EFFECT OF TIME (14DAYS) ON SOME CHEMICAL AND PHYSICAL COMPOSITION OF MAIZE COBS ENSILED WITH WOOD ASH EXTRACT.

BY

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BENIN CITY.

NOVEMBER, 2025

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A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF ANIMAL SCIENCE, FACULTY OF AGRICULTURE, UNIVERSITY OF BENIN, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF AGRICULTURE

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CERTIFICATION

This is to certify that the project work was carried out by Praise Ademidun ADELUGBIN, Department of Animal Science, Faculty of Agriculture, University of Benin, Benin City, Nigeria, under the supervision of Prof F.U. Igene and co-supervisor Mrs. O. B. Abiloro

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Prof F.U Igene Project supervisor	Signature & Date
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Mrs. O. B. Abiloro Project Co-Supervisor	Signature & Date
Dr. N. C. Akaeze Head of Department	---------------------------- Signature & Date

DEDICATION

This research work is dedicated to God Almighty, my father Mr Adelugbin and my siblings

ACKNOWLEDGEMENT

Firstly, Praises and thanks to God Almighty for divine blessings throughout my research work.

I would like to express my deep and utmost gratitude to my Project supervisor,Prof F.U. Igene and my Co-Supervisor Mrs. Abiloro for their continuous support and guidance through

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ABSTRACT

The agricultural sector in Nigeria and sub-Saharan Africa faces persistent challenges in meeting livestock nutritional needs, particularly during dry seasons when conventional feed becomes scarce and expensive. Maize cobs, despite being a widely accessible agriculture by-product of maize processing, are not very useful because of the high fibre content and poor digestion. This study shows the impact of a short-term (14-day) ensiling period with wood ash extract (WAE) on the chemical and physical characteristics of maize cobs, with a focus on their usefulness as a feed ingredient.The cobs were subjected to four treatments: untreated control (T1), water-soaked (T2), ensiled with 250ml WAE (T3), and ensiled with 500ml WAE (T4). Results showed that WAE treatment significantly altered the proximate composition. Moisture content increased from 11.93% in T1 to 22.87% in T4, and ash content rose from 1.55% in T1 to 2.41% in T4, indicating mineral enrichment. However, a leaching effect was observed; crude protein, which increased to 5.53% in T2, decreased to 3.78% in T4. Similarly, ether extract (fat) was lowest (0.39%) in T4. Carbohydrates were substantially reduced from 55.44% in T1 to 40.94% in T4, indicating microbial utilization during fermentation. Mineral analysis revealed that T3 was most effective for enrichment, increasing Potassium to 314.60 mg/100g and Zinc to 1.82 mg/100g, while higher volumes (T4) led to leaching of Phosphorus (25.72 mg/100g). Physically, the treated cobs exhibited a softer texture and a characteristic vinegar-like aroma, indicating successful fermentation.The study concludes that ensiling maize cobs with a moderate volume (250ml) of wood ash extract (T3) optimally enhances the mineral profile and induces beneficial fermentation, presenting a practical strategy for valorizing this agro-waste into a valuable feed resource for smallholder farmers in Nigeria.

CHAPTER ONE10

1.0 INTRODUCTION

The Agricultural sector in Nigeria and across sub Saharan Africa faces persistent challenges in meeting the nutritional requirements of livestock, particularly during dry seasons when conventional feed resources become scarce and expensive. Maize,(*Zea mays L),* represents one of the most widely cultivated cereals in the region, generating maize cobs as by products during grain processing and are often underutilized discarded, burned as fuel, or incorporated back into agricultural fields rather than being processed as animal feed despite its potential as a stable, low cost energy source. According to recent estimates, approximately 180-200 kg of maize cobs are produced per ton of maize grains harvested, which means there is a significant quantity of potentially valuable biomass that remains un-tapped. The narrow range of conventional feed ingredients available to Nigerian livestock producers, coupled with increasing competition between human and animal nutrition for cereal grains, has prompted urgent research into alternative Maize cob feedstuffs that are both abundant and low-cost.

The effective utilization of maize cobs in animal feed formulations requires comprehensive evaluation of both their chemical composition and physical properties, as these factors collectively influence nutritive value, digestibility, and eventual animal performance (Ikwunze *et al*.,2024). This comprehensive evaluation serves as a foundation to address the challenges of feed scarcity while processing maize cob as a low-cost, sustainable feed resource in Nigerian livestock systems. Maize cobs belong to the classification of lignocellulosic biomass, characterized by a complex arrangement of cellulose (45-55%), hemicellulose (25-35%), and lignin (20-30%) that resists degradation by mammalian digestive enzymes (Goke, 2020).This difficult maize cob structure necessitates pre-treatment strategies to enhance their bioavailability as an energy source for livestock.

Wood ash extract has emerged as a valuable additive in modifying the fermentation process during the ensiling of maize cobs. Rich in alkaline minerals such as potassium and calcium, wood ash enhances the fermentation environment by neutralizing acidic inhibitors and promoting the growth of beneficial lactic acid bacteria (LAB), crucial for efficient silage fermentation (Ibrahim *et al*., 2023).This pH modulation accelerates the breakdown of lignocellulosic components, improving microbial accessibility and fermentation quality (Ogunlade and Adepoju, 2021). In Nigeria, where wood ash is readily accessible and economically feasible, its application in ensiling not only improves silage conservation but also contributes to enhanced nutritive value, making it a practical intervention in rural and smallholder livestock production (Goke, 2020).

Ensiling maize cob is important for enhancing feed security, especially in regions with seasonal feed shortages like Nigeria. By converting maize cob into silage, farmers can preserve nutrient content and improve palatability, thereby extending the availability of a vital roughage source throughout the year (Goke, 2020).The process promotes partial hydrolysis of complex fibres and increases digestibility by rumen microbes, leading to improved animal productivity.(Kung,L.,Jr.,*et al.* 2018)Moreover, ensiling reduces wastage and environmental pollution associated with maize residue disposal, aligning with îsustainable agricultural practices.

1.2 JUSTIFICATION OF STUDY

Maize cobs are an abundant, underutilized agricultural by-product of the global maize value chain. In mixed crop livestock systems especially across sub-Saharan Africa crop residues already supply a large share of ruminant diets during the dry season, yet cobs are often discarded or burned despite their year round availability and low or zero purchase cost to smallholders (thereby representing a missed, locally available roughage source) (Amole and Ayantunde, 2021, Balehegn *et al.,* 2022 and Ogunade *et al .,*2021). However, the direct incorporation of untreated maize cobs into livestock rations is severely constrained by inherent nutritional limitations. These challenges include a low crude protein content (often below 5%), high lignin and cellulose fractions, poor digestibility, and limited palatability , which restrict their direct use in ruminant diets without treatment (Njideka *et al.,* 2020,Goke, 2020 and Adejoro, 2019). Converting cobs into safer, storable, and more digestible feed would add value to existing residue streams, help smooth seasonal feed gaps, and reduce dependence on expensive concentrates. This is important where forages quantity and quality both decline sharply from rainy to dry seasons and where affordable, conserved feed is chronically scarce. Ensiling crop residues is widely cited as a practical pathway to bridge that gap for smallholders.

