steps were repeated with the exception of addition of water to produce AIBAC + KC mixed samples. The resulting mixed samples (AIBAC + KC) were calcined in a muffle furnace for one to two hours at 700 °C, thereafter cooled. Scanning Electron Microscopy (SEM), X-Ray Diffraction (XRD), and X-Ray Fluorescence (XRF) were then used to characterize the prepared AIBAC, MK and their combined samples for surface morphology, mineralogical, and chemical contents, respectively. The AIBAC and MK samples were between 2 and 50 nm in size on SEM micrographs, and the intensity peaks of MK XRD plots ranged from 200 to 4000 cps. During calcination, the AIBAC (16.22%) was able to completely remove the undesirable compounds from MK while also increased the compositions of its major oxides (SiO_2, Al_2O_3, Fe_2O_3, and CaO by 2.60, 64.00, 3.26 and 16.00 %, respectively). Finally, *Azadirachta indica* bark activated carbon can be employed efficiently in the treatment of metakaolin in the industrial setting.
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1. Introduction

One of the recently created supplemental cementing ingredients for high performance concrete is Metakaolin (MK). The amorphous alumino-silicate phase, MK, is created by calcining Kaolin Clay (KC) at a certain temperature range in order to remove the chemically bound water from the kaolin's interstices and disrupt the crystalline structure. MK is meticulously refined to lighten its colour, remove inert impurities, and regulate particle size, unlike industrial by-products like silica fume (SF), fly ash, and blast-furnace slag. A highly reactive white or creamy powder with uniform look and performance is produced by this well controlled procedure. MK typically has a particle size of less than 2 mm, which is much smaller than cement particles but not as fine as SF. Usually, it is used to replace 5 to 20 percent of the cement by weight in concrete. It reacts with calcium hydroxide to create secondary C-S-H, which enhances the performance of concrete. High-reactivity MK's colour prevents it from darkening concrete the way SF generally does, making it ideal for colour-matching and other architectural uses. According to research, SF combinations and mixtures with high-reactivity MK perform similarly in terms of strength, permeability, chemical resistance, and drying shrinkage resistance [1,2].

* Corresponding author.
E-mail address: yemmieadyt@yahoo.com (E.A. Adetoro).

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One of the building materials included in the new generation of mineral admixtures that may be utilized as supplemental cementitious materials, offers both technical and environmental benefits is Metakaolin (MK). It can be used as a partial replacement for cement in the concrete mix when it is finely ground. The development of strength is the foundation of indirect approaches. The pozzolan's performance is shown by the pozzolanic activity numbers. Thermogravimetry (TG), FTIR spectroscopy, and X-Ray diffraction (XRD) techniques are included in its direct characterization. Metakaolin's quality and reactivity are highly influenced by the properties of the raw material. Metakaolin can be made from a range of primary and secondary sources, including kaolinite deposits, low-purity tropical soils, paper sludge waste, oil sand tailings, high-purity kaolin deposits, and kaolinite deposits in tropical soils. Though, MK is majorly produced from calcination process of kaolin clay at temperature between 500 and 800 °C (i.e. dehydroxylating process) [3].

When found in nature, kaolin frequently includes various proportions of other minerals such anatase, muscovite, quartz, and feldspar. Iron hydroxide pigments also typically cause crude kaolin to turn yellow. a typical hydrous aluminum silicate mineral that can be discovered in sedimentary rocks, soils, hydrothermal deposits, and sedimentary sediments. The kaolin group minerals, which also include dickite, halloysite, nacrite, ordered kaolinite, and disordered kaolinite, are a group of clay minerals. [$Al_2Si_2O_5(-OH)_4$] has a theoretical chemical formula of 39.8% alumina, 46.38% silica, and 13.98% water, and in practice, these minerals typically do not depart from this formula. They are sheet silicates with a single alumina octahedral layer and a single silica tetrahedral layer linked together. The kaolin group minerals are chemically identical, yet due to the arrangement of these layers on top of one another, each is structurally distinct. The most prevalent member of the kaolin group of minerals, kaolinite, is a crucial industrial raw material utilized in a variety of specialized applications including ceramics, paper coating and filler, paint, plastics, fiberglass, and catalysts [4].

The clay mineral (80 – 90%) is present in commercial kaolin, which is mostly contaminated with quartz and hydrous or fine-grade mica and hardly ever with significant amounts of feldspar. Pegmatites or micaceous schist are often subjected to weathering in order to make kaolin. Alkali-feldspar that has been kaolinized, quartz, and a lot of mica have all been reported to be present in pegmatite. The typical reaction pathways leading to the creation of kaolin are hydrolysis, desilication, and hydration. According to reports, colloidal transfer as well as chemical techniques is both used to maintain the reactions. Incorrect potassium removal during weathering could result in the development of illitic clays (2:1 sheet silicates) rather than kaolinite [2]. Clay impurities will be influenced by the mineral's genesis and will determine the clay's degree of disorder and particle size. Kaolinite does not expand, unlike smectites, and because of its great molecular stability, isomorphous substitution is either minimal or nonexistent. The least reactive clay is kaolinite. However, due to its strong pH dependence, the adsorption of metals is either enhanced or inhibited depending on the pH of the surrounding environment, and this metal adsorption is typically accompanied by the release of hydrogen (H^+) ions from the mineral's edge sites. The flat exposed surfaces of the silica and alumina sheets may also experience adsorption [1,4].

The Indian subcontinent, South East Asia, China, South America, North America, Australia, West Africa, and numerous European nations are among the regions with kaolin mines. The Chinese clay is thought to be the purest kaolin among the many sources. It is mostly made of the mineral kaolinite, which is found in deposits of China clay rock and is made up of 15% china clay, 10% mica, and the remaining 20% quartz [5].

