EFFECT OF DIGESTION OF COW DUNG ON THE PHYSICO-CHEMICAL AND GRAIN YIELD OF GROWN MAIZE GRAIN (*Zeamayz*)

By

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Abstract

This study was carried out to determine the effect of digestion of cow dung on the physic-chemical and grain yield of grown maize grain (Zeamayz). A 200kg of cow dung was divided into two equal aliquot firsts portion was digested with water in ratio 2:1 at 30^{o}C for 21 day, while the second portion was left undigested. The digested and undigested manures were applied to the soil and mixed thoroughly two days before maize grains were sown at a spacing of 10cm by 20cm and depth of 3cm, one grain per hole. The grains were allowed to grow for five months before harvesting. At the end of the experiment, 5 matured plants were randomly uprooted. The grains were extracted and the yield was measured before subjecting to laboratory analysis. Thereafter, the laboratory result was analyzed statistically using One Way Analysis of Variance (ANOVA) at ($P \leq 0.05$) significant level. The results of the proximate composition for digested and undigested samples were moisture 12.26 and 11.71%, ash 2.53 and 1.76%, crude fibre 2.68 and 1.86%, protein 9.26 and 7.84%, fat 5.27 and 4.52% and carbohydrate 68.01 and 72.32% respectively; the phytochemical constituents were alkaloid 1.83 and 1.45mg/100g, saponin 4.77 and 4.00mg/100g, flavonoid 5.72 and 4.17mg/100g and tannin 1.87 and 1.24mg/100g respectively. The research further revealed that the mineral and yield for both digested and undigested samples were potassium 1.22 and 0.56mg/100g, iron 68.63 and 55.66mg/100g then, yield 4000.23 and 3200.45kg/ha respectively. The experimental results of this study have showed that cow dung bio slurry produced higher nutritional values and yield on maize grain when compared with undigested cow dung. Therefore, digestion of cow dung is necessary in order to obtain improved crop yield and nutrients.

Keywords: Digestion, Cow Dung, Physico-Chemical, Grain Yield, maize grain

INTRODUCTION

Agriculture is known to be the oldest industry in the world. Its purpose is for growing of crops and rearing of animals-- all geared towards production of food and feed for man and his livestocks (Okoroafor*et al.,* 2013). Over the years, grain yields have depreciated drastically due to the degrading nature of the soils, poor fertility management and low import technology to improve the fertility of the soil; the use of organic manure could be adopted (Okoroafor*et al.,* 2013). Environmental challenges facing soil management in Nigeria include erosion which is severe in Anambra and Enugu States of Nigeria, with cases of over 50 gullies. Soil salinity, which reduces crop productivity/performance; flooding, which wash farmland resulting in low produce/product turnout and reduction in agricultural activities (Adiaha, 2016). The first attempt at Agricultural research in Nigeria was made in 1899. Initial Agricultural research work in Nigeria was directed at promoting the development of various cash crops including maize, cocoa, oil palm, cotton, groundnut for export purposes. The roles maize play in food value chain called attention to the importance of maize as food crop (Iken and Amusa, 2004). In view of the importance of cereals especially maize in Nigeria, efforts are continuously made to increase maize yield and nutrient composition per unit area of land and to extend areas where it can be grown (Amudalat and Ephraim, 2004).

Maize is a corn and one of the cereal grains, members of the monocot families *Poaceceae*or *Gramineae*. Cereal grains are grown in greater quantities all over the world (Oladapo*et al.*, 2017)*Zea mays* L; also known as maize. Indian corn or corn is a cereal that is one of the most important edible grains in the world (Thoudam*et al.,* 2011). It originated from South and central America. It was introduced to West Africa by the Portuguese in the 10th century (Oladejoand Adetunji, 2012). Maize spreads to the rest of the world due to its popularity and ability to grow in diverse climatic conditions (Oladapo*et al., 2017).* The global maize productivity is 4.92t/ha, but in Nepal maize yield is 2.35 tons per hectare (t/ha) against the attainable yields of 5.7 t/ha (Aniekwe, 2015). Current maize production in the world is estimated to be 784 million tons in 2007 and expected to increase in years ahead (Oladapo et al., 2017). China as at 2003 recorded her production at 81.8 million tons, with yield of 1.9 tons/acre, presenting China as the 2nd largest World maize producer, Brazil accounts for 21.8 million tons, and yield of 0.8 tons/acre. Mexico produces at l1.8million. tons and 0.8 tons/acre of yield (Adiaha, 2016). France, Russia, South Africa, India have also been identified as leading producers of world maize. Nigeria records a value of world maize production at 1.8 million tons, and yield of 0.6 'tons/acre.