Ensiling technology offers a practical solution to these challenges, particularly in Nigeria where seasonal feed shortages are pervasive and limit consistent livestock productivity (Kubkomawa *et al.,* 2015). Ensiling allows for the fermentation and preservation of moist forages and crop residues like maize cobs by creating anaerobic conditions that stabilize the biomass, reduce spoilage, and enhance nutrient availability.

Wood ash is rich in minerals such as calcium, potassium, and magnesium which can act as buffers and provide essential nutrients that support the proliferation of beneficial fermentative microbes (Olaniran, 2023 and Okoli *et al.,* 2015). Moreover, wood ash is affordable and readily available locally in many Nigerian rural and urban areas where firewood is a common energy source, making it a sustainable alternative to commercial silage additives that are often expensive and less accessible (Ojeniyi and Iderawumi, 2020, Adejoro, 2019). Its alkaline nature may help buffer silage acidity and enhance fermentation quality, supporting better nutrient retention and improved physical characteristics of the silage. Utilizing wood ash aligns with sustainable resource use by adding value to an agro-industrial by-product and reducing environmental pollution from indiscriminate ash disposal (Njideka *et al.,* 2020 and Ojeniyi, 2020).

1.3 OBJECTIVE

The aim of this study was to evaluate the impact of a short term (14 days) ensiling phase on the chemical and physical characteristics of maize cobs treated with wood ash extract, with emphasis on their potentials as feed resource for monogastric animals Specifically, the study seeks to:

1. determine the effect of wood ash extract during this ensiling interval on the chemical composition of maize cobs focusing on dry matter, ash , Ether extract,crude protein, crude fiber, nitrogen free extract and minerals content;

2.analyze the physical properties of maize cobs after the 14 days ensiling; and

3. Interpret the combined chemical, fermentation, and physical changes in relation to the nutritive value and feeding potential of wood-ash-treated maize cob silage as a feed ingredient for monogastric diet.

CHAPTER TWO

2.0 LITERATURE REVIEW.

2.1 MAIZE COBS AS AN AGRICULTURAL BY-PRODUCT.

Maize,(*Zea mays L.*)is one of the most important cereal crops in Nigeria and across sub-Saharan Africa, providing both staple food with substantial production volumes, thus generating sizable quantities of cobs estimated at approximately 180 to 200 kg per ton of maize grain harvested (Goke, 2020). It plays a central role in both human and livestock diets. Beyond the grain, maize production generates large amounts of crop residues such as stover, husks, and cobs. These residues can constitute a significant portion of the total plant biomass, with the cobs alone representing a substantial by-product (FAO,1997).These resources are often underutilized, frequently discarded or burned as waste, contributing to environmental pollution and loss of potential feed resources (Oluwafemi *et al.,* 2020 ,Adegbola *et al.,* 1998 ,Amole and Ayantunde 2021). Their availability all year round, especially after harvest, makes them an accessible, low-cost feed option in smallholder and commercial farming systems. The nutritional potential of maize cobs as ruminant feed has gained increasing attention, particularly in developing countries where conventional feed ingredients often remain expensive and sometimes inaccessible to smallholder farmers (Goke, 2020). However, maize cobs possess limitations including low crude protein content, high lignocellulosic fibre fractions, and low digestibility, which challenges their direct use as feed (Uchegbu *et al.,* 2009 and Adejoro *et al.*, 2019)).But When properly processed, maize cobs can provide valuable dietary fibre and energy for livestock, especially during periods of feed scarcity (Adejoro *et al.,* 2019 and Lamidi *et al.,* 2010 and Akinbamijo *et al.,* 2002).In the Nigerian where agricultural by-products are generated in substantial quantities across the maize-producing regions from Sokoto to Enugu, the processing of maize cobs could significantly enhance livestock productivity while reducing environmental waste. The conversion of these by-products into valuable animal feed aligns with sustainable agricultural practices and circular economy principles, potentially reducing the dependence on imported feed ingredients and improving the economic viability of smallholder farming operations (Adejoro *et al.,* 2019, Balehegn *et al.*, 2022, Amole and Ayantunde, 2021).

2.2 NUTRITIONAL LIMITATIONS OF MAIZE COBS AS LIVESTOCK FEED.

Despite their abundance, maize cobs are nutritionally constrained as livestock feed. They are characterized by low crude protein content usually ranging between 2–4%, high crude fibre fractions, and substantial lignification, which limit digestibility and voluntary intake (Babayemi, 2007 and Olorunnisomo, 2011). The high levels of neutral detergent fibre (NDF)and acid detergent fibre (ADF) content value often exceeding 600g/kg and 400g/kg dry matter respectively which reduce the energy available to Animal (Adejoro *et al.,* 2019 and Goke 2020).while the lignin–cellulose and lignin–hemicellulose complexes resist microbial breakdown in the rumen. The lignification of this fibre component creates a physical barrier that impedes microbial attachment and degradation in the rumen, resulting in reduced nutrient availability and voluntary intake by animals. Additionally, maize cobs contain low crude protein below 50 g/kg dry matter, which is insufficient to meet the requirements of ruminants without substantial protein supplementation. These factors often result in low voluntary intake and poor animal performance when maize cobs are fed untreated .necessitating supplementation with energy and protein rich feeds (Akinfemi and Adesanya, 2008). Palatability is another challenge, as the coarse texture and poor aroma of untreated cobs limit feed acceptance also the structural carbohydrates in maize cobs, including cellulose and hemicellulose, are tightly bound with lignin through ester linkages, forming a complex matrix that resists enzymatic hydrolysis in the digestive system of animals (Adejoro *et al.,* 2019). These limitations highlight the need for value addition through appropriate processing or preservation methods that can improve their nutritive potential..

