FACULTY OF AGRICULTURE AND ANIMAL SCIENCES

DEPARTMENT OF ANIMAL PRODUCTION AND SCIENCES

FINAL YEAR PROJECT

NUTRIENT DIGESTIBILITY OF *MORINGA OLEIFERA* SEEDMEAL RATIONS FED TO GROWER PIGS AT ARAPAI CAMPUS FARM.

BY

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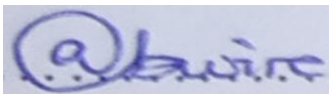
BU/UP 2020/1390

A DISERTATION SUBMITTED TO THE DEPARTMENT OF ANIMAL SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE IN ANIMAL PRODUCTION AND MANAGEMENT OF BUSITEMA UNIVERSITY

FEBRUARY 2O24.

DECLARATION

I BWIRE AUGUSTINE declare that the information presented in this dissertation is my own work and it has never been presented in this university or any other institute of higher learning for a degree award.



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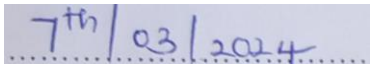

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APPROVAL

This dissertation has been submitted to the Department of Animal Production and Management, Busitema University with the approval of my supervisor.

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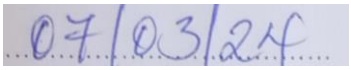

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ACKNOWLEDGEMENT

Firstly, I acknowledge the Almighty GOD for blessing me with a gift of life during my entire period of study, not limited to that but also His, favor, provision and protection up to date. My parents OUMA RICHARD and NAFULA GETURIDE for paying my school dues and encouraging me to work hard always, Academic supervisor Ms. AKURUT IMMACULATE for the guidance, counseling and corrections. My fellow classmates especially NJUBA DENIS, AWINO DOREEN, AMODING NAUME for all the financial assistance, advice and care at the university, I really respect your contributions in my life.

LIST OF ABBREVIATIONS

ADF	-	Acid detergent fiber
ADL	-	Acid detergent lignin
AOAC	-	Association of official analytical chemists
EE	-	Ether extract
FAAS	-	Faculty of Agriculture and Animal Sciences
CP	-	Crude protein
DAPM	-	Department of animal production and management
GE	-	Goss energy
MOSM	-	*Moringa oleifera* seed meal ration
NDF	-	Neutral detergent fiber
SBM	-	Soya bean meal

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ABSTRACT

Moringa oleifera is a highly valuable plant that is gaining value basing on its nutrient profile in consideration with soya bean meal a known plant protein source. However with increasing competition for plant proteins by both humans and animals, arises the need to find alternative protein sources that can substitute soya. It's upon that gap that this research aimed at finding out the nutrient digestibility of *Moringa oleifera* seed meal fed on grower pigs at Arapai farm with the objective of determining palatability and establishing nutrient digestibility of MOSM rations. An experimental design was used in conducting the research with four treatments; T1 (0%), T2 (5%), T3 (10%) and T4 (15%) MOSM inclusion rates. Three replicates were used per treatment in determination of palatability using single bowel method and it was found that there was a significant difference among treatments ,one individual pig was used in establishing the nutrient digestibility of MOSM using total collection method of fecal matter from which 10% of the daily total fecal was collected and prepared for laboratory analysis,

Results from the experiment showed that palatability was highest at (0% MOSM) control feed and increase in Moringa inclusion significantly decreased palatability. On the other hand, increase in Moringa improved both apparent and nutrient digestibility compared to control treatment digestibility. Results obtained show that partial substitution of soya with a % of Moringa significantly improved pig feed in digestibility (figure1) especially at 5% MOSM inclusion which had no negative impacts on desired qualities of palatability and digestibility of soya rather than when used as a whole protein feed.

In conclusion, inclusion of MOSM reduced feed palatability however; digestibility was generally improved. It should be noted that the optimum inclusion rate was established to be 5% as it facilitated a relatively better palatability and digestibility score.

Since this study focused on one category of pigs, I recommend that further research can be conducted on other categories of pigs as well as other animal species.

CHAPTER ONE: INTRODUCTION

1.1 Background

Moringa oleifera belongs to the monogeric family of shrubs and trees known as Moringaceae. Research shows that it originated from India found in the Asian continent(Tree & Oleifera, n.d.), thereafter it spread to the rest of the world including the tropics *(Mallenakuppe et al., 2019)*. *Moringa oleifera* is the most popular of the 13 species of Moringa and it is known by various names; " horseradish tree in Florida, malunggay in Philippines, nebeday in Senegal, benzolive tree in Haiti, drumstick tree in India *(Raja et al., 2017*).