IITA (2014) report indicates 8 million tons of maize production in Nigeria. Annual production of maize in Niger accounts to a value of 5.6 million tons (Adiaha, 2016). Among the cereals, maize remains popularly grown and consumed in ecological zones of Nigeria. It provides more food energy Worldwide than any other type of crop and is a rich source of vitamins, minerals, carbohydrate, fat, oils and protein (Oladapo et al., 2017). Of all cereal, maize has the largest amount of oil, the average chemical composition is starch 68-70%, protein 10% and 3.6-5% oil (Solomon et al., 2012).

Maize is a cereal plant that produces grains that can be cooked, roasted, fried, ground, pounded or crushed to prepare various food items like pap, 'tuwo' 'gwate', 'dokunnu' and host of others. All these food types are readily available in various parts of Nigeria among different ethnic groups, Preparation and uses of the maize grains varied from group to group, though at times with some similarities (Oladejo and Adetunji, 2012).

In Maize production, low soil fertility is one of the limiting factors (Okoroafor et al., 2013). Application of inorganic fertilizers alone has not proven beneficial in intensive agriculture because it aggravates soil degradation. However, the combined application of both organic and inorganic dressings by farmers has been reported to increase yield and conserve soil productivity (Hussein et al., 2017). For example, poultry droppings, cow dung and household wastes have been revealed to increase the efficacy of minerals that do not exist in chemical fertilizers. Furthermore, supplementation with organic manures to reverse the current trend of physical, chemical and biological degradation of the soil has been recommended (Hussein et al., 2017).

The techniques used for the conversion of organic materials to biogas have been in existence for many years (Sagagi et al., 2009). The use of rural wastes for biogas generation, rather than directly used as fuel or fertilizer, offers several benefits such as, the production of energy resource that can be stored and used more efficiently, the production of stabilized residue (slurry) that retains the fertilizer value of original material and the saving of energy required to produce equivalent amount of nitrogen-containing fertilizer by synthetic process (Sagagi et al., 2009). Common starter used in biogas production are activated sludge or the content of rumen fluid (Putria et al., 2012). Therefore, the application of biogas slurry manure might be more important than the addition of chemical fertilizer in maize production. However, there is paucity of information on the effect of biogas slurry from cow dung on the chemical constituents of maize which is the sole aim of this work.

MATERIALS AND METHODS

Study Site: The study was carried out on a farmland in Institute of Management and Technology (IMT) Enugu, Enugu North Local Government Area of Enugu State, Nigeria. Pre-cropping chemical analysis of the experimental soil was not conducted before the land was cleared for planting. The experiment was laid out in a completely randomized design with three replicates.

Preparation of Biogas Slurry

This was prepared using the method as described by Putri et al. (2012) with slight modification. The cow dung of 200 kg was divided into two equal halves. The first portion was poured into digesters (model) and mixed with water in the ratio of 2:1. The sample was mixed briefly until all ingredients were well blended in the digesters before storing a temperature of 30^{o}C for 21 days, while the second portion was left undigested.

Nursery Practices in the Seeds

The nursery practices were carried out using the method of Law-Ogbomo and Ajayi (2009) with slight modification. Seeds of Maize variety from the International Institute of Tropical Agriculture (IITA) Ibadan were sowed in seed trays (nursery) filled with top soil bed by broadcasting the seeds. The seedlings remained in the nursery for four weeks with routine management like watering and weeding when necessary, after which they were transplanted to the field.

Planting procedure: The planting method applied was as described by Mofunanya*et al.*, (2015) with slight modification. The land was cleared manually after which West African hoe was used to make beds with a space of 5cm between beds. The digested and undigested slurries were applied to the soil and mixed thoroughly two days before maize grains variety from the International Institute of Tropical Agriculture (IITA) were sown. Maize grains were sown at 10cm by 20cm and depth of 3cm at one grain per hole. The grains were allowed to grow for 12 weeks before harvesting. Weeding was done manually at 8 and 6weeks after sowing.Eight plants were selected per plot for the determination of grains yield at 4 months after planting. At the end of the experiment, 5 matured plants were randomly uprooted. The grains yield was determined and subsequently dried at temperature 60^{o}C for 18hrs by a constant weight was obtained and were taken from pulverized samples for the determination of physio-chemical constituents of the leaves.

