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EFFECT OF INOCULUM ON BIOGAS FROM CASSAVA PEELS

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ABSTRACT

This research focuses on the effect of inoculum such as cow dung and poultry droppings on biogas produced from cassava peels. Six plastic digesters of 30 liters capacity were used for anaerobic digestion of these wastes. Cassava peels was used as the main substrate with cattle dungs and poultry droppings as inoculum which triggers a catalytic effect in the digestion process. Thermometers and pressure quages were installed on the top of each digester which contained the mixture of cassava peels and inoculum in varied proportions. Temperatures and Pressures were taken each day by 10:00 AM and 4:00 PM. It was discovered that pressures produced were relatively low and directly proportional to ratios of the digesters content. The biogas produced were functions of time variations and content concentrations. Further analysis revealed that the biogas produced were combustible after 91, 94 and 98 days for the three digesters that contained highest substrate and inoculum. Conclusively, the addition of inoculum will enhance maximum production of biogas in cassava peels and increase potentials for combustibility.

Keywords: Cassava peels, inoculum, temperatures, pressures, digesters, substrate and concentrations.

INTRODUCTION

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manures, municipal waste, plant material, sewage, green waste or food waste. Biogas can be produced by anaerobic organisms which digest materials inside a closed system or fermentation of bio gradable materials. It is a mixture of colourless, flammable gases obtained by the anaerobic digestion of plant based organic waste materials (Abubakar 1990). Biogas is typically made of methane (50 -70%) carbon dioxide (30 – 40%) and other trace gases (Cheremisiof, 1990).

Biogas as a renewable source of energy can be used to replace fossil fuels in the generations of heat and power thus by implication reduce greenhouse gases emission, slows down global warming and climate change. The gas has a lot of applications which includes its use for lighting, driving automobiles, powering farm machinery and cooking (Eze, 2011). According to Mshandete and Parawira (2009), biogas is the cheapest form of renewable energy as other sources like solar, hydro and wind require huge economic and technical man power to operate. In addition the sources of biogas are common biological wastes from humans, animals and plants. These wastes increases with increasing population and if they are not managed, they would pose serious health hazards as they become breeding places for diseases and their vectors (Adelegan 2002).

Cassava peels is an example of plant waste which can be used to produced biogas. Cassava is one of the major root crop produced in sub-haran African and the world production as at 2002 was estimated to be 1840 millions tons (Odomenem and Otanwe, 2011). Currently, there is a campaign for expanding the cassava production scale in Nigeria. The implication of this is that there will be increased wastes production from cassava processing. Since cassava peels is a material with high C/N ratio, it will not yield much biogas unless aided with inoculum.

Several researchers have reported biogas production from various materials including pigeon droppings (Aliyu et al, 1995); water hyacinth, Eichhornia species (Bamigboye and Abayomi, 2000); manure from the major farm animals (Adelekan, 2002); carmel and donkey dungs (Dangoggo et al, 2004). Yaru et al (2013) compared biogas production of cattle dung with plantain peels and they reported that the mixture produced more biogas than cattle dung alone. Ojike (2012) also studied biogas production from maize cubs, stalks and chaffs. It was reported that maize stalks produced more biogas. Yaru et al (2015) carried out comparative study on ignition time of biogas from cattle dung and mixtures of cattle dungs with cassava peels and the results showed that the cattle dung produced biogas earlier than the mixtures of the two wastes. Adeyanju (2008) demonstrated the effect of adding wood ash to the biodigestion of mixtures of piggery wastes and cassava peels in a laboratory scale. It was found that the ash addition increased the biogas production of either the biodigestion of piggery wastes and cassava peels only or in combination of both wastes in different proportions.

In this work, the addition of inoculum such as cow dung and poultry droppings to cassava peels in various proportions was studied with the objectives of investigating the mixtures that evolves the maximum heat. Pressures were taken at each day to evaluate the pumping efficiency of each plastic digester. Temperatures were equally taken to determine the heat content in the digesters.

MATERIALS AND METHODS

Sample Collection

The substrate for the experiments which was the cassava peels were collected from farm produce processing section of Agricultural Engineering Technology of the Federal Polytechnic Ado –Ekiti. The inoculum, that is cow dung and poultry droppings were equally collected fresh from the animal husbandry and poultry section. The cassava peels were sun dried and grinded at feed mill in Ado- Ekiti so as to increase the surface area of the peels during biogas production.