Moringa oleifera is a fast growing deciduous tree which can grow to a maximum of about 10-12m, the trunk measuring 45cm in diameter. Tropical conditions have been found ideal for the growth of moringa oleifera (*Qaisar & Zaki, 2022)*. According to Liu (2018), all moringa parts can be utilized as food and as ethno medicine for many diseases for both humans and animals.

Moringa oleifera seeds are the reproductive part of moringa tree enclosed in a pod, the seeds are eaten raw, roasted, powdered and used as a water purifier. According to Saa *et al.*, (2019), Seeds contain 19% and 31% proteins and lipids respectively that are useful in the diets of animals. They also contain a high ratio of monounsaturated and saturated fatty acids *(Leone et al., 2016),* and a polyelectrolyte which is a coagulant *(Bichi, 2013)*. Moringa seeds are also used in cosmetics and the medical department

Moringa oleifera is a highly valuable tree with a remarkable nutritional profile. It is estimated to have 28.50%, 25.02%, 10.42% and 11.38% carbohydrates, proteins, fats and dietary fiber nutrients according to a study by Qaisar &Zaki (2022) that it adds in diets of animals (pigs). Moringa use in pig feed formulation increases daily weight gain, amino acid profile though minor contribution to the pork quality.

The tree has been also used to prevent and cure diseases that are more than 300 according to the ayurvedic traditional medicine. It has been found to have anti-inflammatory, antiasthmatic, analgesic, antipyretic *(Koul, 2015),* antifungal and antibacterial, wound healing, anticancer properties among others *(Fidrianny et al., 2021).* These uses have made the tree to be called " a

multipurpose tree" (Dubey et al., 2013), whereas others refer to it as " the tree of life" or "miracle tree" *(Sharma et al., 2020)*

In Uganda it was not until 1980s when the tree was discovered as a medicinal plant, that local media promoted its massive growth *(Kasolo et al., 2010)*. It has been noted that some commercial companies have adopted Moringa growing on large scale in Uganda e.g. Rain tree farm in Masindi district *(Batte et al., 2020)*

1.2 Problem statement

Arapai is a place located in soroti city of eastern Uganda (cattle corridor zone) practicing livestock production on large scale. Inspite of the fact that cattle are reared on large scale and depend on natural pastures*(Valentine, 2017*), other livestock ventures are also practiced like piggery. Mr. olupot Julius (arapai farm manager noted it while addressing internship students on 14th January 2022 that " piggery section is doing bad irrespective of huge profits formerly used to generate, this is due to feeding challenges." This has made small scale farmers to fail to transit to large scale production for piggery production to enjoy benefits of large-scale production.

With eminent feeding challenges for scarce and expensive proteins sources that are greatly competed for by both humans and animals that reduce production efficiency in the area has prompted research to establish alternative protein sources that can substitute soya bean meal feed sources to be conducted on various plants of which moringa was found ideal for this research as the plant can withstand harsh climatic conditions of Arapai. *Taiwo et al., (2014)* describes moringa oleifera to have considerable amounts of nutrients i.e. crude proteins, carbohydrates, fats and fibers in all its parts for animal diets and yet *Auwal et al., (201*9) reports a number of ant nutritional factors of moringa; phytates, oxalates, alkaloids, tannins that bind with other nutrients reducing their bioavailability. *Yuangsoi & Charoenwattanasak, (2015)* reports that moringa seeds had no significantly different nutrient composition with leaves on proximate analysis with proteins concentration of about 49.02% crude protein, 33.3% fats that are even higher than that of standard averages for soya that is entirely relied on in Soroti as a food crop, besides all the findings about compositions of Moringa, there is still a gap to establish palatability and nutrient digestibility of moringa oleifera seed meal rations fed on grower pigs as soya bean replacers of which this research aims to find out to help on recommending for farmers an alternative for feeding constraints.

1.3 Main objective

To evaluate the nutrient digestibility of *Moringa oleifera* seed meal rations fed on grower pigs at Arapai farm.