Analysis carried out

Analysis

Moisture, Ash, Fat, Crude fibre, Protein and carbohydrate contents were determined using the method of AOAC, (2010). For the phytochemical determinations of the tannins, the method of Ojinnaka*et al*., (2013) was adopted, while the rest followed the procedures of AOAC (2010).

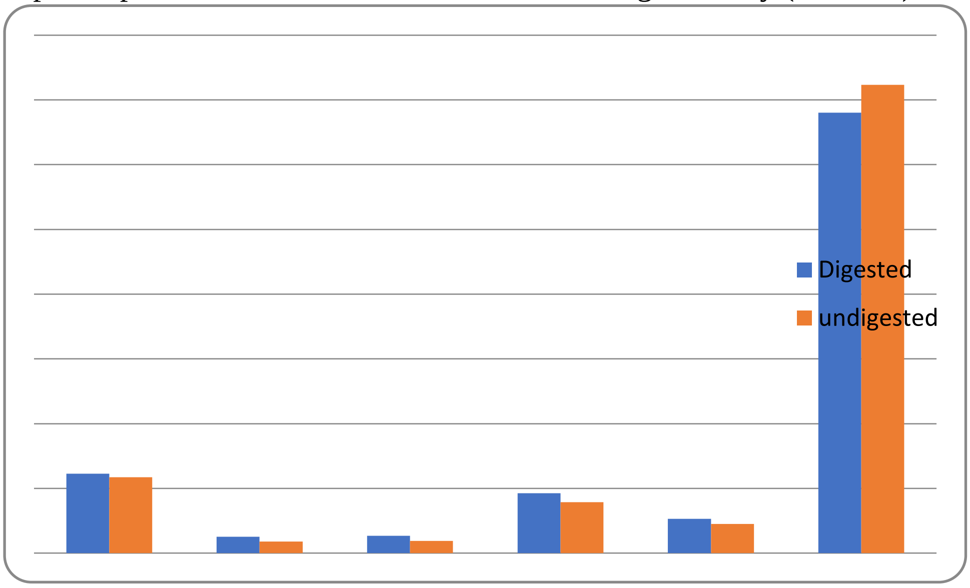
Statistical analysis was carried out using SPSS version 23.0.0 (SPSS, 2010).

RESULTS AND DISCUSSIONS

Table 1: Proximate composition of Maize grown with digested (biogas slurry) and undigested cow dung

Sample	Moisture (%)	Ash (%)	Crude fibre (%)	Protein (%)	Fat (%)	Carbohydrate (%)
Digested	12.26^{a}±0.58	2.53^{a}±0.04	2.68^{a}±0.070	9.26^{a}±0.04	5.27^{a}±0.01	68.01^{b}±0.61
Undigested	11.71^{a}±0.21	1.76^{b}±0.08	1.86^{b}±0.01	7.84^{b}±0.01	4.52^{a}±0.51	72.32^{a}±0.35

Values are mean ± standard deviation of duplicate determination. Mean with different superscript letters are different from each other significantly ($P < 0.05$).



The moisture content of the maize grown with digested and undigested cow dung samples were 12.26 and 11.71% respectively, although digested sample had higher moisture content (12.26%) than undigested sample (11.71%), but both samples were significantly similar (P3005).

These values were similar to the findings of Dilip and Aditya (2013) with the moisture content of 10.23% and in agreement with 9 and 11% moisture in maize grown with poultry droppings and farmyard manures respectively as reported by Muhammad et al. (2013). This showed that manure had no significant effect on the moisture content of crop grown in it.

However, the low moisture content is an indication that the maize could have higher shelf stability and thereby being less prone to microbial proliferation.

The ash contents of the maize were 2.53 and 1.76% for both digested and undigested grown cow dung maize respectively with digested sample having higher ash content than the undigested sample. However, both samples differed significantly (P≤5) from each other. The ash content of the samples was in line with 2.33% ash in maize as reported by Tajamul*et al.* (2016). The higher ash content was in line with the work of Okereke *et al.* (2015) that had higher ash content in rice grown with cow ding than the poultry droppings. Ash is an indication of minerals in food. Food with high ash is said to possess high mineral constituents (Okereke et al., 2015)