Slurry Preparation

6 kg of cassava peels was mixed with 250 ml of water in the first digester labeled A. 3 kg of cassava peels was added 3 kg of cattle dung with 250 ml water dilution inside digester B. 3 kg of cassava peels and 3 kg of poultry dung were mixed thoroughly with 250 ml water dilution inside digester C. 2 kg of cassava peels, 2 kg of cattle dung plus 2 kg of poultry dung with 250 ml of dilution was inside digester D. in fifth digester labeled E were 2 kg of cassava peels plus 3 kg of cattle dung and 1 kg of poultry dung with 250 ml water dilution. In digester F were 2 kg cassava peels, 1 kg of cattle dung plus 3 kg of poultry dung with 250 ml water dilution.

METHODS

The content in each digester were thoroughly mixed and the PH of the content in each digester were recorded. Each digester was properly covered with lid and epoxy resins applied to prevent air leakage during digestion. The six digesters were placed in an open space where the daily temperatures were being taken at 10 AM and 4 PM. The digesters were subjected to periodic shaking to ensure thorough mixing of the contents and the experiment was observed for a period of 100 days. The pressures of each digester were monitored through the quage valve and combustibility of digesters contents were also tested.

RESULTS AND DISCUSSION

It was observed from Figure 1 that the digester A with 6 kg of cassava peels has the lowest value of pH (6.2), which implied acidic condition, this is as a result of acidic content in cassava peels due to hydrogen cyanide (Adelekan, 2012). The pH of the substrate rose as the quantity of cassava peels in the substrate reduced.

In figures 2 to 7, it was observed that the evening temperatures were higher than the morning temperatures for both the surrounding (ambient) and the digesters. This was because the weather is always cool in the night and therefore the low ambient and digesters temperatures in the morning as the digesters were placed in an opened space where the air flow was not controlled. The wavy nature of the graphs was as a of result variation in weather conditions especially when rain fell either in the night or during the day. Also it was observed that the temperatures of all the digesters were similar for any given day making the graphs to be identical.

It was also observed that the digesters temperatures were proportional to those of the ambient as the temperatures of the digesters were not controlled. The minimum morning ambient and digesters' temperatures were $22^{o}C$ and $21^{o}C$ respectively while the maximum evening ambient and digesters' temperatures were $39^{o}C$ and $40^{o}C$ respectively. These temperatures are within the mesophilic temperatures.

Figure 8 shows the time (days) for the onset of biogas production for each of the digesters. The onset of biogas production were 63rd, 44th, 29th, 21st, 23rd and 17th days for digesters A, B, C, D, E and F respectively. Digester A containing cassava peels only was the last to produce biogas which means that the addition of animal wastes (cattle dung and poultry dung) as inoculum has catalytic effect that speeds up the rate of biogas production from cassava peels in other digesters.

Also the mixing ratio of the substrate has significant effect on the onset of production of biogas as could be seen from Figure 8. This is in agreement with Adelekan and Bamgboye (2009). Likewise it could be seen from same figure that blending the cassava peels with two different animal wastes reduced the time it takes to produce biogas compared to when blended with only one animal waste. This agreed with Oparuku (2013) that said that blending cassava peels with more than one waste improved its biogas productivity.

The ignition time of the biogas from each digester is as shown in Figure 9. In the figure it was revealed that the ignition time for biogas from each of the digesters were 91st, 94th, and 98th days for digesters F, D and E respectively. The biogas from digesters A, B and C has not shown any sign of combustion after one over hundred days. The implication of this is that mixing ratio of the substrate has effect on the ignition time of biogas from cassava peels. Also blending the cassava peels with two animal wastes reduced the ignition time when compared with blending the cassava peels with one animal waste only.

CONCLUSION

In this work, the effect of inoculum (cattle and poultry dung) on biogas from cassava peels was studied. Suitable digesters were successfully constructed for the anaerobic digestion of the plant and animal wastes used. Anaerobic digestion of cassava peels and cassava peels mixed in different ratios with cattle dung and poultry dung was carried out.

The results showed that the addition of these animal wastes hastens the production time and combustion time of the biogas from cassava peels. The study also revealed that mixing ratio of these wastes has significant effect on the production and ignition time of the biogas from cassava peels.