A typical word for carbon compounds, including charcoal, is activated carbon (AC), sometimes known as activated coal or activated charcoal. Because of the fine structure of AC, its pores have a larger surface area (greater than1000 m2/g), which gives them strong adsorptive capabilities. The three main forms of carbon are powder, granular, and pellets. Nevertheless, granular and powdered AC is the most often utilized. There are additional types of AC as well, and they amazingly catch researchers' notice. Among them are felts, clothing, and fiber, which are mostly made from petroleum pitch and isotropic coal. Due to the AC's large surface area, it has been found to be effective in eliminating numerous contaminants from both potable water and wastewater. Because of its ease of design and operation, selectivity for specific substances, and complete elimination of pollutants even from diluted solutions, AC is used by researchers in almost every area of chemistry and environmental engineering [6].

The development of inexpensive adsorbent materials for decontamination or desalination purposes has recently attracted the attention of numerous experts across the globe. Due to its vast surface area and various surface functional groups, such as carboxylic, carbonylic, phenolic, quinonic, lactonic, and other groups that are attached to the graphite-like layers, activated carbons are widely utilized in adsorption technology. Because of this, activated carbons are widely employed as the best adsorbent material. In recent years, a variety of activated carbons (particularly those made from fruit peels) have been manufactured with an emphasis on increasing adsorption capacity while maintaining a cheap cost [7].

Azadirachta indica, Carica papaya, rice husk, banana, carbon fly ash, cork waste, bagasse fly ash, groundnut shell, coconut, and other plants are utilized to make low-cost adsorbents. It has been discovered that they are reliable suppliers of activated carbon. These items are leftovers from the agricultural and industrial sectors. They serve as organic biosorbents as well [8]. *Azadirachta indica*, sometimes known as the neem tree, is a well-known medicinal plant with a reputation for being able to treat a variety of illnesses. It is used to treat and prevent malaria and is included in the pharmacopeia of many traditional medical systems around the world. Additionally, it is discovered to be helpful in the removal of heavy metals from wastewater [2].

The presence of impurities or undesirable compounds in Metakaolin is a serious problem, but it is not properly addressed. The generally accepted method of removing unwanted compounds from Metakaolin is by calcination, which may not likely remove all of them. Bioremediation has prospect in the removal of undesirable compounds from the metakaolin and allied pozzolans due to their availability, low cost, time efficiency ease of use, reuse and practical method [9,10]. Using commercial AC for the biosorption process is always expensive due to its difficult accessibility. Therefore, the activated carbon used in this study was made from locally available agricultural biomaterial (i.e. *Azadirachta indica* bark).

While [8,11] among others, employed *Azadirachta indica* activated carbon as adsorbents in wastewater treatment, [4,10,12,16] and others studied effects of Metakaolin and some materials (i.e. rice husk ash, nanosilica etc) on concrete performance. The use of any agricultural adsorbent on Metakaolin treatment to remove its unwanted components, however, is not widely documented in the literature. The purpose of this work was to investigate the effects of *Azadirachta indica* bark-derived activated carbon on the reactivity of metakaolin. This helps in removal of undesirable compounds from the metakaolin produced. The scope of this study is restricted to the assessment of influences of *Azadirachta indica* bark activated carbon (AIBAC) on reactivity of Metakaolin (MK), which involves collection of Kaolin Clay (KC) sample, preparation of activated carbon from *Azadirachta indica* bark powder by chemical activation method using HCl acid as activated agent. The adsor-

bent produced was mixed with MK at 0 to 20% proportion (by MK weight). The surface morphology, mineral and chemical composition of the mixed samples was examined through Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD) and X-ray fluorescence (XRF) laboratory analyses.

2. Materials and methods

2.1. Gathering of resources

Azadirachta indica bark and Kaolin Clay (KC) were employed as the research's foundational components. The Federal Polytechnic Ado Ekiti research farm, located in Ekiti State, Nigeria, at coordinates of Lat. 7.6050 °N and Long. 5.28880 °E, was the source of the *Azadirachta indica* bark collection. While Kaolin Clay (KC) was procured from a borrow pit behind the Redeemed Christian Church of God in Ikere-Ekiti, Ekiti State, Nigeria, at latitude and longitude of 7.480°N and 8.300°E. Before being used, the materials were promptly packed in bags. After then, it was moved to the laboratory of the Federal Polytechnic in Ado-Ekiti's Department of Civil Engineering.

2.2. Azadirachta indica bark activated carbon (AIBAC) preparation

As shown in Fig. 1, the activated carbon was made using hydrochloric (HCl) acid as an activating agent in accordance with the [9] method. Before being turned into powder, the sample was divided into pieces, cleaned, and allowed to air dry. The powder sample was then carbonized for two hours at 700 °C in a muffle furnace at the Federal Polytechnic's Civil Engineering lab in Ado-Ekiti, Nigeria. The carbonized sample was rinsed repeatedly until it reached a pH of roughly 7.0. It was then given a 24-hour soak in 0.3 M of HCl acid to activate it. The sample that had been soaked was also rinsed to a pH of around 7.0, dried in an oven at 110 °C, chilled, and then kept in a desiccator.

2.3. Preparation of Metakaolin (MK)

Metakaolin (MK) was prepared using a modified version of [4] method. In order to produce Metakaolin (MK), as shown in Fig. 2, the acquired KC sample was calcined in a muffle furnace (located inside the Civil Engineering laboratory of the Federal Polytechnic, Ado-Ekiti, Nigeria) at 700 °C for one to two hours. After that, let it cool and then store it in a desiccator.