2.3 ENSILING AND EFFECT ON CROP RESIDUES

Ensiling is a biological conservation method or preservation technique that relies on the anaerobic fermentation of water-soluble carbohydrates by lactic acid bacteria, leading to acid production and pH reduction to stabilize nutrients (Huang *et al.,* 2021;

Goke, 2020). It has been widely applied to various forage crops and agricultural by-products. Ensiling involves the anaerobic fermentation of plant materials by lactic acid bacteria (LAB). The lactic acid fermentation process during ensiling lowers pH, inhibits spoilage organisms, and can improve digestibility by partially breaking down fibrous cell walls (Huang *et al., 2*021; Goke, 2020).This acidic environment effectively stabilizes the nutritive value of the ensiled material, preventing undesirable proteolysis and preserving energy nutrients that would otherwise be lost through oxidative processes (Adejoro *et al.,* 2019). Ensiling has been shown to improve palatability and sometimes digestibility by softening tissues and modifying structural carbohydrates, thus enhancing digestibility (Lamidi *et al.*, 2010; Adejoro *et al.*, 2019; Goke, 2020).The production of volatile fatty acids and other fermentation products during ensiling also improves the aroma and taste of the material, potentially increasing voluntary intake by animals. These beneficial effects make ensiling a particularly valuable approach for improving the utilization of maize cobs in ruminant nutrition, especially in resource constrained agricultural systems where access to more sophisticated processing technologies may be limited and also extends storage life, ensuring feed availability during scarcity (Chaple *et al.,* 2015 and Okeke *et al.,* 2022). Recent studies have begun to quantify these levers, showing that cobs as been silages or cob mixtures can achieve acceptable pH and acids while improving feed availability in smallholder systems (Tinat *et al.*, 2024). The lactic acid fermentation process during ensiling lowers pH, inhibits spoilage organisms, and can improve digestibility by partially breaking down fibrous cell walls (Huang *et al., 2*021; Goke, 2020). For fibrous materials like maize cobs, ensiling can initiate a beneficial breakdown of complex cell wall structures, potentially improving digestibility and nutrient availability. This technology is vital for smallholder farmers, as it allows for the conservation of feed during periods of plenty for use during dry seasons, thereby mitigating the effects of feed scarcity on livestock productivity and body condition (Okeke *et al.,* 2022).

2.3.1 THE NEED FOR VALUE ADDITION.

The mechanical properties of maize cobs significantly impact their process-ability and incorporation grinding into animal feeds, as their microstructure determines how they respond to size reduction operations like and milling. Processing and preservation enhance the feeding value of maize cobs and related crop residues. Physical processing such as grinding improves particle size and intake but has limited effect on fibre digestibility. Biological methods, including fungal inoculation, are effective but not widely accessible to smallholder farmers due to cost and technical requirements (Akinfemi, 2010). Chemical treatments, particularly alkali based methods, have been widely studied for their ability to disrupt lignin–hemicelluloses linkages and enhance digestibility (Sarnklong *et al.,* 2010). Ensiling remains one of the most practical approaches because it combines preservation with biochemical modification, ensuring that residues can be stored and fed during scarcity periods (Olorunnisomo, 2011).

2.4 ALKALINE TREATMENTS AND WOOD ASH EXTRACT APPLICATION

Alkaline treatments have emerged as effective chemical processing methods for improving the nutritive value of fibrous crop residues by disrupting the ester linkages between lignin and polysaccharides in plant cell walls. Alkaline agents such as sodium hydroxide, lime, or ammonia have long been used to solubilise hemicelluloses and reduce lignin interference, but they are often expensive or unsafe for smallholder systems (Sarnklong *et al.,* 2010).Wood ash extract represents a locally available, inexpensive, and environmentally friendly alternative. It is rich in potassium, calcium, and magnesium and other minerals that possesses alkaline properties when dissolved in water which not only contribute to the mineral profile of treated residues but also enhance fermentation by buffering pH and promoting microbial stability. Importantly, wood ash extract has the pH between 10 and 12 creating a sufficiently alkaline environment which gives ability to break ester bonds between lignin and hemicelluloses , thereby improving fibre degradation and digestibility (Oluwafemi *et al.,* 2020). Its abundance in rural households and farming communities in Nigeria makes it a practical and sustainable additive for silage preparation (Goke, 2020).The application of wood ash extract to maize cobs before ensiling serves multiple beneficial functions. Secondly, the minerals present in wood ash extract, particularly potassium and calcium, contribute to buffering capacity during ensiling, moderating the pH decline and potentially creating a more favourable environment for certain beneficial microbial populations. Thirdly, these minerals supplement the dietary mineral content of the resulting silage, potentially addressing mineral deficiencies that might otherwise limit animal performance (Adejoro *et al.,* 2019).The buffering effect of wood ash minerals against acidification can moderate pH fluctuations, promoting more stable fermentation (Adekayode and Olojugba, 2010). The combined effect of these actions makes wood ash extract treatment a valuable value addition strategy for enhancing the utilization of maize cobs as livestock feed in Nigerian smallholder farming systems. Its availability from household and farm activities makes it a practical, environmentally friendly additive, especially in rural Nigerian communities (Goke, 2020).

2.4.1 SIGNIFICANCE OF THE SHORT-TERM ENSILING PERIOD.

The early fermentation period is strategically chosen because it is when the most significant biochemical and microbial changes occur, soluble carbohydrates are rapidly metabolized, organic acids are produced, and the pH declines sharply to stabilize the silage (Goke, 2020,Li *et al.,* 2020 and Huang *et al.,* 2021). During this interval, lactic acid bacteria dominate, producing sufficient acids to lower the pH (McDonald *et al.,* 1991, Olorunnisomo, 2011). Most ensiling studies emphasize the importance of these initial period as the critical stage for fermentation, biochemical changes, the utilization of water soluble carbohydrates, accumulation of organic acids, stabilization of protein, and modification of fibre fractions take place largely within this period. Evaluating maize cobs treated with wood ash extract at this stage therefore logical, as it allows assessment of the effectiveness of fermentation and alkali treatment in improving their chemical composition, physical quality, and potential feeding value. During the early ensiling , lactic acid bacteria become established as the dominant microbial population, outcompeting undesirable microorganisms, driving the pH decline that ensures silage preservation .protein content begins to increases due to microbial synthesis, while fibre components undergo partial degradation, enhancing digestibility (Uchegbu *et al.,* 2009; Akinbamijo *et al.,* 2002).The combination of wood ash extract and ensiling has the potential to address the challenges of poor nutritive value and preservation of maize cobs. Alkali treatment modifies the fibre matrix, while ensiling ensures long term storage and enhances palatability . Alkaline treatment prior to ensiling improves fermentation efficiency by increasing substrate accessibility to microbes and providing minerals that buffer and stabilize the system (Oluwafemi *et al.,* 2020). Focusing on the Short -Term ensiling duration allows researchers to capture the most substantial treatment effects while maintaining practical relevance for farmers who may require relatively short processing periods. Additionally, this shorter ensiling duration aligns with the operational activities of many smallholder farmers in Nigeria, who often require flexible feeding strategies that can respond to seasonal variations in feed availability (Adejoro *et al.,* 2019 and Goke, 2020).