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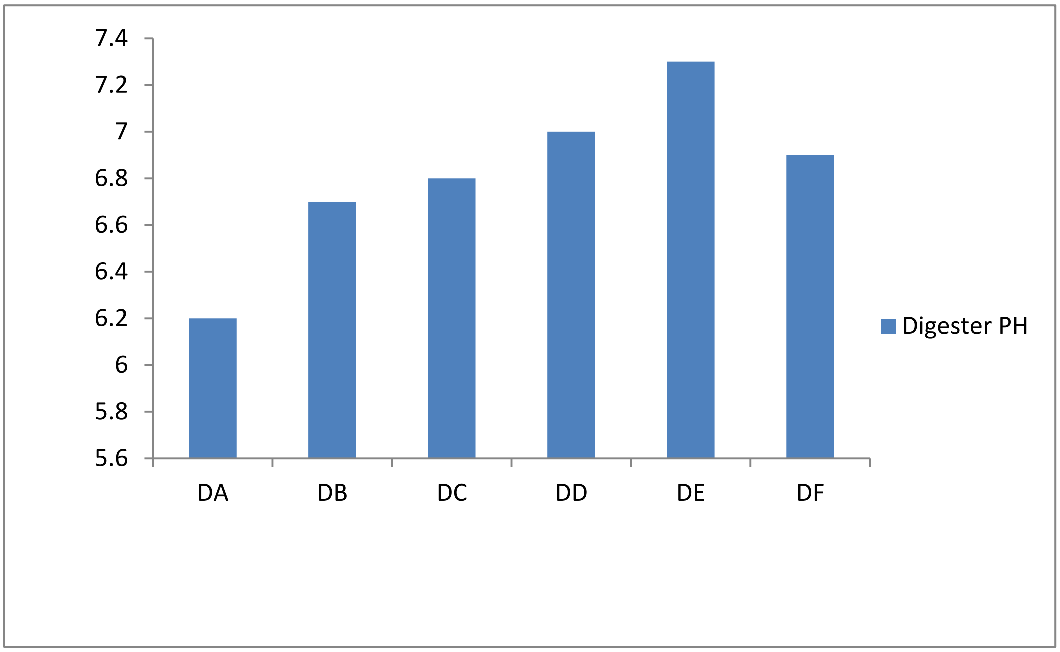

Figure 1: The pH of substrate in each of the digesters before digestion.

The plots of ambient and digesters temperatures against time (days) for digester A containing 6 kg of cassava peels is shown in Figure 2.

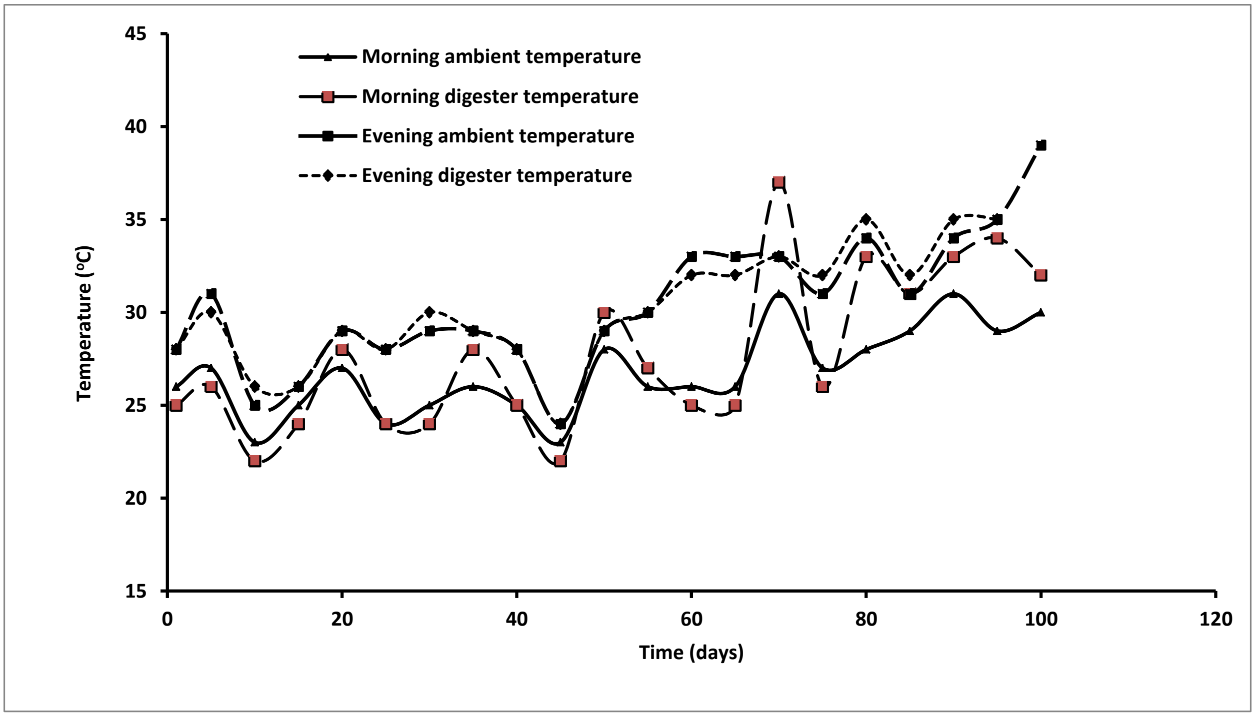

Figure 2: Plots of ambient and digesters temperatures against time (days) for digester A (6 kg of cassava peels)

Figure 3 shows the plots of ambient and digesters temperatures against time (days) for digester B containing mixture of 3 kg of cassava peels and 3 kg of cattle dung.