2.4. Treatment of samples

In each of the four conical flasks, which contain 5, 10, 15, and 20% of AIBAC, 200 g of MK was measured out and added. The AIBAC was proportioned according to MK weight. The measured samples were then evenly mixed in each conical flask to create homogeneous samples. To encourage reaction between the AIBAC and MK samples, water (125 mL) was added. After 24 h, the mixture was dried at 110 °C. The four mixed samples were subsequently put through the chosen laboratory tests. For the mixing of AIBAC and KC samples, the aforementioned steps were repeated with the exception that water was not added. The resulting mixed samples (AIBAC + KC) were calcined in a muffle furnace for one to two hours at 700 °C, and then they were allowed to cool before going through tests in the lab.

2.5. Laboratory testing

Scanning Electron Microscopy (SEM), X-Ray Fluorescence (XRF), and X-Ray Diffraction (XRD) laboratory tests were used to examine the samples' surface morphology, mineralogical and chemical contents.

(i) *SEM analysis*: The surface morphology was analysed at Rolab research and diagnostic laboratory, opposite IITA, Ibadan, Nigeria using SEM machine (Joel – JSM – 7600F model) according to [9] standard methods.

(ii) *XRD analysis*: Pelletized powdered samples were sieved to 0.074 mm. These were later captured in a 35 × 50 mm aluminum alloy grid on a flat glass plate, covered in paper. By gently pressing the samples with the palm of the hand, they were compacted. Each sample was put through the Rigaku D/Max-lllC X-ray diffractometer with the CuKa radiation set to 40 kV and 20 mA and the scanning rate set to 20 per minute at room temperature. The obtained diffraction information (d value and relative intensity) was compared to the standard data for minerals from the mineral powder diffraction file, which contained and still contains the standard data for more than 3000 minerals. Similar diffraction data indicates that the sample's minerals are identical to those found in nature.

(iii) *XRF analysis*: The Gyro-mill was cleaned after each grinding to prevent contamination. In order to serve as a binding agent, 1 g of stearic acid was weighed into an aluminium cup. The cup was then filled with the sample until it reached the level point. The cup was then transported through Herzong pelletizing equipment at pressure of 200 KN for 60 s. The x-ray machine's sample holder was filled with the 2 mm pellets for analysis. Using an X-ray



Fig. 1. The creation of activated carbon from powdered *Azadirachta indica* bark.

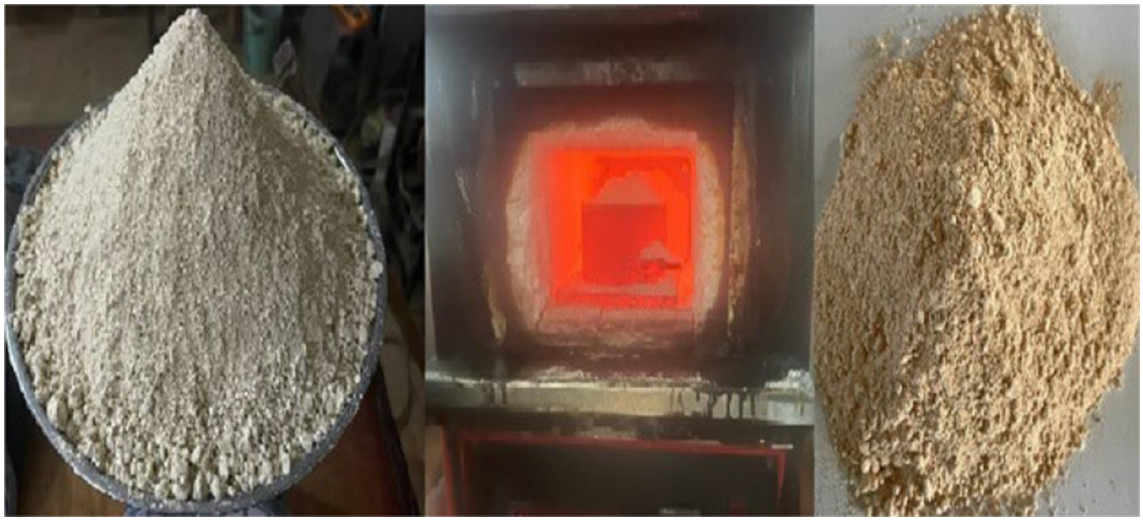


Fig. 2. The transformation of kaolin clay (KC) into metakaolin (MK).

diffractometer from Rigaku, the samples' mineralogical composition was evaluated (Rigaku miniflex and diffraction model).

3. Results and discussion

3.1. Effects of AIBAC on Metakaolin

Fig. 3 shows the surface structure of the mixed samples (AIBAC + MK) using SEM. AIBAC + MK mixed samples had surfaces that were scraggly, flaky, platy, and bristly in texture. Due to AIBAC, substantial kaolinite structures with hard surfaces and several magnitudes were present. Fig. 3 shows SEM micrographs containing kaolinite and impurity conglomerates, which were more noticeable in 15% AIBAC + MK.