1.4 Specific objectives

1. To determine palatability of *moringa oleifera* seed meal ration fed to grower pigs

2. To establish the nutrient digestibility of *Moringa oleifera* seed meal rations as fed to grower pigs at Arapai farm.

1.5 Research questions

i. Is *moringa oleifera* seed meal ration palatable to grower pigs?

ii. What is the nutrient digestibility of *moringa oleifera* seed meal in grower pigs?

1.6 Significance of the study

The study was to provide information to various stake holders such as farmers, academia and other researchers about nutrient digestibility and palatability of Moringa oleifera seed meal ratio fed on grower pigs.

1.7 Rationale of the study

Pig farming being an important economical project that have short return period following the short gestation and high prolificacy nature of pigs yet they are considered as high feeders competing with humans for similar nutrients like proteins (soya bean) as the main plant proteins and yet climatic conditions of Arapai cannot continuously favor its growth. Therefore this research is of importance as Moringa can withstand this harsh conditions and be a sustainable alternative in regards to seasoned soya bean due to its ability to regrow.

1.8 Scope of the study

The study was carried out in Busitema University at Arapai campus farm found in Soroti City of Eastern Uganda. The study investigated palatability and nuturient digestibility using 12 and 4 grower intact male pigs fed on 0%, 5%, 10% and 15% MOSM rations respectively for a one month period.

CHAPTER TWO: LITERATURE REVIEW

2.1 Description of *Moringa oleifera* tree

Moringa oleifera is a deciduous tree shrub indigenous to sub-Himalayan tracts of northern India, from where it spread all over the world including serious cultivation in the tropics and subtropics (Moyo et al., 2011) after discovering its nutritional, pharmacological and other benefits (Bichi, 2013).

The tree stem has whitish-grey bark surrounded by a thick cork when mature while younger shoots have greenish-white or purplish bark. it grows to a height of 10-15m high (Feedipedia, 2016). Leaves are ovoid in shape, tri-pinnately compound and alternatively arranged on petiole with fern like appearance (Coppin, 2008). Flowers appear yellowish and creamy white with a sweet fragrant smell, petals are elongated and are white, cream or have yellow streaks in the center whereas petals are spoon like(Singh et al., 2020).

Moringa tree has dark brown globular seeds carried in hanging fruit capsules that open on drying to pass out seeds(Idris & Jami, 2016).

2.2 Ecology of moringa tree

Moringa tree grows well in a range of humid to dry climates, a wide range of soil types preferably well drained, sandy or loamy soil and with minimal growth and success in water logged clay soils according to Calm (2007). The tree is highly resistant to drought conditions and performs well in soils of PH range 5.0- 9.0 (Gopalakrishnan et al., 2016) with rainfall of around 2500-3000mm (Dubey et al., 2013). According to Anwar (2023), suitable ecological conditions are based in the tropical climate in spite of the fact that moringa can thrive also in harsh conditions.

2.3 Nutrient profile of moringa seeds

Moringa is considered the most nutrient rich plant on earth *(Ijarotimi et al., 2013)* with all its parts suited for nutritional values *(Gopalakrishnan et al., 2016*). Bichi (2013) highlights nutrients in moringa as proteins, calcium, iron, vitamin C and carotenoids that are suitable for utilization in nutrition. According to Auwal (2019), moringa contains nutrients and bioactive compounds that are necessary in feeding and treatment of diseases.

Seeds have seven essential amino acids that make them good protein alternative sour*ces (Biel et al., 2017).* Proximate composition analysis of *Moringa oleifera* seeds provides evidence for composition of macro elements such as K, Na, Mg and microelements like iron. Inclusion of MOSM in concentrated feeds for goats increased digestibility, growth performance and antioxidant property *(Leitanthem et al., 2023)* rendering vital in feeds formulation to address increasing feeding challenges.

2.4 Anti nutritional factors

Anti-nutritional factors are biological compounds present in foods that reduce nutrient utilization or food uptake. The anti-nutritional components (phytate, saponins, phenolics, tannins, and trypsin inhibitors) have been detected in moringa seeds *(Cuevas-Rodríguez et al., 2020).* Phytate was the most abundant while tannins and trypsin inhibitors were detected in smaller quantities. Auwal (2019) brings out oxalate as part of the anti-nutritional factors and describes moringa to have a bitter taste from cyanogenic glycosides.

2.5 Palatability

Despite the fact that *moringa oleifera* has considerable amounts of nutrients, it is more fibred *(Su & Chen, 2020)* and contains anti-nutritional factors such as cyanides that reduce its likeness due to a sour taste from cyanogens to animals according to Idris & Jami (2016). Antinutritional factors reduce bioavailability of nutrients.