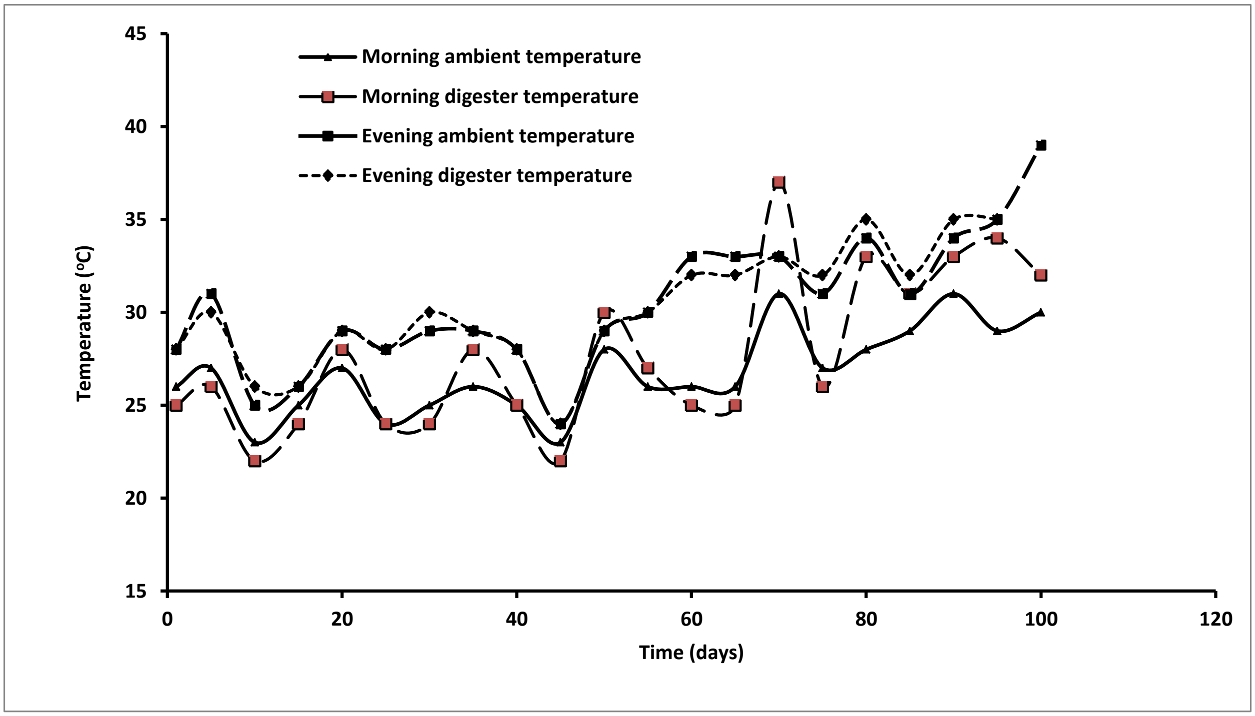

Figure 3: Plots of ambient and digesters temperatures against time (days) for digester B (3 kg of cassava peels and 3 kg of cattle dung)

The plots of ambient and digesters temperatures against time (days) for digester C having 3 kg of cassava peels and 3 kg of poultry dung is shown figure 4.