As a result of the activating agent's modification, they have numerous pores. The surface of the mixture had significant pore structures with a number of rough voids due to the pyrolysis of cellulosic materials. Materials with established cavities are usually

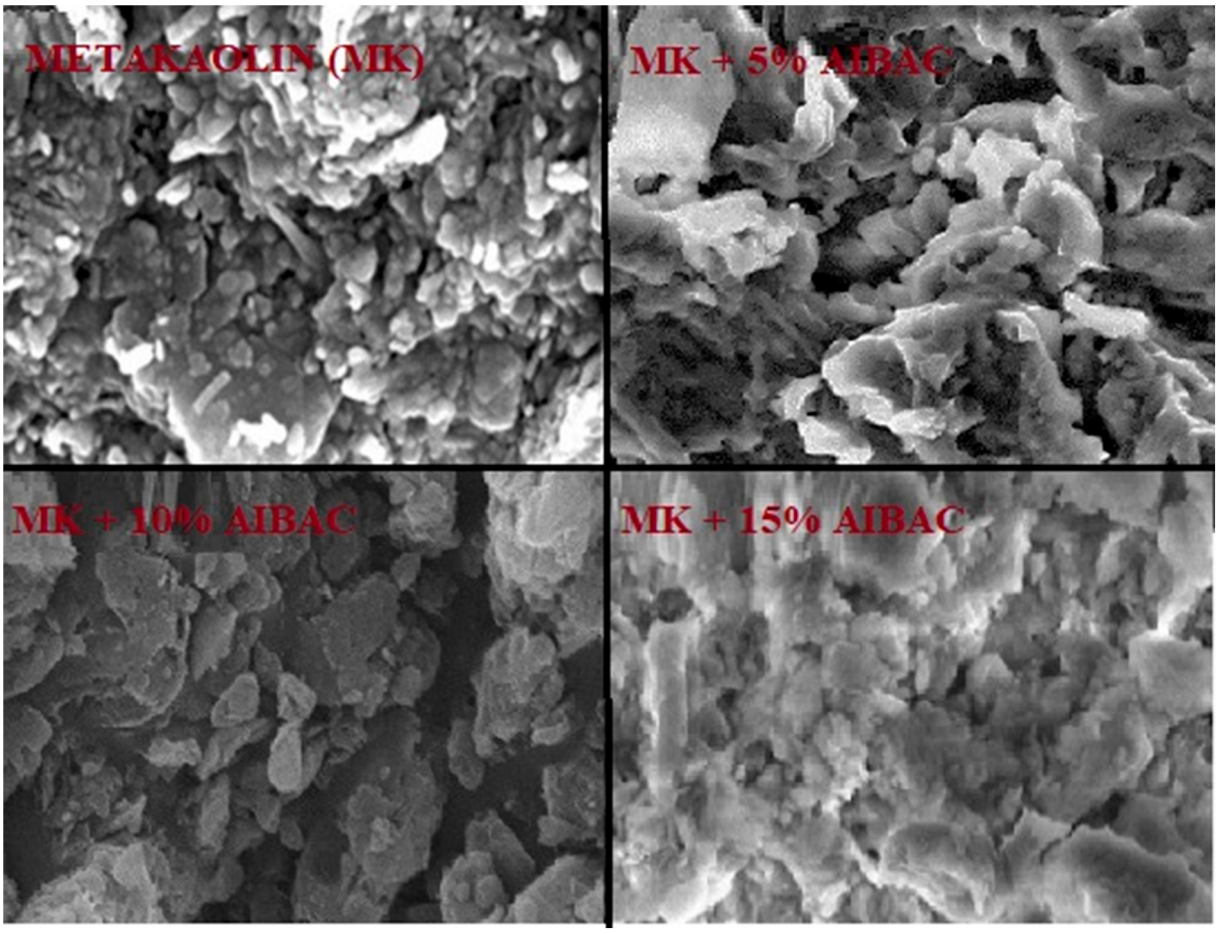


Fig. 3. Surface structure of MK + AIBAC samples using SEM (magnification: x 12,000).

the result of active chemical evaporation. When the reaction rate increased during calcination, carbon was "burnt off" and good pores formed on the precursor. Porous materials were created as a result of the physiochemical treatments described by [8]. There were significant kaolinite structures with compact surfaces and a variety of sizes, as evident by the work of [10,13]. The presence of multiple large cavities on the surfaces of the refined MK demonstrated that the calcination procedure and AIBAC were successful in producing high granular surface structures by establishing non - homogenous and very well defined cavities on their surfaces. The granular surfaces aided the remediation efforts of AIBAC on MK.

Using XRD studies, Fig. 4 displays the mineralogical composition of mixed samples from AIBAC (0–15%) and MK (100%). Their peak intensities were compared in order to confirm where there are shifts. Calcite, dolomite, microline and muscovite reappeared along with silica-rich aggregates corresponding to quartz in 15% AIBAC + MK. The XRD plots attested to SEM results in Fig. 3. According to the XRD plots in Fig. 4, the intensity peaks of the MK sample's quartz varied from 0 to 4000 cps, whereas those of the sample's other minerals were 1000 cps and below. While the other minerals had intensities below 300 cps, the intensity peaks of quartz for AIBAC + MK mixed samples ranged from 200 to 400 cps. Generally speaking, the peaks decreased from 4000 to 400 cps. This shift in peak intensity levels or modifications therein supported the effects of AIBAC on Metakaolin (MK).

All of the peaks remained sharp in all of the samples, indicating that they are crystalline materials. These findings corroborate those of [10,13]. The appearance of kaolinite, muscovite, and other minerals, as well as silica-rich aggregates correlating to quartz, in the MK + 15% AIBAC XRD plot, confirmed the SEM result (Fig. 3).