The crude fibre contents of the digested and undigested samples were 2.88 and 1.86% respectively. Maize sample grown with digested cow dung possessed higher fibre content (2.68%) than the undigested one. Both digested and undigested samples differed significantly (P≤5) from each other. The crude fibre content of the samples was similar to 2.15% reported by Dilip and Aditya (2013) in maize. A number of studies have indicated that components of plants such as dietary fiber have beneficial effects in lowering blood cholesterol levels aside from the decreased intake of saturated fat and cholesterol that occurs with high intakes of plant foods (Ekumankama, 2008)

The protein contents of the digested and undigested cow dung grown maize were 9.26 and 7.84%. Digested sample possessed higher protein content (9.26%) than undigested sample (7.84%). However there was significant difference between both samples. The finding of this studywere in line with the report of Tajamul et al. (2016) with 8.84% protein in maize. Nitrogen is one of the major nutrients required for plant growth. Biogas slurry contains a considerable amount of both macro and micro nutrients besides appreciable quantities of organic matter than other organic fertilizer (Sandeep et al., 2015).

The fat content of the samples were 5.27 and 4.52% with digested sample having higher fat content (5.27%) than the undigested sample (4.52%). The study also revealed that there was no significant different (P≥0.05) between both samples. These values were in agreement with 4.27% reported by Tajamul et al. (2016). Crude fat is one of the most important components of maize grains; improvement in fat content is useful for good human health (Kabir et al., 2019). The higher fat content in digested sample could be due to the higher nutritional composition of the bioslurry. Bioslurry may be considered as a good quality organic fertilizer. Analysis of representative cow dung and poultry litter slurry samples from biogas plants has shown that slurry contains a considerable amount of both macro and micro nutrients besides appreciable quantities of organic matter (Islam, 2006).

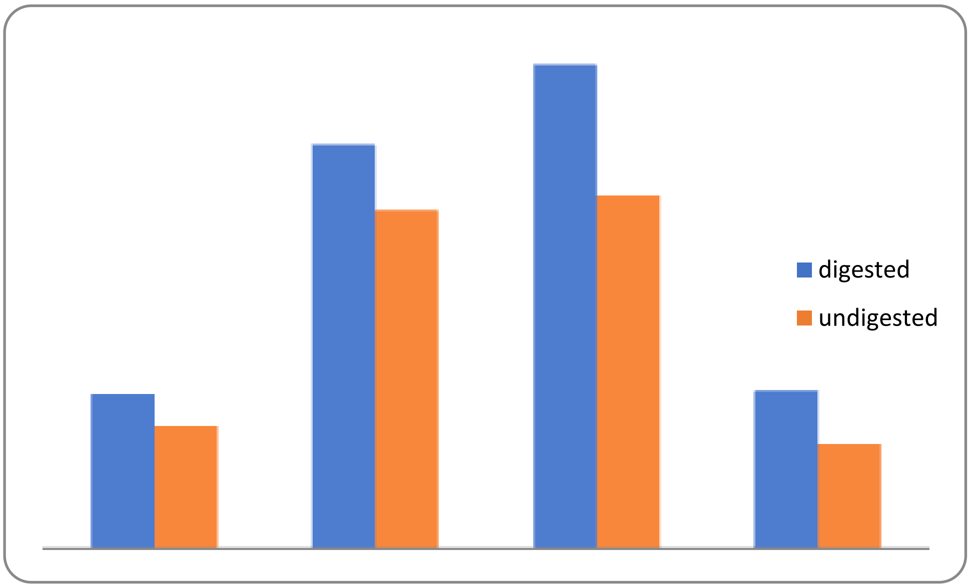
The carbohydrate content of the digested and undigested cow dung grown maize was 68.01 and 72.32%. Both samples differed significantly (P≤0.05) from each other; also digested sample had lower carbohydrate content (68.01%) than undigested sample (72.32%). These values were lower than 84.41% reported byBintu et al. (2017). The lower carbohydrate content in the digested sample could be due to higher protein, ash, fibre and fat content. Repeated, long-term application of compost or manure could result in elevated soil phosphorus concentrations. Thus, management should play an important part in the long-term sustainability of corn grown with organic fertilizers (Venhauset al., 2015).

Table 2: Phytochcmical constituents of Maize grown with digested (biogas slurry) and

undigested cow dung

Sample	Alkaloid (mg/100g)	Saponin (mg/100g)	Flavonoid (mg/100g)	Tannin (mg/100g)
Digested	1.83^{a}±0.07	4.77^{a}±0.06	5.72^{a}±0.02	1.87^{a}±0.05
Undigested	1.45^{b}±0.04	4.00^{b}±0.04	4.17^{b}±0.08	1.24^{b}±0.03

Values are mean ± standard deviation of duplicate determination. Mean with different superscript letters are different from each other significantly (P < 0.05).