2.5 CHEMICAL CHANGES DURING ENSILING OF MAIZE COBS.

Chemical composition (dry matter, crude protein, non-structural carbohydrates, NDF/ADF/ADL, minerals).On average, maize cobs contain approximately 30.2 g/kg dry matter (DM) of crude protein, 45.3 g/kg DM of ash, and 7.5 g/kg DM of ether extract, values substantially lower than those observed in conventional fibre sources like wheat bran .The fibre components are notably high, with neutral detergent fibre (NDF) and acid detergent fibre (ADF) averaging 816.4 g/kg DM and 520 g/kg DM respectively, creating physical limitations on intake due to their bulk density and water-holding capacity. The mineral content varies considerably depending on factors such as cultivar, soil type, climate conditions, and stage of maturity at harvest, with implications for both nutritional value and process-ability . The low protein and high fibre content collectively contribute to reduced palatability and digestibility when incorporated into animal diets without appropriate pre-treatment. Predicates fermentation kinetics and, ultimately animal response. Research shows that biological or chemical pre-treatments of cobs/husks can reduce fibre fractions and adjust anti-nutritional factors, thereby improving their suitability as feedstock for fermentation and feeding (Ibaze *et al.,* 2022). The most notable chemical changes begin with the fibre fractions. The application of wood ash extract, rich in potassium and calcium hydroxides and carbonates, initiates a partial alkaline hydrolysis of the lignocelluloses matrix. The pH reduction limits spoilage bacteria and favours lactic acid bacteria, enhancing preservation (Goke, 2020). Crude protein contents typically increase due to microbial protein synthesis and fermentation by products, improving the nutrient profile (Uchegbu *et al.,* 2009). Concurrently, the solubilisation and partial degradation of cellulose, hemicelluloses , and lignin reduce crude fibre, which improves the digestibility and intake of maize cob silage (Akinbamijo *et al.,* 2002).This results in a significant reduction in neutral detergent fibre (NDF) and acid detergent fibre (ADF) values, as the hemicelluloses and cellulose fractions are solubilised (Adejoro, 2019). Crucially, the treatment effectively reduces the lignin content by disrupting the ester bonds linking lignin to hemicelluloses, thereby increasing the potential digestibility of the fibre (Olaniran,2019).Wood ash treatment synergistically facilitates these changes by alkali induced fibre swelling and disrupting lignin carbohydrate complexes, thus accelerating fermentation and nutrient release (Adegbola *et al.,* 1998). Crude protein content in maize cobs is inherently low, often between 2 and 4%,during this period, the apparent protein concentration can increase slightly on a dry matter basis due to solubilisation of structural carbohydrates and stabilization of nitrogenous compounds .The elevated initial pH from the ash extract suppresses the activity of Proteolytic bacteria, leading to lower ammonia N (NH_3N) concentrations compared to untreated silage, indicating superior protein preservation and reduced nitrogen losses (Adejoro, 2019).According to Goke

(2020), the addition of wood ash extract enhances this protein increment by supplying minerals that support microbial growth and activity. Fibre fractions, notably Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), and lignin, decrease as fermentation progress. This means that even though maize cobs remain a protein deficient feed, ensiling with WAE enhances nitrogen retention compared to untreated silage (Olorunnisomo, 2011 and Goke, 2020). The pH and buffering capacity are influenced, While the initial pH is higher, the PH decline during ensiling due to the lactic acid bacterial (LAB) accumulation, signifying effective fermentation .The high mineral content, particularly carbonates, confers a strong buffering capacity, preventing drastic pH swings and ensuring fermentation stability (Olaniran, 2019, Adekayode and Olojugba, 2010).Ensiling without WAE causes some softening of tissue but does not substantially reduce fibre bound lignin, making WAE treated silage more digestible and nutritive (Oluwafemi *et al.,* 2020).The pH trajectory during the first 14 days is decisive for silage stability. In untreated maize cob silage, rapid lactic acid production reduces pH to around 3.8–4.5. In WAE treated cobs, the buffering minerals initially raise pH, but lactic acid bacteria still dominate the fermentation and eventually lower the pH into a safe preservation range of 4.1 - 4.6 and is accompanied by a higher proportion of acetic acid, which enhances aerobic stability upon feed out. Notably, butyric acids are virtually absent, indicating successful inhibition of Clostridial activity, while ethanol production is minimized (Adejoro, 2019). This balance ensures good preservation while limiting excessive acidity that could impair microbial activity in the stomach (McDonald et al., 1991). WAE also enriches the mineral content of maize cobs. Ash and mineral content is substantially augmented. The silage is enriched with potassium (K), calcium (Ca), and magnesium (Mg) leached from the wood ash, transforming the cobs from a mineral poor residue into a mineral supplemented feed, which can contribute to the dietary mineral requirements of animal.

Potassium is most abundant, with calcium and magnesium contributing significantly to the ash fraction. These minerals improve rumen buffering capacity and fermentation but can create risks if inclusion levels are not managed carefully. For instance, excessive potassium may interfere with magnesium absorption in dairy cows, so feed formulation must account for these changes (Goke, 2020).Fermentation products after 14 days typically show a favourable profile in well preserved silage. Lactic acid is the dominant fermentation acid, with moderate acetic acid, low ethanol, and trace or absent butyric acid. Ammonia N values remain low, indicating controlled proteolysis. The presence of WAE does not inhibit fermentation but modifies the conditions, resulting in stable silage with good preservation quality (Olorunnisomo, 2011).

2.6 PHYSICAL CHANGES DURING ENSILING OF MAIZE COBS.

Maize cobs exhibit complex mechanical properties that influence their process-ability and functionality as feed ingredients. Micro-structural analysis reveals that maize cobs possess a heterogeneous, multiphase composition with varying density gradients along their axial cross-section .These mechanical properties significantly influence the energy inputs required for size reduction processes like grinding and milling, which are necessary to increase the surface area available for microbial attachment and enzymatic degradation during digestion. Force /compaction matter because porosity and bulk density dictate how quickly oxygen is excluded, a prerequisite for lactic. Physical attributes such as texture, colour, and aroma signal the progress and quality of maize cob silage. Maize cobs undergo structural softening during the 14day ensiling period as cell wall components break down enzymatically and microbially, with wood ash treatment accelerating this process via alkalimediated fibre swelling and lignin disruption (Lamidi *et al.,* 2010 and Goke, 2020). The cobs become more pliable and less abrasive, which encourages feed intake and reduces the risk of impaction in animals (Adejoro, 2019). Visually, the silage develops a uniform, pleasant brownish-green colour, a sign of good preservation, as opposed to the grey or black discoloration often associated with spoilage and mould growth in poorly preserved untreated silage (Olaniran, 2019). The odour of the final product is a sharp, pleasant, and vinegar-like aroma due to the dominant acetic acid, with no detectable putrid or rancid smells. This means that that there is an improvement in palatability, as animals typically show a marked preference for the treated silage. The moisture content is effectively managed by the absorbent properties of the wood ash, which helps bind excess moisture, reduce effluent loss, and facilitate better compaction to expel oxygen, creating an optimal environment for anaerobic fermentation (Adejoro, 2019).The combined effect of these physical changes is improved palatability, greater animal acceptance, and safer longterm storage of maize cobs .