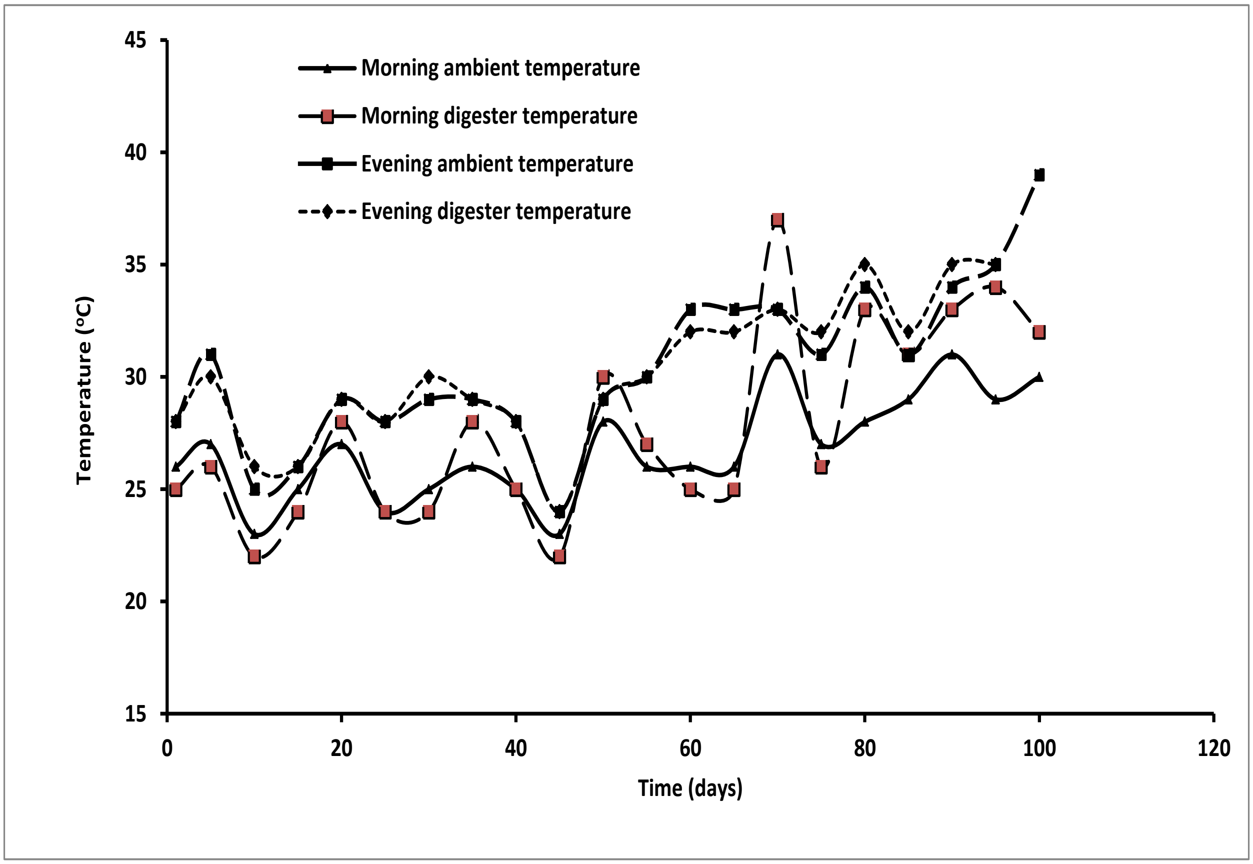

Figure 4: Plots of ambient and digesters temperatures against time (days) for digester C (3 kg of cassava peels and 3 kg of poultry dung)

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Figure 5 shows the plots of ambient and digesters temperatures against time (days) for digester D containing mixture of 2 kg of cassava peels, 2 kg of cattle dung and 2 kg of poultry dung.