The alkaloid content of the maize grown with digested and undigested cow dung was 1.83 and 1.45 mg/100g. The maize grown with digested cow dung had higher alkaloid content (1.83 mg/ 100g) than the undigested counterpart (1.45 mg/ 100g). There was significant different (P≤0.05) between both samples. These values were slightly higher than 0.17 mg/ 100g reported by Ugwu et al. (2013) in maize. The variation could be due to the high nutritional composition of the bioslurry and the cow dung which increased the alkaloid content of the maize. Alkaloids have many pharmacological activities including anti-hypertensiveeffects (many indole alkaloids),anti-arrhythmic effect (quini-dine, spareien), anti-malarial activity (quinine), and anti-cancer actions (dimericindoles, vincristine, vinblastine). These are just a few examples illustrating the great economic importance of this group of plant constituents. Some alkaloids have stimulant property as caffeine and nicotine, morphine are used as the analgesic and quinine as the antimalarial drug (Deepak et al., 2018)

The tannin contents of the digested and undigested samples were 1.87 and 1.24 mg/100g for digested and undigested samples respectively. Both samples differed significantly (P5005) from each other. These values were slightly higher than 0.11 reported by Oladapo et al. (2017) in corn.

Tannins are concentrated mainly in the seed coat, preliminary de-hulling constitutes the simplest method for their removal. Significant differences in the tannin content were seen among rice, wheat, barley and oat bran.

The tannins form complexes with protein and reduce their digestibility (Deepak et al., 2018)

The saponin mean values of this research were 4.77 and 4.00 mg/100g in digested and undigested samples. Both samples differed significantly (P≤0.05) from each other.Alsothe digested sample had higher saponin content (4.77 mg/100g) than undigested sample (4.00 mg/100g). The

saponin content of this research was higher than 0.09 mg/100g reported by Ugwu et al. (2013) in corn in maize. The variation could the due to the fertility status of the soil and the condition of the maize before analysis as fresh maize contains higher phytochemicals than the dry maize. The anti-nutritional effects of saponins include increased permeability of small intestinal mucosa cells thereby inhibiting nutrient transport. Other properties of saponin may play a role in its growth depressing action (Ugwu and Oranye (2006).

This research also revealed that the flavonoid content of the digested and undigested samples were 5.72 4.17 mg/ 100g respectively. There was also significant different (P≤0.05) between the samples. The digested sample possessed higher flavonoid (5.72 mg/100g) than undigested sample (4.17 mg/100g). The flavonoid content of these samples were also higher than 0.61 mg/100g in maize as reported by Sarepoua et al. (2013). The higher flavonoid in the digested sample could be due to the higher nutritional properties of the manure than the undigested sample.

Flavonoids are the most common and widely distributed group of phenolic compounds, occurring in com silk parts. These compounds possess a broad spectrum of chemical and biological activities including radical scavenging properties. Based on the results, total flavonoid contents of all fractions from corn silk were in descending orders similar to those of total phenolic contents, and flavonoids are the major phenolic compounds present in corn silk (Maksimovic et al., 2005)

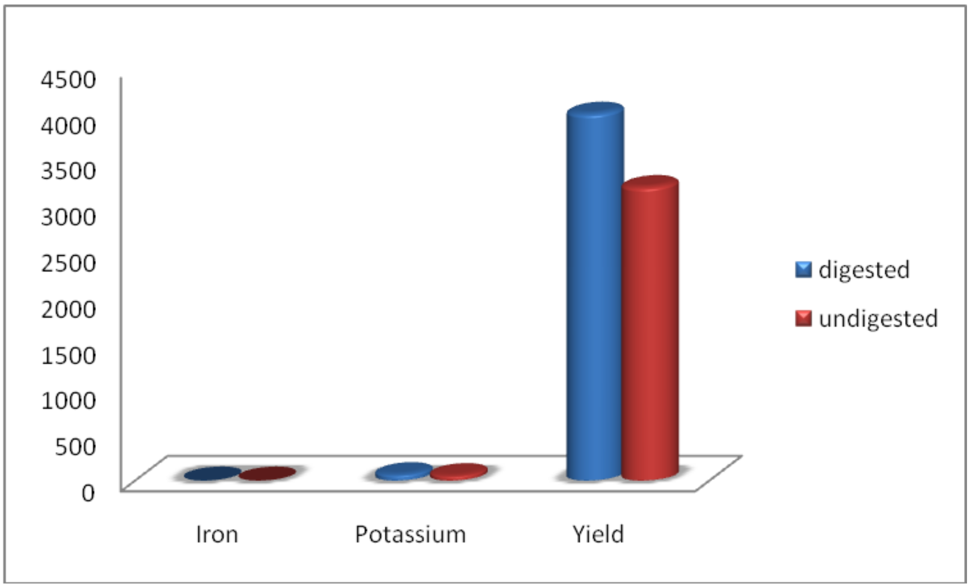
Anti -nutrients are substances, to which we are all exposed to through food and water that reduces food nutrients needed for good health.