2.7 COMPARATIVE EFFECT OF WOOD ASH EXTRACT.

When comparing maize cobs ensiled with and without wood ash extract, the extract significantly enhances microbial activity by supplying essential minerals and buffering silage pH, leading to faster and more stable fermentation (Muck 2010). Untreated maize cob silage often undergoes a hetero-fermentative process dominated by entero-bacteria and yeasts due to its low water-soluble carbohydrate content, resulting in high pH, substantial protein degradation (high ammonia N), and energy losses as heat and gas (Olaniran, 2019).In contrast, WAE treated cobs show greater solubilization of hemicellulose, softer texture, and enhanced fermentation stability due to the buffering effect of minerals. These changes create a silage with higher nutritive potential and improved handling characteristics compared to untreated controls (Oluwafemi*et al.,* 2019; Goke, 2020).Preservation quality also improves by lower pH, reduced spoilage markers, and better retention of nutrients such as crude protein and minerals in wood ash treated silage (Adekayode and Olojugba, 2010). Nutrient retention is higher due to decreased protein degradation and fibre breakdown favouring digestibility, contrasting with untreated silage where slower fermentation may permit losses and off flavours (Uchegbu *et al.,* 2009). Wood ash thus acts as an effective silage additive both improving microbial ecosystem functionality and contributing nutritional minerals.

2.7.1 PRACTICAL IMPLICATIONS FOR LIVESTOCK FEEDING

The treatment of maize cobs with wood ash extract (WAE) reduces fiber content and improves nutrient availability, enhancing their suitability as a feed ingredient for monogastric animals like poultry and swine (Lin et al., 2020). The alkaline process partially breaks down lignocellulosic bonds, making structural carbohydrates and proteins more accessible to digestive enzymes, thereby improving energy and amino acid availability compared to untreated cobs (Adejoro, 2019; Abdulazeez et al., 2020). Furthermore, WAE treatment enriches the cobs with valuable minerals such as calcium, potassium, and magnesium, which are essential for bone development, eggshell formation, and enzymatic functions (Babalola et al., 2020). However, significant limitations must be acknowledged. The monogastric digestive system remains inherently inefficient at utilizing high-fiber feeds (Jha & Berrocoso, 2015). Consequently, inclusion rates must be carefully controlled to avoid diluting dietary energy density. Suggested levels are 5–10% for grower-finisher swine and 3–7% for poultry, introduced gradually in a finely ground form (Adejumo, 2020)."

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 EXPERIMENTAL SITE: This study was conducted at the Animal Science Laboratory, Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria. The laboratory is located at latitude 6°20'N and longitude 5°37'E, with an altitude of approximately 78 meters above sea level. Benin City experiences a tropical climate with average annual rainfall 2000-2500mm and mean temperature ranging between 25°c and 28°c.

3.2 SOURCE OF MATERIAL

3.2.1 Maize Cobs

Maize cobs were obtained maize cob vendors at New Benin market, Benin City, Edo State. The cobs were collected immediately after shelling of maize grains to ensure freshness. Only clean, undamaged cobs free from mold contamination were selected for the study. The maize variety used was the commonly grown yellow maize hybrid in the region.

3.2.2 Wood Ash

Wood ash was sourced from food vendors in Edo State. The wood ash was sieved through a 2mm mesh to remove large particles and debris, and stored in airtight container prior to extraction

3.2.3 Preparation of Wood Ash Extract

One kilogram (1kg) of sieved wood ash was mixed with 10 litres of clean water in a plastic container, giving a ratio of 1:10. The mixture was stirred thoroughly and allowed to stand for 24hours at room temperature with intermittent stirring every 6 hours. After 24 hours, the mixture was filtered through a clean cloth to obtain a clear extract . The extract was stored in plastic containers.

3.3 EXPERMINENTAL DESIGN AND TREATMENTS

The maize cobs were ensiled with different quantity of wood ash extract.

Treatment 1 (UMC): this was untreated ground maize cobs (250g) not soaked in water. It served as the control

Treatment 2 (WMC): This was ground maize cobs (250g) soaked in 1 litre of clean water for 30 minutes, then thereafter sieved and sundried.

Treatment 3 ($MCWAE_{250ml}$): This was ground maize cobs (250g) soaked in 1 litre of clean water for 30 minutes, then thereafter sieved and ensiled in 250mls of wood ash extract for 14 days and sundried.

Treatment 4 ($MCWAE_{500ml}$) This was ground maize cobs (250g) soaked in 1 litre of clean water for 30 minutes, then thereafter sieved and ensiled in 500mls of wood ash extract for 14 days and sundried.

3.4 ENSILING PROCEDURE

3.4.1 PREPARATION OF MAIZE COBS

The maize cobs were first broken manually into smaller pieces then was grinded with milling machine.

3.4.2 SOAKING PROCESS

For treatment involving water (WMC), the grinded maize cobs were placed in plastic containers and covered with clean water at a ratio 1:2 (w/v). For wood ash extract treatments MCWAE and MCWAE, the prepared wood ash was used instead of water at different volumes 250ml and 500ml for 250grams of maize cob.

3.4.3 FERMENTATION CONDITIONS

All containers we're covered tightly with polythene sheets to create anaerobic conditions necessary for proper ensiling. The containers were kept at ambient room temperature (25-28°c) in a well ventilated room. The experiment units designated for 14-day treatments were opened after 336 hours.

3.5 PHYSICAL PROPERTIES DETERMINATION

3.5.1 COLOUR CHARACTERISTICS

Colour characteristics were assessed visually and recorded for each treatment. The observations included colour intensity (light brown, brown, dark brown) and a uniformity of colour distribution. Digital photographs were taken under standard lighting conditions for documentation.

3.5.2 TEXTURE ASSESSMENT

Texture of the ensiled products was assessed manually by feel and visual observation. The smoothness, coarseness, and physical integrity of the samples were recorded. Any signs of degradation, mold growth, or fly attraction were also documented

3.6 MINERAL ANALYSIS

Mineral analysis was conducted at the Laboratory using standard analytical procedures. Samples were first digested using the wet digestion method with a mixture of nitric acid and per chloric acid.

3.6.1 SAMPLE DIGESTION

Two grams (2 g) of each milled sample was weighed into a digestion flask. Twenty milliliters (20 ml) of a mixture of concentrated nitric acid and perchloric acid in a ratio of 3:1 (v/v) was added. The flask was heated gently on a hot plate until the solution became clear. The digest was cooled, filtered, and made up to 50 ml with distilled water.

3.6.2 MINERAL DETERMINATION

The following minerals were determined from the digest:

Nitrogen (N): Determined by Kjeldahl method and expressed in mg/100g

Phosphorus (P): Determined using the vanadomolybdate colorimetric method and expressed in mg/100g

Potassium (K), Calcium (Ca), Sodium (Na): Determined using flame photometry and expressed in mg/100g

Zinc (Zn): Determined using Atomic Absorption Spectrophotometry (AAS) and expressed in mg/100g

All mineral determinations were performed in duplicate and mean values recorded.