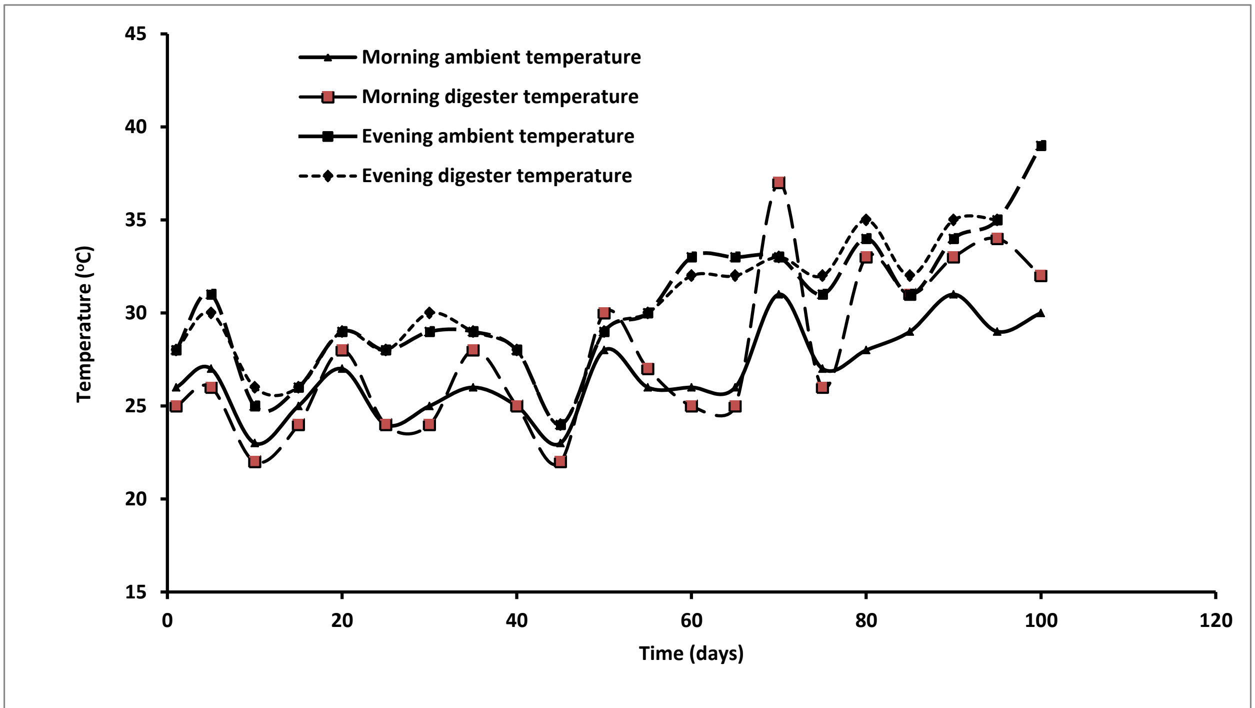

Figure 5: Plots of ambient and digesters temperatures against time (days) for digester D (2 kg of cassava peels, 2 kg of cattle dung and 2 kg of poultry dung).

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The plots of ambient and digesters temperatures against time (days) for digester E containing 2 kg of cassava peels, 3 kg of cattle dung and 1kg of poultry dung is shown in figure 6.

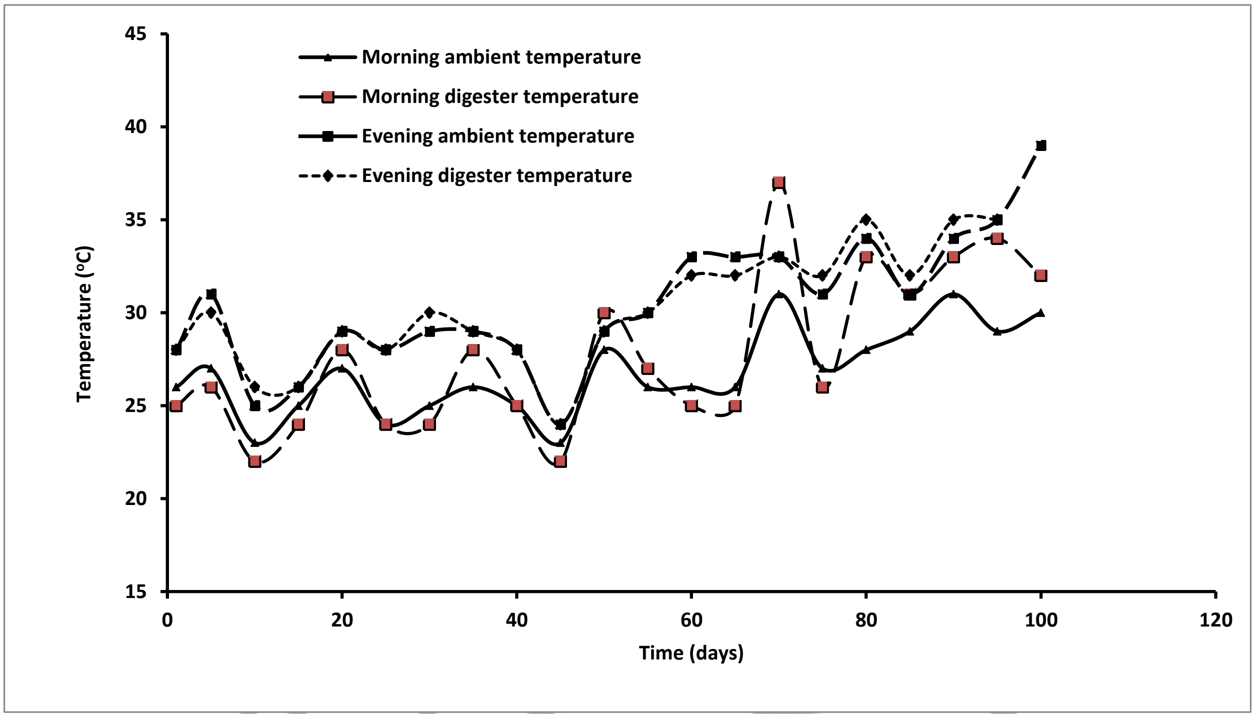

Figure 6: Plots of ambient and digesters temperatures against time (days) for digester E (2 kg of cassava peels, 3 kg of cattle dung and 1 kg of poultry dung).