These, antinutrients inhibit digestive enzymes, some cause problems by creating a greater need for certain nutrients, while others make nutrients to be excreted more rapidly from the body. Many of the anti-nutrients have either a direct or indirect effect on the immune system and nutritional status of the body. However, some of the anti-nutrientsprotect the body from various types of cancers, free radicals and radiations (Ugwu and Oranye (2006).

Table 3: Mineral constituents and grain yield of Maize grown with digested (biogas slurry) and undigested cow dung

Sample	Iron (mg/100g)	Potassium (mg/100g)	Yield (kg/ha)
Digested	$1.22^{a}\pm0.03$	$68.63^{a}\pm0.06$	$4000.23^{a}\pm0.00$
Undigested	$0.56^{a}\pm0.06$	$55.66^{b}\pm0.05$	$3200.45^{b}\pm0.00$

Values are mean i standard deviation of duplicate determination. Mean with different superscript letters are different from each other significantly (P < 0.05). ‘



The potassium mean value of the samples was 122 and 0.56 m ‘ /100g for the digested and undigested cow dung grown maize. ere was significant difference between both samples. However, the digested sample contained higher potassium due to the higher minerals in the biogas slurry applied. The values of potassium obtained in this research were in line with 0.60 mg/100g as reported by Kabir et al. (2019) in maize. Potassium has been reported to play vital role in maintaining fluid balance and proper functioning of the essential organs such as the brain, nerves, heart and muscle (Usman er al., 2015).

The iron content of the digested and undigested samples was 68.63 and 55.66 mg/100g with digested sample having higher iron content (68.63mg/ 100g) than the undigested sample (55.66 mg/100g). The higher iron content in the digested sample could be due to the iron improvement in the biogas slurry produces which imparted to the produce. However, both samples differed significantly from each other. The values recorded were higher than 2.3 mg/100g recorded by Tajamuler al. (2016) in maize and in line with 67.44 mg/100g reported by Kabir et al. (2019) in maize. Iron has several vital functions in the body. It is essential to most life forms and to normal human physiology. Iron is an integral part of many proteins and enzymes that maintain good health. It is an essential component of proteins involved in oxygen transport (Eze, 2012).

The grain yield for digested and undigested samples was 4000.23 and 3200.45kg/ha. The digested sample was higher in yield (4000.23 kg/ha) than undigested sample (3200.45 kg/ha). Similarly, Simon et al. (2015) confirmed that due to the high available nutrients content,

digestate application resulted in significantly higher aboveground biomass yields.
Kurt et al. (2008) reported that If the liquid slurry was incorporated immediately after soil addition, the organically bound N of undigested slurry seems to have enough time in long-cycle crops, such as maize, to become partially mineralised and available to crops. Some studies also showed that the yield of corn can increase by 7% (Sandeep et al., 2015).

CONCLUSION

The result of this study showed that the maize grown with digested cow dung was higher in fat, protein, fibre and ash than undigested cow dung grown maize. The phytochemicals, minerals and the yield was higher inthe digested biogas slurry than its counterpart. Hence, based on digestion of slurry, the results presented show that better synchronization of crop nutrient demand and nutrient supply on arable land can be achieved from digested slurry only if it is incorporated into the soil before planting the seedlings. Digestion is a technique which also allows productive use of other biomasses such as cow dung. The experimental results of this study have showed that cow dung bio slurry produced higher nutritional values and yield on maize grain when compared with undigested cow dung. Therefore, digestion of cow dung is necessary in order to obtain improved crop yield and nutrients.

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