Fig. 5 shows plots of oxides' compositions (i.e. SiO_2, Al_2O_3, Fe_2O_3, CaO and others (i.e. undesirable compounds)) against AIBAC (0 – 20%). There was dip in Silica Oxide (SiO2) between 0 and 7.5%, thereafter, indicated an increase in compound levels all the way to 20% AIBAC. Aluminium Oxide (Al_2O_3) initially increased and

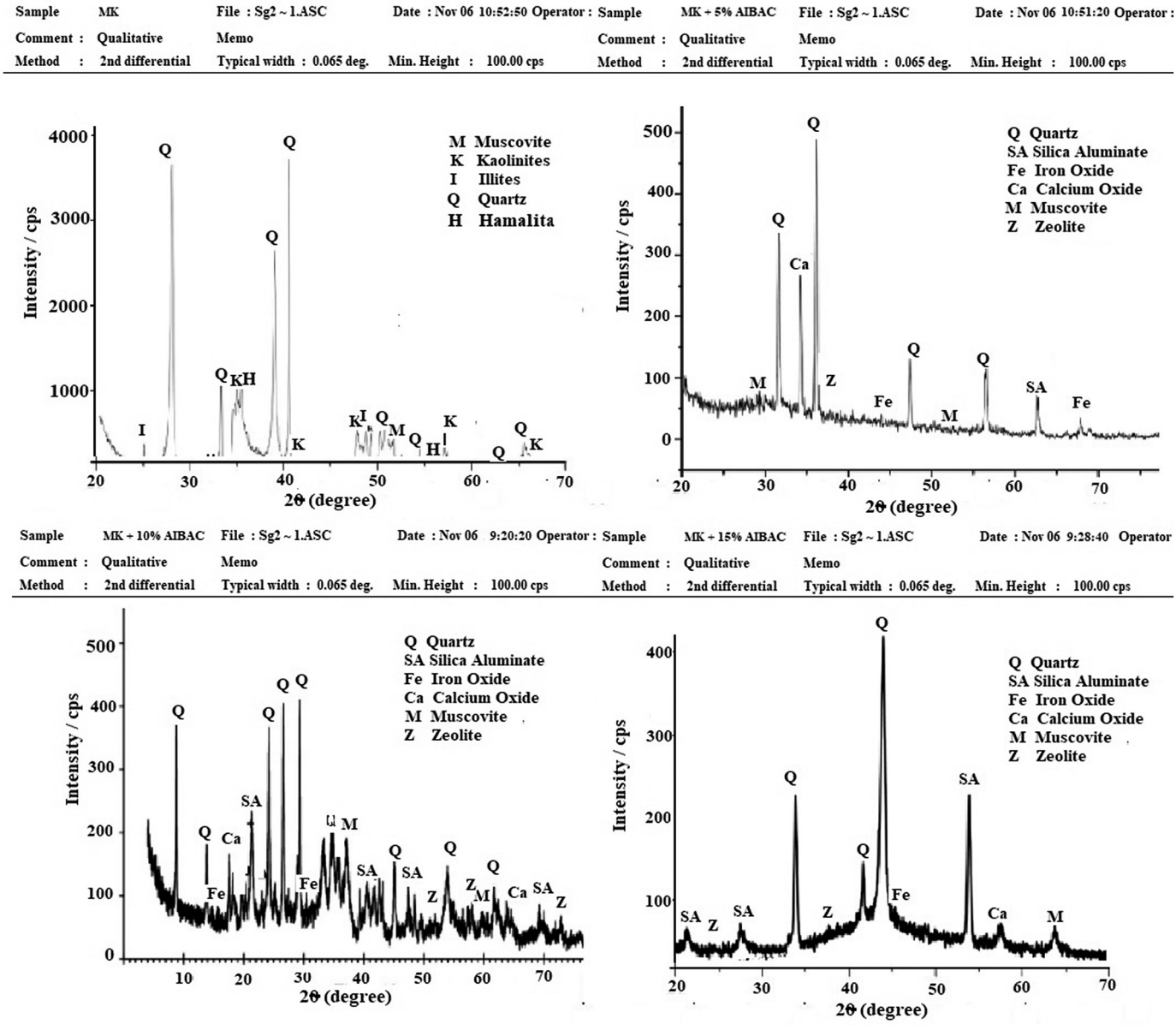


Fig. 4. Mineralogical contents - XRD intensities of MK + AIBAC samples (a) MK; (b) MK + 5% AIBAC; (c) MK + 10% AIBAC; (d) MK + 15% AIBAC.

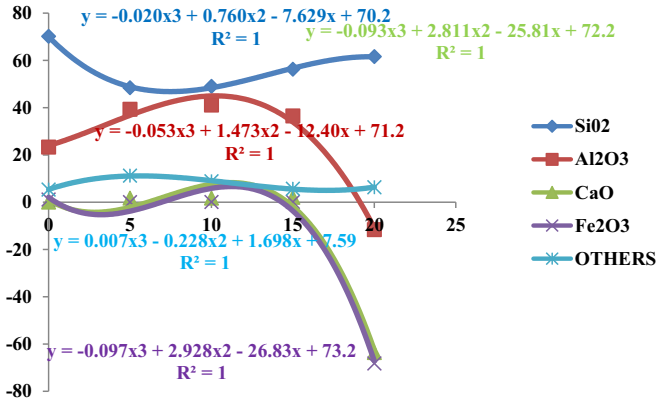


Fig. 5. Chemical contents - graphs of MK compounds against AIBAC.

reached maximum at 10%; thereafter decreased till 20%. Calcium Oxide (CaO) and Ferric Oxide (Fe_2O_3) showed downward spiraling from 0 to 20% AIBAC; while others (i.e. undesirable compounds) portrayed erratic increment from 0 to 20%. These results showed that addition of *Azadirachta Indica* Bark Activated Carbon (AIBAC) to Metakaolin actually increase the percentages of undesirable compounds present in Metakaolin instead of eliminating them. As a result, when applied directly to MK, AIBAC has a negative impact (s).

3.2. Effects of AIBAC on kaolin clay (KC)

The structure of surface of the mixed samples (i.e. AIBAC + MK) using SEM are depicted in Fig. 6. Just like that of Fig. 3, all the surfaces of AIBAC + MK mixed samples were bristly, flaky, platy and scrawny in nature. There were presence of significant kaolinite structures with hard superficial and numerous magnitudes due to AIBAC. There were also conglomerate of kaolinite and impurities, which were more pronounced than that of Fig. 3. However, at 15% AIBAC + MK mixed sample, the conglomerate appeared to be clearer, which could portrayed the domination of kaolinite (quartz) and reduction of impurities.