Retardation in growth performance of rats fed on higher moringa ration inclusion could be attributed to feed intake *(Nakanishi & Iwashita, 2007).* Therefore need arises to investigate palatability and nutrient digestibility in one of the growing animal enterprises that is faced with high feeding challenges (piggery enterprise)

2.6 Applications of *Moringa oleifera* seeds

Moringa oleifera seed have been notably identified for several applications for example, medicinal applications *(Razis et al., 2014),* feed applications and industrial use in making of cosmetics, water purification *(Semanka et al., 2022*) all derived from its essential components. Not limited only on the above uses, it has been discovered to have preservation properties in the foods thus enhancing food quality assurance *(Gull et al., 2016).* With the fore mentioned nutrient

values of protein, carbohydrates, macro and micro nutrients have led to adoption of use of MOSM as an animal feed particularly addressing a challenge of limited protein sources like SBM.

Conclusion of literature review

The above data provides prove for the use of Moringa seeds in many applications including being used as animal feed due to its high nutrient composition determined to meet the increasing protein requirements. However, some research findings show inefficiency in the results obtained besides the essential nutrients which would be as a result of poor digestibility or palatability that reduce nutrient bioavailability of nutrients and low intake respectively hence need to determine both parameters and best level of inclusion of *Moringa oleifera* seed meal ration.

CHAPTER THREE: METHODOLOGY

3.1 Study area

The research was carried out at Busitema Arapai farm of Arapai sub county located along Moroto road, about 8 kilometers, by road, north of Soroti City. The coordinates of Arapai are: 1° 46' 48.00"N, 33° 37' 30.00"E (Latitude: 1.7800; Longitude: 33.6250).

3.2 Research design

An experimental design was used to establish a relationship of varying MOSM treatments on palatability using feed refusals and nutrient diigestibilty using (crude protein, fat, ADF, NDF and NFE).

3.3 Experimental design and data collection methods

A Completely randomized design (CRD) approach was used during the process of assigning treatments to the experimental units (pigs). Twelve intact male grower pigs were used in experimenting palatability, they were first fed on the control feed T1 (0%) for a period of 7days. Thereafter four treatments (T1, T2, T3 and T4) of different *Moringa oleifera* seed meal inclusions (0%, 5%, 10% and 15%) were randomly assigned to four experimental units with each unit consisting of 3 pigs for a period of 20 days.

After 20 days period, 2 extra pigs were removed per pen leaving only one pig which was used to determine nutrient digestibility. The pigs were continuously fed on their respective assigned feed for 3 days without collecting data to allow them acclimatize. After which nutrient digestibility data was collected for 7 days.

3.3.1 Experimental animals and their management

The experiment was carried out on twelve intact grower male pigs of relatively same age and breed ‘‘large white’’ housed under four different units

A cemented floor house was used for reasons of easy cleaning, disinfection and fecal collections management. Prior to commencement of the experiment, the house was cleaned and disinfected, pigs dewormed, sprayed against ecto parasites and treated with antibiotics to minimize disease

attack. Restricted feeding approach was used where pigs were fed half of their daily feed in the morning (8:00 am) and the remaining half in the evening (4:00 pm) while water given ad libitum, a total of 3kgs and 2kgs daily feed respectively for palatability and nutrient digestibility evaluation.

3.3.2 Experimental rations

Ingredient composition of the rations included, maize bran, fish meal, calcium carbonate, vitamin mineral premix, salt, varying inclusions of soya bean meal (SBM) and *moringa oleifera* seed meal (MOSM). MOSM was got from moringa processors in Soroti City while other ingredients purchased from animal feed shops within Soroti. Experimental feed formulation comprised of different inclusion rates of MOSM (0%, 5%, 10% and 15% in R1, R2, R3 and R4) as soya bean meal replacers. The formulation were made basing on standard grower pig formulation by victor pellet MILL 2023.

Ingredient composition in 100kg formulation.