Figure 7 shows the plots of ambient and digesters temperatures against time (days) for digester F containing 2 kg of cassava peels, 1 kg of cattle dung and 3 kg of poultry dung.

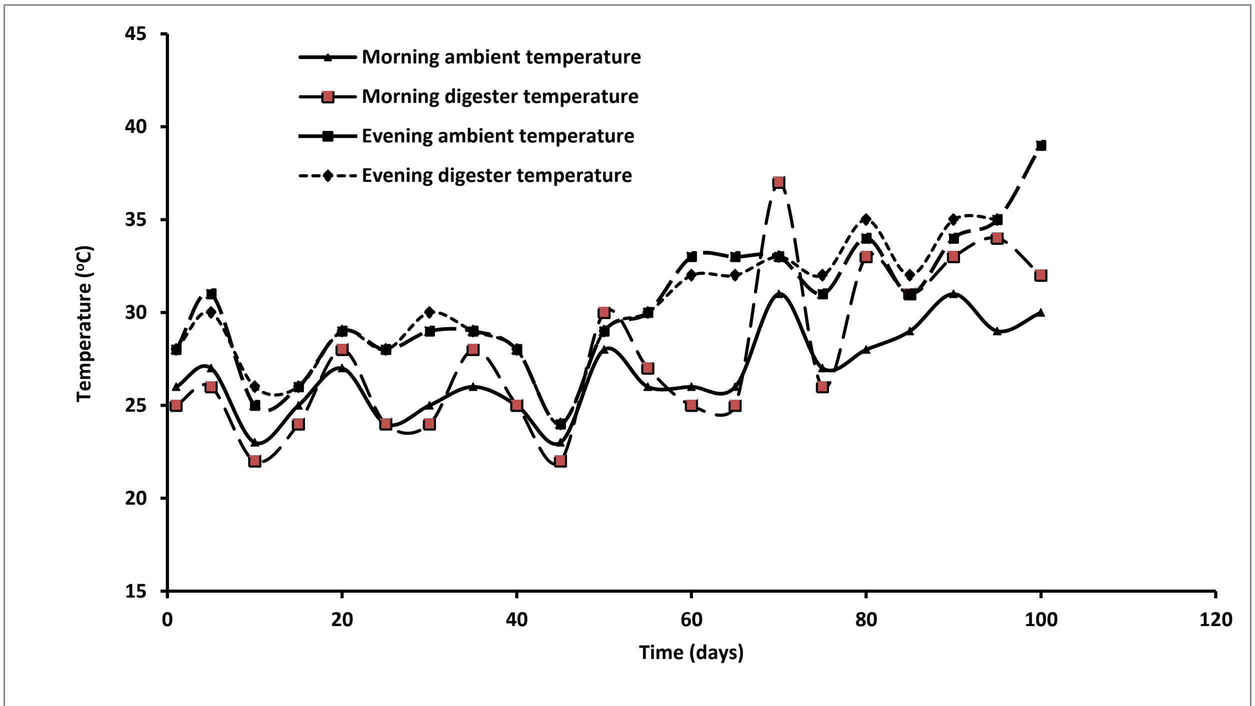

Figure 7: Plots of ambient and digesters temperatures against time (days) for digester F (2 kg of cassava peels, 1 kg of cattle dung and 3 kg of poultry dung).

Figure 8 shows the onset of biogas production for each of the digesters.