Fig. 7 shows the mineralogical contents of AIBAC (0 – 15%) and MK (100%) mixed samples using XRD analyses. Their peak intensities were compared in order to confirm where there are shifts. The SEM results in Fig. 6 were verified by the reappearance of calcite, dolomite, microline and muscovite along with silica-rich aggregates corresponding to quartz as shown in 15% AIBAC + MK XRD plot (Fig. 7). The XRD plots in Fig. 7 indicated that the intensity peaks of the MK sample ranged from 0 to 4000 cps for quartz, while other minerals were below 1200 cps. The intensity peaks of quartz ranged from 200 to 400 cps for MK + 5% AIBAC, MK + 10% AIBAC and MK + 15% AIBAC samples; while the other minerals have intensities that were below 200 cps. Generally, the peaks shifted downward from 4000 to 400 cps. This shift or changes in peak intensity values confirmed effects of addition of AIBAC to Metakaolin (MK).

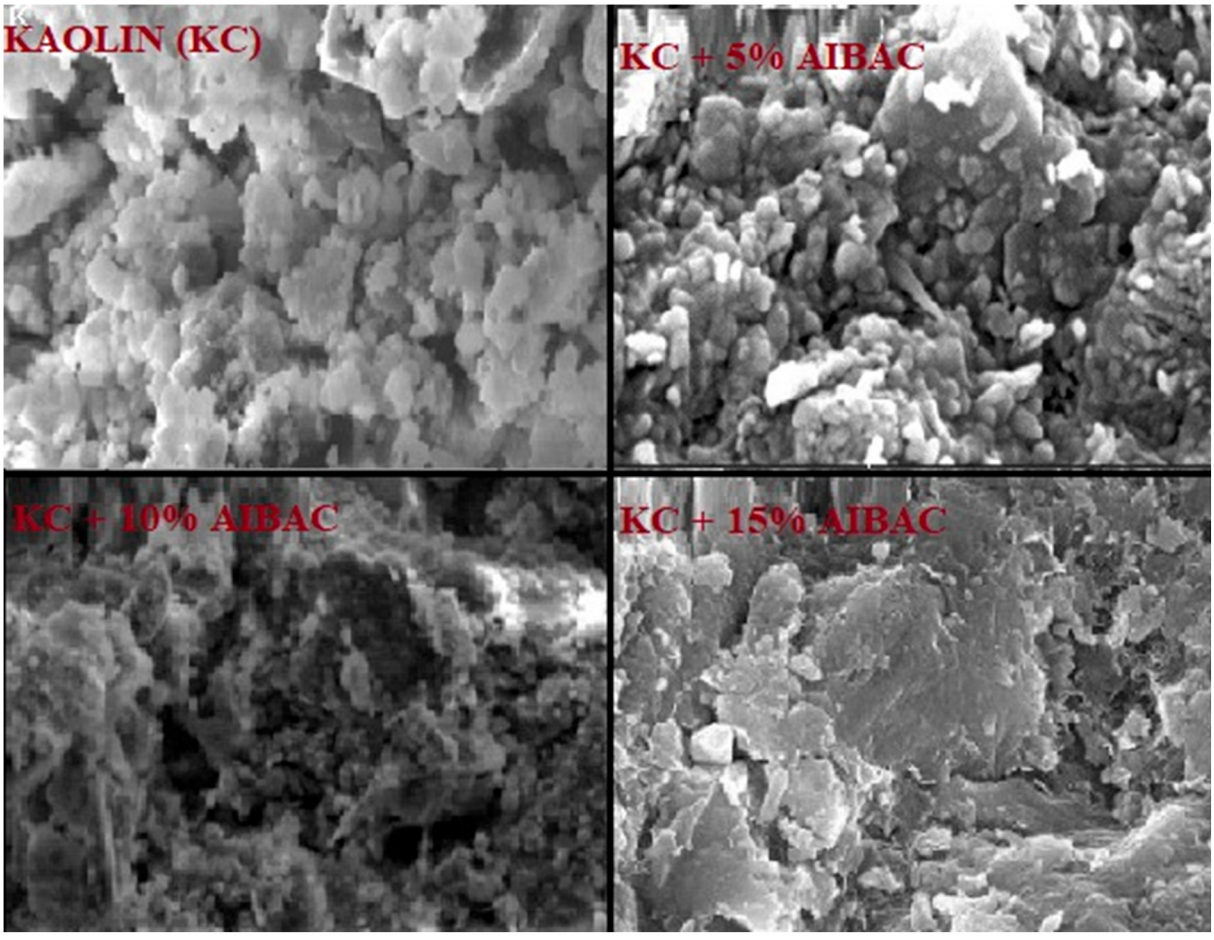


Fig. 6. Surface structure of KC + AIBAC samples using SEM (magnification: x 12,000).