3.7 DATA COLLECTION

Data were collected on the following parameters for each experimental unit:

- Physical properties: moisture content, colour, and texture
- Chemical properties: moisture, CP, CF, E.E Ash, CHO
- Mineral content: nitrogen, phosphorus, potassium, calcium, zinc, and sodium

3.8 PROXIMATE ANALYSIS

Proximate analysis of experimental materials .The standard methods of analysis of theAssociation of Official Analytica lChemist (AOAC,2000) were used to determine the moisture content, dry-matter, crude-protein, ash- content, ether- extract (crudefat) and nitrogen free extract

3.8.1 MOISTURE DETERMINATION

Moisture is determined by the loss in weight that occurs when a sample is dried to a constant weight in an oven.2g each of the maize cobs treatment was weighed into a silica dish previously dried and weighed. The sample was then dried in an oven for 105°C for 24 hours, cooled in a desiccator and weighed. The drying and weighing continues until a constant weight was achieved.

Since the water content of feed varies very widely, ingredients and feeds are usually compared for their nutrient content on moisture free or dry matter (DM) basis.

%DM = 100 - %Moisture

3.8.2 ASH

Ash is the inorganic residue obtained by burning off the organic matter of feedstuff at 550+/-50°C in Muffle furnace for 6 hours. 2g each treatment sample was weighed into a pre-heated crucible. The crucible was placed into the Muffle furnace at 550+/-50°C for 6 hours or until whitish-grey ash is obtained. The crucible was then placed in the desiccator and weighed. Organic matter was determined by subtraction the value of ash from 100

% Organic matter=100 - Ash

3.8.3 ETHER EXTRACT

The ether extract of a feed represents the fat and oil in the feed. Soxhlet apparatus is the equipment used for the determination of ether extract. It consist of 3 major components: an extractor, comprising the thimble which holds the sample; condenser for cooling and condensing the ether vapor and a 250ml flask.

Procedure: 150ml of an anhydrous diethyl ether (petroleum ether) of boiling point of 40-60°C was placed in the flask. 5g of the sample was weighed into a thimble and the thimble was plugged with cotton wool. The thimble with content was placed into the extractor. The ether in the flask is then heated. As the ether varpor reaches the condenser through the side arm of the extractor, it condensed to liquid form and drop back into the sample in the thimble. The ether soluble substances were dissolved and were carried into solution through the siphon tube back into the flask. The extraction continued for 4 hours. The thimble was removed and most of the solvent is distilled from the flask into the extractor. The flask was then disconnected and placed in an oven at 65°C for 4 hours, cooled in a desiccator and weighed.

%Either extract= weight of oil/weight of samples ×100/1

3.8.4 CRUDE FIBRE

The organic residue left after sequential extraction of feed with ether can be used to determine the crude fibre. The fat-free sample materials were transferred into flasks. 200ml of pre-heated 1.25% $H_2SO_4$was added and the solution was gently boiled for about 30 minutes, maintaining constant volume of acid by the addition of hot water. The Buckner flask funnel fitted with Whatman filter was pre-heated by pouring hot water into the funnel. The boiled acid sample mixture was then filtered hot through the funnel under sufficient suction. The residue was then washed several times with boiling water (until the residue is neutral to litmus paper) and transferred back into the beaker. Then 200ml of pre-heated 1.25% Na_2SO_4 is added and boiled for another 30 minutes. It was filtered under suction and washed thoroughly with hot water and twice with ethanol. The residue was dried at 650°C for about 24 hours and weighed. The residue was transferred into a crucible and placed in Muffle furnace (400-600°C) and ashed for 4 hours, then cooled in a desiccator and weighed.

% Crude fibre= weight of CF/weight of samples ×100/1

3.8.5 CRUDE PROTEIN

Crude protein is determined by measuring the nitrogen content of the feed and multiplying it by a factor of 6.25. This factor is based on the fact that most protein contains 16% nitrogen. Crude protein is determined by Kjeldahl method. The method involves: Digestion, Distillation and Titration.

Digestion: 2g of the sample was added into a Kjeldahl flask and 25 ml of concentrated sulphuric acid, 0.5g of copper sulphate, 5g of sodium sulphate and a speck of selenium tablet were added .Heat in a fume cupboard was applied slowly at first to prevent undue frothing. Digestion continued for 45 minutes until the digesta became clear pale green. It was left until completely cool and thereafter 100ml of distilled water was rapidly added. The digestion flask was 2-3 times and the rinsing was added to the bulk.

Distillation: Markham distillation apparatus is used for distillation. Steam up the distillation apparatus was streamed up and 10ml of the digestive added into the apparatus via a funnel and allowit to boil. 10 ml of sodium hydroxide was added from the measuring cylinder so that ammonia is not lost. Distillation into 50 ml of 2% boric acid containing screened methyl red indicator was done.

Titration: The alkaline ammonium borate formed was titrated directly with 0.1N HCl. The titre value which was the volume of acid used was recorded. The volume of acid used was fitted into the formula which becames:

VA = volume of acid used

W = weight of sample

% Crude protein = %N x 6.25

3.8.6 NITROGEN FREE EXTRACT (NFE)

NFE was determined by mathematical calculation. It was obtained by subtracting the sum of percentages of all the nutrients already determined from 100.

%NFE = 100 – (%Moisture + % CF + % CP + % EE + % Ash)

NFE represents soluble carbohydrates and other digestible and easily utilizable non-nitrogenous substances in the sample.

3.9 STATISTICAL ANALYSIS

Data obtained from the experiment was subjected to an ANOVA using GENSTAT 12th edition. Means were separated using Duncan Multiple Range Test (DMRT) at significance level of $p<0.05$.

CHAPTER FOUR

4.0 RESULTS

4.1 PHYSICAL PROPERTIES OF MAIZE COB ENSILED IN WOOD ASH EXTRACT

The physical properties of maize cob ensiled in wood ash are shown in Table 1.

Table 1: Physical Composition of Ensiled Maize Cobs

Parameter	Colour	Texture	Odour
Treatment 1	Light brown	Granular	Slightly vegetal
Treatment 2	Light brown	Taupe	Slightly sweet
Treatment 3	Light brown	Coarse	Vinegar-like
Treatment 4	Brownish-green	Less abrasive	Fetid

Note: Treatment 1; UMC= Untreated maize cob, Treatment 2; WMC= Wet maize cob, Treatment 3; $MCWAE_{250ML}$ =Maize cob ensiled in wood ash extract 250ml, Treatment 4; $MCWAE_{500ML}$ =Maize cob ensiled in wood ash extract 500ml

4.2 PROXIMATEANALYSISOF ENSILED MAIZE COBS IN WOOD ASH.

The proximate analysis of ensiled maize cobs in wood are presented in Table 2.