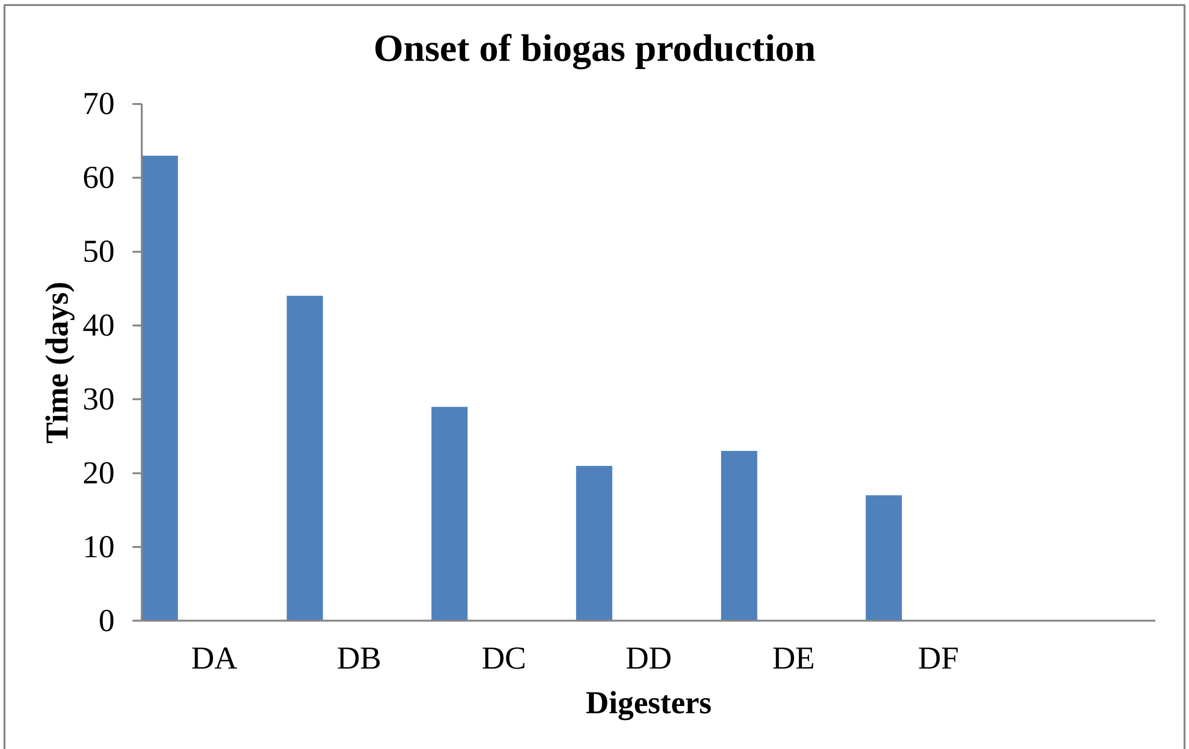

Figure 8: Onset of biogas production for each of the digesters

Figure 9 shows the column chart of the ignition time of biogas from each of the digesters.

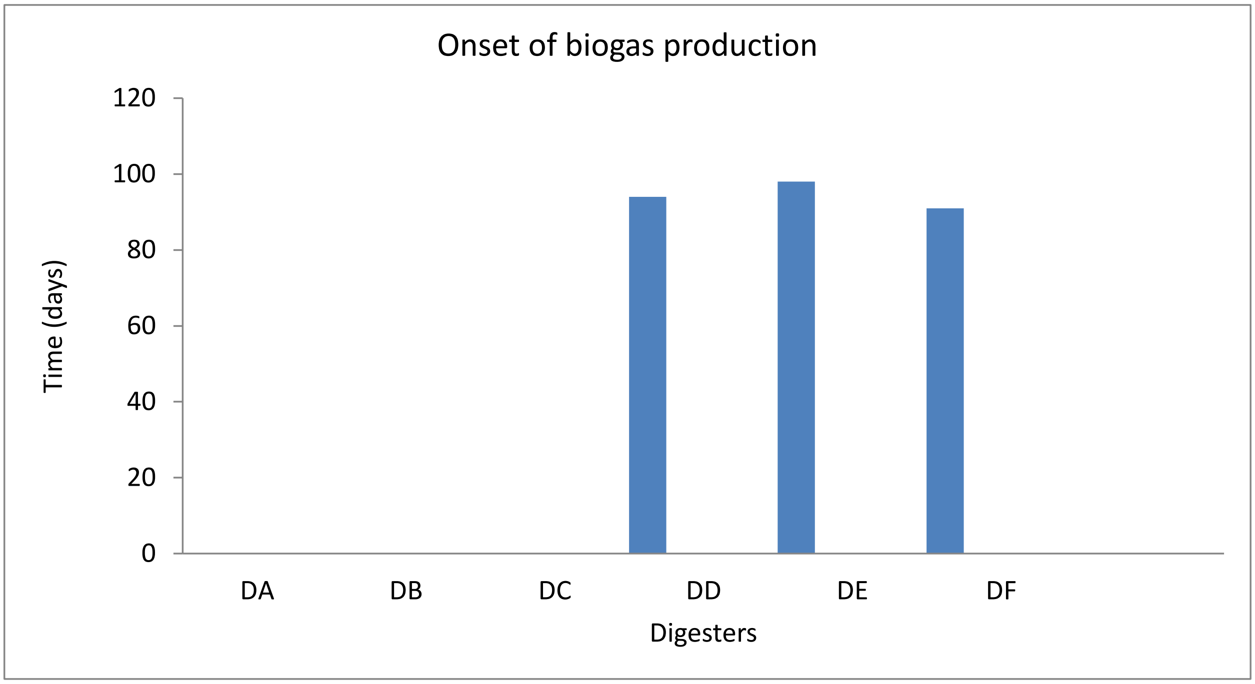

Figure 9: A column chart showing the combustion time for each of the digesters.