Ingredient composition	T1	T2	T3	T4
Maize bran	65	65	65	65
Fish meal	12.5	12.5	12.5	12.5
Animal salt	0.5	0.5	0.5	0.5
Vitamin mineral premix	0.5	0.5	0.5	0.5
Calcium carbonate	1.5	1.5	1.5	1.5
Soya bean meal	20	19	18	17
Moringa seed meal	0	1	2	3
TOTAL	100	100	100	100

3.3.3 Palatability testing

Single-bowl test method was used and feed was weighed and offered to the animal, feed intake was determined by difference from initial feed on offer and leftovers for a period of 20 days. This was monitored under normal feeding parameters singly per day

3.3.4 Digestibility trial

Total Collection method of the dung was used. Prior to collection of fecal samples, the pigs were given three days on their assigned rations for acclimatization to the new setting after removing the other two replicates. 10% of individual total daily fresh fecal sample was collected and those from a similar treatment were pulled together to make a composite sample that was dried in a hot air oven and stored in a freezer. Both fecal and feed samples were grinded, sealed then taken for chemical analysis. Apparent digestibility was obtained as AP= Feed intake- fecal matter/ feed intake.(Tende et al., 2014.).

3.4 Chemical analysis/Proximate composition

Proximate composition of feeds and fecal matter for crude Proteins (CP), ether extract, neutral detergent fiber(NDF), acid detergent fiber(ADF) and ash content was determined according to standard procedure of association of official chemists (AOAC, 2000) described by Li et al.,(2016) The ash content was obtained by heating the sample in a muffle furnace at 550°C for 3 hours. The nitrogen content determined by the kjeldahl method and Crude protein (CP) calculated as N*6.25.Ether extract extracted using soxhlet extractor with petroleum ether, after ensuring complete extraction, petroleum ether was evaporated and the residue dried to constant weight at 105°C. NDF, ADF and ADL were determined using a method described by Van Soest et al., (1991). The Gross energy (GE) of the samples was determined using a bomb calorimeter.

3.5 Data analysis

Palatability and digestibility was subjected to analysis of variance (ANOVA) using the general linear model (GLM) procedure of SAS software. Treatment mean comparison was made using least significance difference (LSD) test. Statistical differences between means were considered at $P<0.05$

3.6 Environmental consideration.

Moringa trees were not cut down as the research used only seeds in the study to avoid negative impacts of deforestation on the ecosystem. Wastes from the experimental study were disposed into one hole to avoid scattering the environment with wastes leading to buildup of other pathogens and environmental pollution.

3.7 Ethical consideration

This research topic was submitted to the research coordinator of Faculty of Agriculture and Animal Sciences (FAAS) under department of Animals Production and Management (DAPM) who recommended it to be carried out. I diligently stuck on the core values of Busitema University while conducting my data collection and laboratory analysis. I also established a rapport with people whom I worked with to achieve the objectives of this research.

3.8 Anticipated limitations

Parasites and diseases that caused illnesses and death of pigs.

Financial constraints as a result of increased expenses and miscellaneous.

CHAPTER FOUR: RESULTS AND DISSCUSION.

4.1 Results

4.1.1 Palatability of *Moringa oleifera* seed meal (MOSM) rations fed to grower pigs

Palatability was simultaneously determined using feed refusals and observance of liking behaviors of individual pigs towards their assigned rations. Uniform amounts of 2 kilogram daily feed was used across all treatments and was fed into two shifts.

Results showed that there was no significant difference P> 0.05 with P value of 0.0579 across all treatments on palatability.

Table 1: Daily feed refusals for grower pigs fed on MOSM rations.

Day	1	2	3	4	5	6	7	mean	standard Deviation	std. error of mean
T1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000	0.000
T2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.05714	0.1134	0.044286
T3	0.5	0.4	0.3	0.2	0.2	0.0	0.0	0.1857	0.1773	0.06701
T4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.08571	0.1215	0.04592

4.1.2 Apparent Digestibility of *Moringa oleifera* seed meal rations as fed to grower pigs

Digestibility was assessed using apparent digestibility and nutrient digestibility.

To establish apparent digestibility, total fecal matter on wet basis was collected and then dried to get fecal matter on dry basis from which apparent digestibility was calculated as in table 2.

There was a significant different among treatments for crude protein, fat and NFE as their P Values were less than 0.05; P< 0.0063, 0.0140, 0.0140 respectively.