Table 2 :Proximate Composition of Ensiled Maize Cobs

SAMPLE	MC%	CP%	E.E%	CF%	Ash%	CHO%
Treatment 1	11.93[a]	3.21[a]	0.45[c]	30.42[c]	1.55[b]	55.44[d]
Treatment 2	17.48[c]	5.53[d]	0.57[d]	29.75[b]	1.28[a]	45.39[c]
Treatment 3	17.30[b]	3.92[c]	0.43[b]	33.82[d]	1.93[c]	42.60[b]
Treatment 4	22.87[d]	3.78[b]	0.39[a]	29.62[a]	2.41[d]	40.94[a]

Note: Treatment 1; UMC=Untreated maize cobs, Treatment 2; WMC= Wet maize cobs Treatment3; $MCWAE_{250ML}$ =Maize cob ensiled in wood ash extract 250ml, Treatment4; $MCWAE_{500ML}$ =Maize cob ensiled in wood ash extract 500ml E.E =Ether extract, P = Crude protein, CF = Crude fibre, CHO = Carbohydrate content. Mean values with the same letters along the same row are not significantly different at 5% probability level ($p>0.05$).

The table presents the proximate composition of maize cobs ensiled in wood ash, showing the percentage values of key nutritional components in different treatment samples. Here's an explanation of each parameter.

Moisture (%):

This represents the water content in the sample. The treatment 1 has 11.93%, while treatment 4 have higher moisture content at 22.87% compared to treatment 2 and treatment 3 at 17,48% and 17.30% respectively, indicating greater water absorption at higher soaking level.

CP (Crude Protein, %):

This measures the total protein content, an essential nutrient for animal feed. The treatment 1 has 3.21%, but treatment 2 slightly increased at 5.527% while fermentation slightly decreased with higher soaking volume treatment 4 at 3.777% relative to treatment 3 at 3.9233% this reduction maybe due to leaching of soluble Nitrogen compound into the soaking medium.

Fat (%):

This represents the crude fat (lipid) content, which provides energy. Treatment 2 has the highest at 0.5733%, while treatment 4 has the lowest at 0.3867%, indicating that fermentation may affect the fat content.

CF (Crude Fibre, %):

Indicates the fibre content, which is important for digestion in animals. The treatment 1 has highest fibre content at 30.42%, for treatment 2 the fibre content was at 29.75% with little or no significant reduction with treatment 4 at 29.62%, showing fermentation may not have effect on fibre.

Ash (%):

This represents the total mineral content in the sample. The treatment 1 has 1.55% and 1.28% for treatment 2, while fermentation alters ash content, with treatment 4 showing 2.41%, indicating higher mineral availability.

CHO (Carbohydrates, %):

This represents total carbohydrates, calculated by subtracting protein, fat, fibre, and ash from 100%. The treatment 1 and treatment 2 has 55.44% and45.39% respectively, while the ensiled samples generally have lower carbohydrate percentages, with treatment 3 at 42.60% and treatment at 40.94%, suggesting fermentation breaks down complex carbohydrate.

4.3 MINERAL ANALYSIS OF MAIZE COB ENSILED IN WOOD ASH.

The mineral analysis of ensiled maize cob are presented in Table 3.

Table 3: Mineral Composition of Ensiled Maize Cob.

SAMPLE	N(mg/100g)	P(mg/100g)	K(mg/100g)	Ca(mg/100g)	Zn(mg/100g)	Na(mg/100g)
TREATMENT1	501,4[a]	68.79[d]	329.1[d]	87.30[c]	1.64[b]	37.91[a]
TREATMENT2	893.5[d]	42.81[c]	247.7[a]	96.5[b]	1.00[a]	39.86[c]
TREATMENT3	630.9[c]	29.64[b]	314.60[c]	117.60[d]	1.82[d]	43.20[d]
TREATMENT4	589.30[b]	25.72[a]	294.40[b]	96.20[a]	1.61[c]	39.56[b]

Note: Treatment 1; UMC=Untreated maize cobs, Treatment 2; WMC= Wet maize cobs, Treatment3; $MCWAE_{250ML}$ =Maize cob ensiled in wood ash extract 250ml, Treatment4; $MCWAE_{500ML}$ =Maize cob ensiled in wood ash extract 500ml, N = Nitrogen, P = Phosphorus, K = Potassium, Ca = Calcium, Zn =Zinc, Na = Sodium. Mean values with the same letters along the same row are not significantly different at 5% probability level (p>0.05).

The table presents the mineral composition of maize cobs ensiled in wood ash extract, showing the concentrations of key minerals in different treatment samples. Here's an explanation of each mineral parameter:

N (Nitrogen, mg/100g):

Essential for growth and development in the animals. Treatment 4 has higher Nitrogen content at 630.9 mg/100g while treatment 3 has a reduced Nitrogen content at 589.3 mg/100g indicating Nitrogen content decreases with higher soaking volume due to the mineral diffusion into the soaking medium.

P (Phosphorus, mg/100g):

Essential for energy metabolism, bone formation, and cell function. Treatment 3 has 29.64 mg/100g, while treatment 4 has the lowest at 25.72mg/100g, meaning phosphorus leached during ensiling.

K (Potassium, mg/100g):

Important for nerve function, muscle contraction, and fluid balance. Treatment 3 has 314.6 mg/100g, while treatment 4 has 294.4mg/100g, showing that fermentation increases potassium levels.

Ca (Calcium, mg/100g):

Essential for bone development and muscle function in animals. The treatment 3 has higher Calcium content at 117.6 mg/100g, while treatment 4 has the lowest at 96.2 mg/100g, indicating that calcium content decreases with higher soaking volume.

Zn (Zinc, mg/100g):

Helps in cell growth, repair and immune system support,Treatment 4 has 1,607mg/100g while treatment 3 has the highest at 1.823mg/100g indicating fermentation enhances Zinc content.

Na (Sodium, mg/100g):

Helps maintain electrolyte balance and supports nerve function. Treatment 3 has 43.20mg/100g, while treatment 4 has the lowest at 39.56 mg/100g, indicating sodium content decreases with higher soaking volume.

CHAPTER FIVE

5.0 DISCUSSION

5.1 PROXIMATE COMPOSITION OF MAIZE COB ENSILED IN WOOD ASH EXTRACT

The proximate composition of maize cob ensiled in wood ash extract at different volume (250ml and 500ml) reveals significant variations in moisture, crude protein (CP), crude fibre (CF), ash, and carbohydrate (CHO) content.