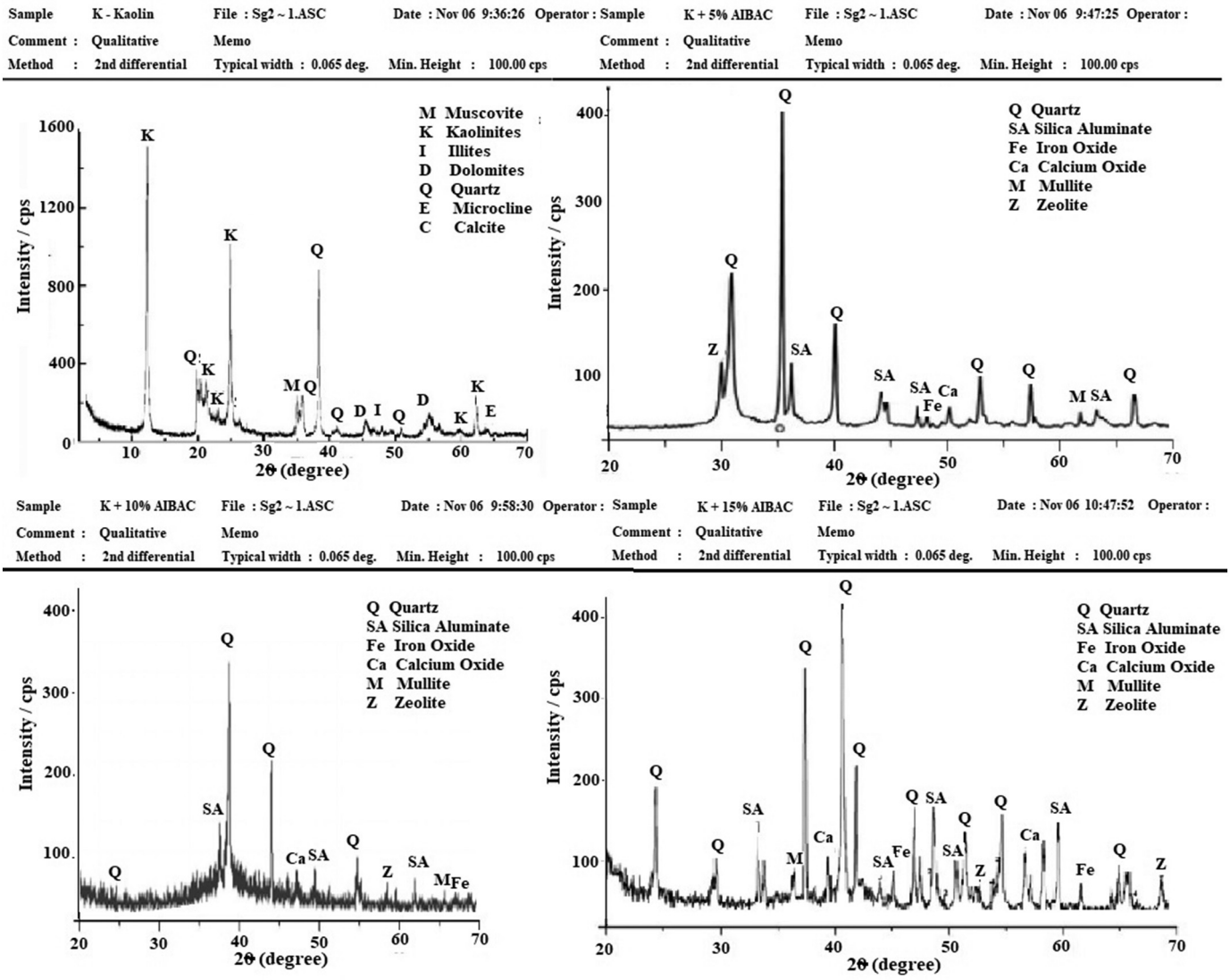


Fig. 7. Mineralogical contents - XRD intensities of KC + AIBAC samples (a) KC; (b) KC + 5% AIBAC; (c) KC + 10% AIBAC; (d) KC + 15% AIBAC.

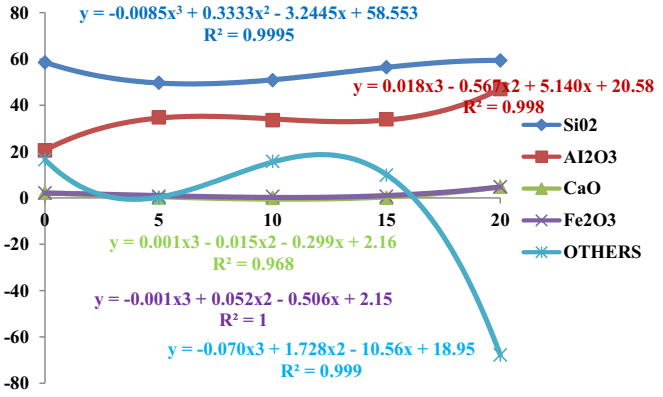


Fig. 8. Chemical contents - graphs of KC compounds against AIBAC.

Fig. 8 shows plots of oxides' compositions (i.e. SiO_2, Al_2O_3, Fe_2O_3, CaO and others (i.e. undesirable compounds) against AIBAC (0 – 20%). There was initial decrease in SiO2 from 0 to 7.5% AIBAC content, and then increased from 7.5 to 20%. Al_2O_3, Fe_2O_3 and CaO showed increment from 0 to 20% AIBAC content. The undesirable compounds (i.e. others) decreased from 0 to 5%, increased from 5 to 12.5%, thereafter declined till it reached 20% AIBAC content. The AIBAC content portrayed major compounds increment and removal of undesirable compound after 15%, thus, it has indirect effect (s) on MK. It is suitable for undesirable compounds'.

elimination from MK during calcination process. An addition of *Azadirachta indica* bark activated carbon (AIBAC) to Kaolin Ckay (KC) during calcination process will actually eliminate undesirable compounds (i.e.) from Metakaolin being produced.

In general, the chemical constituents of Kaolin Clay (KC) and Metakaolin (MK) have high silica and alumina components. These findings were supported by XRD analyses (Figs. 4 and 7) and previous studies by [4,10] among others. There was also the presence of undesirable compounds or oxides (i.e. others) in KC that remained in MK after calcination (though in smaller quantities), indicating the presence of impurities because they are unrelated to kaolinite structure. The XRD analyses (Figs. 4 and 7) show that these compounds are related to hematite, illite, and others [13,14]. The AIBAC, on the other hand, is capable of removing impurities from the MK during the calcination process.