Table2: showing apparent digestibility of different treatments for a week

Treatment	FI	FM	Apparent digestibility AD = (FI-FM)/FI	%AD
T1	14	6.0	0.571	57.1
T2	13.6	5.2	0.618	61.8
T3	12.4	3.7	0.701	70.1
T4	13.6	4.9	0.639	63.9

FI= total feed intake, FM= total dry fecal matter and AD= apparent digestibility

Nutrient digestibility of MOSM

To determine nutrient digestibility of MOSM, 10% of the total daily wet fecal matter was weighed and dried in air free room to preserve nutrient composition. After drying, all the fecal sample under a similar treatment was mixed together to obtain a composite sample that was subjected to laboratory analysis.

Table3: Nutrient digestibility of MOSM based composites

	T1	T2	T3	T4
Nutrients in feed				
Crude protein	17.93	18.49	18.23	19.84
Fat	18.41	19.82	18.52	18.55
NFE	27	24.56	26.37	26.09
Nutrients in fecal matter				
Crude protein	15	13.91	12.02	14.71
Fat	15.18	11.01	12.94	11.04
NFE	1.3	7.18	8.53	6.03
Digestibility				
Crude protein	2.93	4.58	6.21	5.13
Fat	3.23	8.81	5.58	7.51
NFE	25.7	17.38	17.84	20.06
Percentage nutrient digestibility				
Crude protein	16.34	24.77	34.06	25.86
Fat	17.54	44.45	30.13	40.49
NFE	95.19	70.77	67.65	76.89

Composition of NDF and ADF in feed and fecal sample

NDF and ADF were higher in fecal sample than feed sample and were significantly different for different MOSM treatments $P<0.05$ with P values of 0.0057, 0.0206 for NDF and ADF respectively.

Table4: showing NDF and ADF nutrients in feed and fecal matter

	T1	T2	T3	T4
Nutrients in feed				
NDF	19	18	17	15
ADF	7	6	6	6
Nutrients in fecal				
NDF	26	28	27	29
ADF	10	9	10	1

4.2 DISCUSSION

Determination of Palatability of *Moringa oleifera* seed meal (MOSM) rations fed to grower pigs

During experimentation, it was observed that pigs assigned to T2 (10%) and T3 (15%) MOSM inclusion did not finish their daily feeds for a number of days as shown in table1 below and their liking behavior seemed low, this could be attributed to bitter taste caused by glucosinolates and phytates (Ebeid et al. 2022; Mahaman et al 2022) or possibly adaptation to different taste of higher Moringa inclusion rate compared to soya, a control feed caused the effect.

Firstly, palatability was highest at 0% MOSM which was the control feed, this was on observance of feed refusals and the liking response of the assigned pig towards its feed basing on feed refusals as the pig assigned to 0% ration completed all its feed in time.

Generally palatability decreased with increase in Moringa concentration replacing soya bean meal, this result is slightly in agreement with Olusanya et al., (2020) who found out that feed acceptability decreased with increase in Moringa inclusion beyond 20% for finisher pigs and explained it to be due to color and aroma of moringa. Still, palatability improved with number of days and this was attributed to adaptability of pigs to moringa.

However, Palatability was lower at 10% than 15% MOSM inclusion, this deviation could have been due to diseases that lower appetite for feeding as a pig assigned to 10% ration showed some behaviors of dullness or else due to bioactive moieties (cationic proteins) contained in Moringa that elicit antimicrobial response stronger than necessary(Hassan et al., 2023) thus affecting feeding response.

Palatability was highest at 5%MOSM inclusion which was the lowest of treatments with Moringa and this is in line with Bhokre et al., (2021) who found that 25%MOSM inclusion had superior results on digestibility (50%, 75% and 100%). This then signifies that lower inclusion of moringa is needed in formulating feeds for grower pigs in order to increase feed efficiency.

Apparent Digestibility of *Moringa oleifera* seed meal rations as fed to grower pigs

Apparent digestibility was highest with 10% MOSM inclusion and lowest with 0% (control ration), this could be due to composition of good proteins by Moringa (Bhokre et al., 2021) or low crude fiber content (structural carbohydrates) (Arise et al., 2014) that makes it easily digested compared to soya bean.

Higher apparent digestibility with 10% MOSM inclusion slightly resembles Ismail & Abdalla (2015) findings of higher digestibility within broiler birds while using a 75% MOSM than 25%, 50% and 100%. High digestibility in T3 (10%) could be attributed to mobilization of secondary metabolites of phytates found in Moringa to provide energy for enzymes to increase digestibility according to Abdel-raheem & Hassan, (2021).