The moisture content increased significantly from Treatment 1 (11.93%) to Treatment 4 (22.87%). Treatment 1, being the unprocessed control, represents the typical low moisture of dry maize cobs. The higher moisture in Treatments 2, 3, and 4 was essential for initiating and sustaining anaerobic fermentation, as adequate moisture is critical for microbial activity (McDonald *et al*., 1991). The highest moisture in Treatment 4 can be attributed to the higher volume of wood ash extract (500ml) added, which directly increased the water content of the silage mass. Crude Protein (CP) the substantial increase in Treatment 2 (5.53%) compared to the control (3.21%) is likely due to microbial activity during fermentation. Lactic acid bacteria and other microbes can convert non-protein nitrogen into true microbial protein, effectively increasing the CP value of the silage (Kung *et al*., 2018). However, the subsequent decrease in CP in Treatments 3 and 4, especially with the highest level of wood ash extract, supports the hypothesis of leaching. The alkaline soaking solution may have caused soluble nitrogenous compounds to be lost from the cobs into the surrounding liquid, thereby reducing the final measurable CP in the solid feed (Ojewole *et al*., 2017). Similarly, the Ether Extract (fat) content though low overall as expected in a fibrous feedstuff, also showed significant changes. The highest value in Treatment 2 (0.57%) suggests that simple water soaking may have concentrated these components. The lower values in the wood ash treatments, particularly Treatment 4 (0.39%), indicate that the alkaline environment may have induced saponification, a process where fats are broken down into soap and glycerol, making them less extractable by ether and thus reducing the measured value (AOAC, 2016).

Crude Fibre (CF) shows a complex situation. Although Treatments 2 and 4 significantly lowered CF compared to Treatment 3 and the control, the reduction was less than expected from an alkaline process. The unusually high CF in Treatment 3 (33.82%) suggests its specific wood ash concentration (250ml) was either too weak to break down fibers or had a reverse effect. Conversely, the low CF in Treatment 4 confirms that alkaline treatments like wood ash effectively reduce crude fiber by breaking down hemicellulose and lignin bonds, which can enhance digestibility (Fahey and Jung, 1989). The consistent and significant reduction in total Carbohydrates (CHO) from 55.44% to Treatment 4 (40.94%) demonstrates that effective fermentation took place. This occurs because lactic acid bacteria, which are crucial for proper ensiling, use soluble carbohydrates for energy, converting them into preservative organic acids like lactic and acetic acid (McDonald *et al.,* 1991, Muck, 2010). As a result, the pH drops, safeguarding the forage. The fact that Treatment 4 had the lowest carbohydrate content confirms it experienced the most intensive and successful fermentation. The rising ash content from 1.55% to 2.41% across treatments directly shows that adding wood ash extract successfully enriches the agro-waste with minerals. This process, which leverages the natural potassium, calcium, carbonate, and phosphate in wood ash, enhances the material's nutritional value for use in animal feed (Ojiako and Onyejekwe, 2011).

5.2 MINERAL COMPOSITION OF MAIZE COB ENSILED IN WOOD ASH EXTRACT

The mineral composition of maize cob ensiled in wood ash extract at different volume (250ml and 500ml) reveals significant variations in nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), zinc (Zn), sodium (Na) content. Nitrogen (N),

The nitrogen content, which indicates protein potential, varied significantly between treatments. The simple water soak (T2) yielded the highest nitrogen, likely due to concentrated microbial protein. In contrast, wood ash treatments (T3, T4) had lower levels, with the weakest result in T4. Since crude protein is calculated as N x 6.25, this loss directly contributes to the reduced crude protein observed in the proximate analysis. This reduction is attributed to leaching of soluble nitrogen compounds into the soaking medium during ensiling. For monogastrics, this means a potential reduction in protein availability, which could negatively impact growth rates if not supplemented adequately (Goke 2020 and Adebowale 2021). The Phosphorus levels decreased from 42.81 mg/100g in control to 25.72 mg/100g at the highest soaking volume. This loss through diffusion may pose challenges in meeting the high phosphorus demands of monogastric animals. Phosphorus is vital for skeletal strength, energy transfer (via ATP), and cell membrane structure. A deficiency can lead to rickets in young animals and poor bone quality in layers. The leaching of (P), much of which is stored as phytate in plant materials, suggests that the process may be washing out this mineral regardless of its bioavailability (Bolarinwa, 2023). This would need to be balanced with inorganic phosphate supplements in the diet.

The Potassium content increase in Treatment 3 (314.6 mg/100g) compared to the control (T1) and the water-soaked sample (T2) is a direct result of potassium being added *from* the wood ash extract. However, the subsequent decrease in Treatment 4 suggests that with a higher volume of extract, the leaching effect begins to outweigh the enrichment effect for this highly soluble element. Potassium, is important for nerve function, muscle contraction, and fluid balance, a naturally potassium-enriched feed ingredient can support metabolic stability and overall health (Salami and Ocheja, 2021).

Sodium content increase in Treatment 3 shows the highest value (43.20 mg/100g), confirming the contribution from the wood ash. The drop in Treatment 4 dual role of the additive as both a mineral source and a leaching agent for soluble ions.

The highest Calcium (Ca) level was recorded in Treatment 3 at 117.6 mg/100g. This initial rise confirms that wood ash, which is rich in calcium compounds like carbonate and oxide, effectively enriched the material. The subsequent decline in Treatment 4, while surprising, can be attributed to the intricate solubility behavior of calcium under alkaline conditions. Although calcium carbonate itself is not very soluble, other forms may leach away, or the increased liquid volume could have diluted the concentration and caused physical loss (Ojewole *et al.,* 2017).

In zinc (Z) Treatment 3 resulted in a significant rise in zinc content (Zn) (1.82 mg/100g), demonstrating that the wood ash extract is a source of this essential mineral. While Treatment 4 saw a slight decrease, likely from leaching, the effect was minor compared to more soluble elements. This zinc retention is important because zinc is critical for livestock's enzymatic and immune systems (Underwood and Suttle, 1999).

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study examined the effect of short-term ensiling of maize cobs with wood ash extract on both the physical and chemical properties of this agricultural by-product. The treatment successfully implemented a fermentation process, as shown by physical changes like texture softening and the development of a vinegar-like odour. Chemically, while it caused the leaching of some water-soluble nutrients like crude protein and phosphorus, it also significantly enhanced the mineral profile, particularly for potassium and zinc, by transferring these elements from the wood ash. The reduction in complex carbohydrates suggests a partial breakdown of the lignocellulosic structure, which could potentially improve digestibility. The optimal treatment was identified as 250ml of WAE (T3), which effectively balanced mineral enrichment with acceptable nutrient retention. Therefore, the ensiling of maize cobs with a moderate amount of wood ash extract offers a viable method to upgrade this agricultural waste into a more valuable, mineral-enhanced feed ingredient, supporting sustainable livestock production by utilizing local, low-cost resources.

6.2 Recommendation

Drawing from the result of my study, I suggest that:

- Examine the potential on wood ash extract for ensiling, research on the ideal wood ash extract volume and fermentation time should be taken into consideration.

- Assess the economic feasibility of this approach at a smallholder level, examining the cost-effectiveness of processing and inclusion in livestock diet
- Research is should be caried to determine the long-term storage stability (e.g., 30, 60, 90 days) of WAE-treated maize cob silage, monitoring for spoilage, contamination, and nutrient changes over time to establish safe storage durations.
- Further studies should be carried out on different methods of reducing the fibre content of maize cobs aside using wood ash extract.

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