Table 1
Change in constituents of MK.

Oxide	MK	MK + AIBAC	Change	KC	KC + AIBAC	Change
SiO_2	70.2	61.05	−13.03%	58.53	60.05	2.60%
Al_2O_3	23.3	18.09	−22.36%	20.5	33.62	64.00%
Fe_2O_3	1.13	0	−100.00%	2.15	2.22	3.26%
CaO	0.02	0	−100.00%	2.25	2.61	16.00%
Others	5.35	5.39	0.75%	16.57	0	−100.00%

Table 2
Chemical constituents of Metakaolin (MK).

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	Others	Source
MK	60.05	33.62	2.22	2.61	0.00	This study
MK	55.10	34.10	5.24	0.28	5.28	[15]
MK	57.37	38.63	0.77	0.03	3.20	[1]

When the XRF results for the mixed samples were subjected to optimization studies for optimal performance during calcination process using Design expert software (version 13), MK + AIBAC sample has optimization solution of 18.34 % of AIBAC producing 61.05 % of SiO_2, 12.29 % of Al_2O_3, 0 % of Fe_2O_3, 0 % of CaO and 5.39 % of undesirable compounds (i.e. others) compositions of Metakaolin (MK). This solution resulted in increase in undesirable compounds, depletion of some major compounds (i.e. Fe2O3 and CaO) and reduction in the quantities of the remaining major compounds (i.e. SiO_2 and Al_2O_3). These negative changes in compositions of MK produced from MK + AIBAC as shown in Table 1 are −13.03, −22.36, −100.00, −100.00 and 0.75 % for SiO_2, Al_2O_3, Fe_2O_3, CaO and others, respectively.

KC + AIBAC sample has optimization solution of 16.22 % of AIBAC producing 60.05 % of SiO_2, 33.62 % of Al_2O_3, 2.22 % of Fe_2O_3, 2.61 % of CaO and 0 % of undesirable compounds (i.e. others) compositions of Metakaolin (MK). This solution resulted in depletion of undesirable compounds and increase in the major compounds. These positive changes in compositions of MK produced from KC + AIBAC as shown in Table 1 are 2.60, 71.12, 3.26, 16.00 and −100.00 % for SiO_2, Al_2O_3, Fe_2O_3, CaO and others, respectively. The standard error of the mean ranged between 0.13 and 0.48 %, which clearly showed that it is less than the 5 % significant level. This solution predicted actual percentage of AIBAC required for calcination of KC to produce MK without undesirable compounds.

The chemical constituents of MK produced from KC + AIBAC in the presence of calcination portrayed better production when compared with past research works as shown in Table 2.

4. Conclusion

This study, based on the aim, objectives and results showed that activation and calcination play a prominent role in enhancing the remediation process between AIBAC and MK compounds. The modifications of MK by AIBAC during calcination process resulted in large granular and refined mixtures with cavities on the surfaces of the by-products. These cavities provided excellent surfaces for the AIBAC and MK compound remediation process. Peak intensity values changed from 4000 to 400 cps, confirming the effects of the AIBAC on the KC during calcination process to form MK. AIBAC's effects on MK were most noteworthy during the calcination process, rather than after. AIBAC (16.22%) was able to remove undesirable compounds and elements (such as P_2O_5, K_2O, TiO_2, SO_3, Na_2O, Ba, Zn, Cr, Cu, and Ni) from KC while also increased the constituents of notable oxides such as SiO_2, Al_2O_3, Fe_2O_3, and CaO by 2.60, 64.00, 3.26 and 16.00 %, respectively. Therefore, *Azadirachta Indica* bark Activated Carbon (AIBAC) as an adsorbent can be used to remove undesirable compounds from Metakaolin.

CRediT authorship contribution statement

Ezekiel A. Adetoro: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft. **Rasheed Abdulwahab:** Writing – review & editing, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Omolara D. Adetoro:** Writing – review & editing, Writing – original draft, Validation, Resources, Funding acquisition, Formal analysis, Data curation. **Samson O. Ojoawo:** Writing – review & editing, Visualization, Supervision, Project administration, Methodology, Conceptualization. **Pushparaj Naik:** Writing – review & editing, Software, Resources.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Ezekiel A. Adetoro – holds B.Eng. (KWASU), Postgraduate Diploma (FUTA), M.Sc. (Twente, Netherlands) and Ph.D (LAUTECH) degrees in Civil Engineering. He has many publications in reputable books, journals, conference proceedings and has presented academic papers at some conferences / workshops / seminars both internationally and locally. He is a Lecturer and Registered Civil Engineer.

Rasheed Abdulwahab – holds B.Tech. (LAUTECH), M.Sc. (Ibadan) and Ph.D (LAUTECH) degrees in Civil Engineering. He has many publications in reputable books, journals, conference proceedings and has presented academic papers at some conferences / workshops / seminars both internationally and locally. He is a Lecturer and Registered Civil Engineer.

Omolara D. Adetoro – holds B.Tech. and M.Tech (LAUTECH) degrees in Food Science. She has presented academic papers at some conferences / workshops / seminars. She is a Teacher.

Samson O. Ojoawo – holds B.Tech. (LAUTECH), M.Sc. and Ph.D (Ibadan) degrees in Civil Engineering and a Postdoctoral Fellowship (India). He is currently a Professor of Civil Engineering (Water Resources and Environmental Engineering) in the Faculty of Engineering and Technology, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. He has many publications in reputable books, journals, conference proceedings and has presented academic papers at some conferences / workshops / seminars both internationally and locally. He is a Registered Civil Engineer and a public orator.