Generally, an increase in digestibility with Moringa inclusion was observed and this could be due to composition of bioactive agents like mullein and riseofulvin that enhances digestion or Moringa being free from saponins, lectin, glucosides that inhibit trypsin and amylase absorption(Hassan et al., 2023).

Decrease in apparent digestibility with 15% MOSM could be due to accumulated anti-nutritional factors contained in moringa that interfere with nutrient absorption according to Ijarotimi et al., (2013)

While conducting the experiment, it was also observed that pigs that were assigned to 10% and 15% excreted watery feces. This is in line (Gao et al., 2023) who also found out that Moringa increased defecation in mice through inhibiting constipation-causing" microbiota, such as Bacteroidaceae, Clostridiaceae, Bacteroides. Excretion of watery feces had a significant effect on

dry matter (DM) as T3 and T4 had higher wet fecal matter but lower on DM basis compared to T1 and T2.

Evaluation of Nutrient digestibility of MOSM based composites

Crude protein, fat and nitrogen free extract content was tested in both fecal and feed samples to establish concentration in each sample from which net nutrient digestibility was calculated as seen in table3, it was found out that there was a significant difference in nutrient digestibility among treatments.

In this experiment, Crude protein was highly digested at 10% MOSM inclusion followed by 15%, 5% and then 0%. This does not comply with Society et al., (2017) who recorded high CP with 0% followed by 5%, 15% and then 10% instead.

However, there was a general increase in crude protein digestibility with increase in Moringa concentration, this is in correlation with Olusanya et al., (2020) findings in his study from which he reports that increase of Moringa from 2% to 6% significantly increased protein content in merino sheep. He also suspects it to be due to composition of essential amino acids by moring which are greatly needed for absorption in the body.

Meanwhile, digestibility for CP started declining after 10% with extra addition of another 5% moringa; this could be due to excess of proteins beyond optimal points of absorption or accumulated amounts of anti-nutritional compounds limiting absorption(Kasolo et al., 2010).

Control feed (0%) MOSM inclusion had the lowest crude protein just as in the study for Nasehi, (2018) when experimenting on the effects of moringa on digestibility of goats under desert conditions, this was attributed to crude fiber content of soya that reduces digestibility.

Fat digestibility was highest with 5%MOSM inclusion and lowest with 0%, overall increase in fat digestibility with introduction of moringa was observed anis in agreement with Olusanya et al., (2020) findings who in his experiment found out that moringa had good fatty acid and its inclusion generally increase fats by 50%

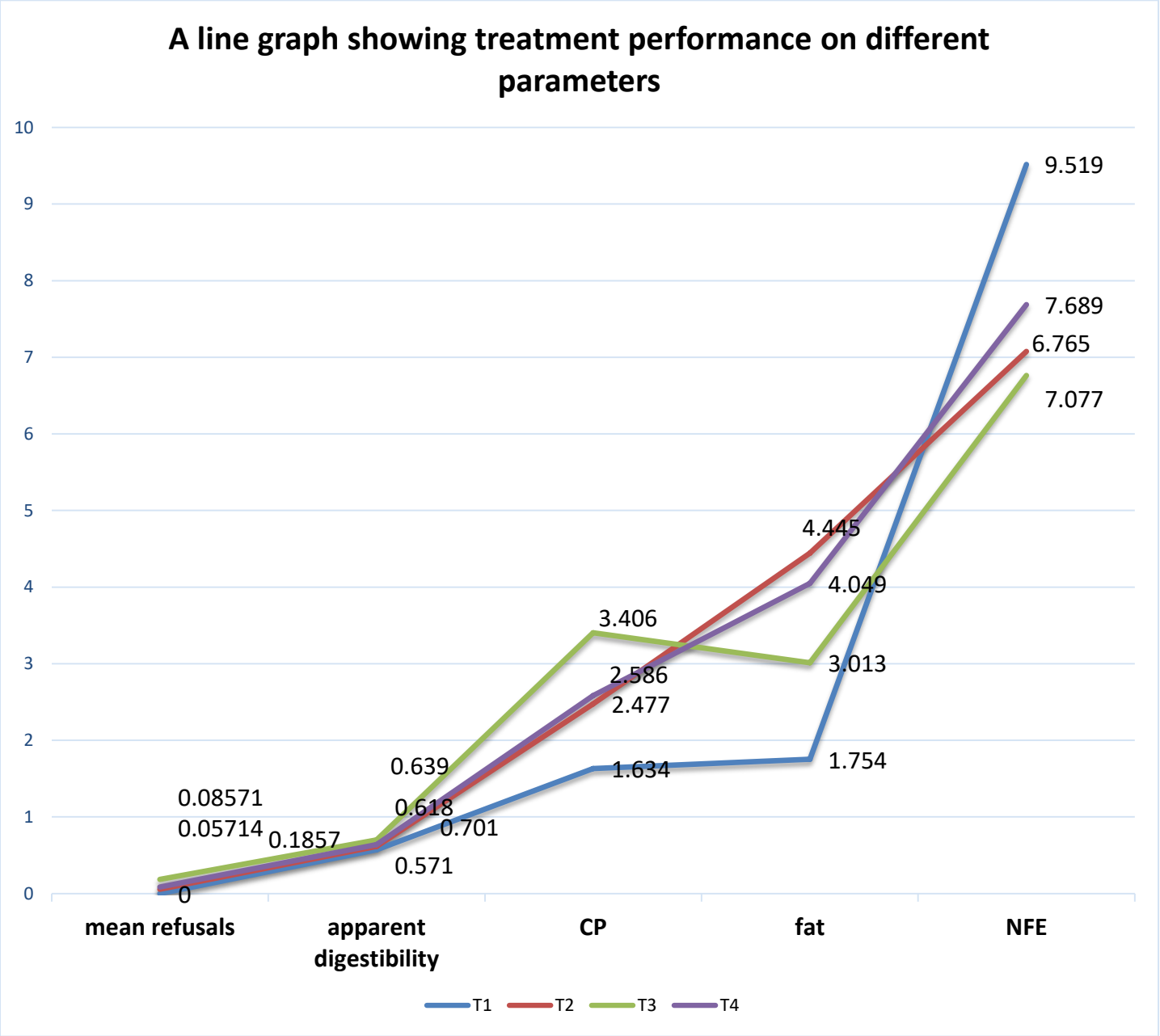
Regarding high values of NFE is because it accounts to the highest composition percentage for feeds on dry matter basis and the reason for its being low with moringa inclusion is because of higher fat content for moringa.

NDF and ADF impact on nutrients

NDF and ADF in feed was highest at 0% and decreased with increase in MOSM following 5%, 10% and 15% inclusion, NDF and ADF were higher in fecal sample than feed, this is because gross energy concentration of NDF and ADF decreases with increase in concentration of indigestible lignin in fecal matter than feed. Hindrichsen et al., 2006).

NDF and ADF concentration in feed negatively affected crude protein digestibility just as reported with (Indah et al., 2020) as high crude fiber lowers protein digestibility. NDF and ADF positively impacted NFE, this is because a percentage of hemicellulose and lignin that are a fraction of NDF appear in NFE(Fahey et al., 2019) meaning that NFE increases with NDF.

Figure1: Effect of different treatments on palatability (mean refusals) and digestibility.



T1=0%, T2=5%, T3=10% and T4=15%MOSM inclusion

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Following the nutrient composition of moringa, nutrient digestibility and palatability as discussed above, it shows that *moringa oleifera* has a non-negligible impact in formulation of grower pig rations and can be incorporated into feed formulations for grower pigs to solve a problem of feed scarcity to farmers.

5.2 RECOMMENDATIONS

The results showed that 5% MOSM inclusion as seen in figure 1 had the moderate results both in digestibility and palatability indicating that it's the best inclusion level of *moringa oleifera* seed meal ration. Therefore 5% MOSM can be advocated for inclusion into diet formulations for grower pigs to supplement on performance of soya bean meal that is already used as a plant protein.

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APPENDICES

Appendix1:showing experimental setup with three Replicates of pigs

Appendix 2: fecal sample collection process.

Appendix: feed mixing method.

Appendix4: fat extraction using soxhlet

AppendixB: Annalytical data

Proximate analysis data

	CP	Fat	Mc	Ac	CF	NFE	MEcal/kg
MB	14.66	11	7.11	12.17	15.88	39.18	1958.12
SBM	20.84	16.36	6.03	10.53	10.53	38.9	1508.96
FM	54.73	3.96	3.62	19.73	19.73	17.84	1393.92
MOSM	49.87	15.6	5.93	4.64	4.64	20.16	884.65

MB= maize bran, SBM= soya bean meal, FM= fish meal and MOSM= moringa oleifera seedmeal ration.