بسم الله الرحمن الرحيم

Sudan university science and technology

College of graduate studies

Evaluating in-vitro nutritive value and digestive coefficient of moringa (*moringa oleifera*) as diets for ruminants

(Leaves and Hulls)

تقويم القيمة الغذائية ومعامل الهضمية للمورينقا اوليفيرا

غذاءآ للمجترات (الأوراق وقشرة الثمر)

By

Sarah Kamal Hamid Mohamed

Bs.c. department of animal production- college of Agriculture studies - shambat-Sudan University of science and technology

A thesis submitted in partial fulfillment of the degree of M.S.c. in animal production

Supervisor

Dr. Ahmed Khalil Ahmed

College of Agriculture studies department of Animal production-Sudan University of Science and Technology

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الآية

قال تعالى:

(اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ* خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ* اقْرَأْ وَرَبُّكَ الْأَكْرَمُ* الَّذِي عَلَّمَ بِالْقَلَمِ عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ)

صدق الله العظيم

سورة العلق الآيات (1-5)

DEDICATION

To my parents:

To my father Kamal Hamed

To my mother Hanan Ahmed

To my brothers and sisters

Sohair, Asim ,Esmat, Radeah, Yathreb,

Mortada , Abd Al Hamed and Ahmed

With My Best Wishes

ACKNOWLEDGEMENT

I am very indebt to **Dr. Ahmed Khalil Ahmed**, my advisor for his advice, suggestions, support, careful supervision, and guidance.

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ABSTRACT

This study was conducted to determine nutritive valuale of *moringa oliefera* plant (leaves and hulls) when used in the synthesis of diets concentrates and precisely know digestive coefficient of diets containing as plant moringa source of protein primarily instead of groundnut cake in as a source of protein in intensive traditional diets. Namely: Moringa 22% ration (T1); and they contain; moringa leaves 22%, moringa hulls 15%, wheat bran 24%, sorghum 10%, groundnut hulls 15%, groundnut cake 5%, molasses 12%, limestone 1%, salt 1%. Moringa 25% ration (T2); and they contain; moringa leaves 25%, moringa hulls 15%, wheat bran 24%, sorghum 9%, groundnut hulls 10%, groundnut cake 4%, molasses 11%, limestone 1%, salt 1%. compared to these diets in terms of the level of digestive coefficient with a ration-free moringa the control ration (T) which consisted of: wheat bran 24.5%, sorghum 26%, groundnut hulls 17%, groundnut cake 12%, molasses 18%, limestone 1%, salt 1%.The coefficient tracts of three diets account (T, T1, T2) in laboratory using a method digestion in the lab ;(which is the way it is to provide an environment similar to digestion in the rumen animal laboratory). The results were obtained after digestion of the three diets in the laboratory as were follows: Control rations (T): digestive higher coefficient of (83.38%). Moringa 22% ration (T1): after the control diet digestive factor of (81.54%).Moringa 25% ration (T2): they were less digestive coefficient of (77.52%).

الملخص

أجري هذا البحث لمعرفة القيمة الغذائية الهضمية لنبات المورينقا(الأوراق والقرون) عند استخدامها في تركيب العلائق المركزة ،وبالتحديد معرفة معامل الهضمية للعلائق المحتوية علي نبات المورينقا كمصدر للبروتين بدلا عن أمباز الفول السوداني المستخدم كمصدر للبروتين في العلائق المركزة التقليدية.في هذا البحث تم استخدام ثلاثة علائق مركزه وهي:/عليقة مورينقا (22%): وكانت تحتوي علي:مسحوق أوراق المورينقا بنسبة 22%، مسحوق قشرة ثمرة المورينقا بنسبة 15%، ردة القمح 24%، فتريتة 10%، امباز الفول 5%، قشرة الفول 15%، مولاس 12%، حجر جيري 1%، ملح1%./ عليقة مورينقا (25%): وكانت تحتوي علي :مسحوق أوراق المورينقا 25%، مسحوق قشرة ثمرة المورينقا 15%،ردة القمح24%،فتريتة 9%، امباز الفول 4%، قشرة الفول 10%، مولاس 11%، حجر جيري 1%، ملح1وتم مقارنة هذه العلائق من حيث مستوي معامل الهضمية مع عليقة الكنترول الخالية من المورينقا والتي تكونت من : فتريتة 26%، ردة قمح 24.5%، امباز فول 12%، قشرة الفول 17%، مولاس 18%، حجر جيري 1%، ملح 1%تم إيجاد معامل الهضميه للثلاثه علائق (مورينقا 22% ، مورينقا 25% ،كنترول) في المعمل باستخدام طريقه يتم فيها توفير بيئة مشابه لبيئة الهضم في كرش الحيوان معمليا .وكانت النتائج المتحصل عليها بعد هضم الثلاث علائق معمليا كما يلي:عليقة الكنترول: ذات اعلي معامل هضميه بنسبة(83.38%))عليقة المورينقا22%: تلي عليقة الكنترول بمعامل هضميه (81.52%))عليقة المورينقا25%: وهي كانت اقل معامل هضميه بنسبة (77.52%)

CHAPTER ONE

1.1 Introduction

Makkar, H P S. *et al,* (1997). the *Moringa oleifera* (*M. oleifera*) is native to the sub-Himalayan tracts of north-west India, Pakistan, Bangladesh and Afghanistan.
In the Sudan, dry *Moringa oleifera* seeds are used in place of alum by rural women to treat highly turbid Nile water, **Suleyman, A. *et al,*1995.**
According to **Vijay K *et al*. (2012).** *Moringa oleifera* belongs to the family *Moringaceae* which is a single genus family of shrubs and trees cultivated across the whole of the tropical belt and used for a variety of purposes. The dry seed suspension is known to be a natural coagulant and coagulant aid.
According to **Girma G. 2004**. An animal's feed intake, and how well that feed is digested, determine the feed's production performance. The in vitro gas production technique is a relatively simple method for evaluating feeds, as large numbers of samples can be incubated and analyzed at the same time. This method has been applied successfully at UC Davis for a variety of purposes in feed evaluation, including calculating organic matter digestibility, the metabolizable energy of feeds and kinetics of their fermentation; determining how feed value is affected by added fat, antinutritive factors and rumen modifiers; quantifying the energy value of feed mixtures (rations); monitoring microbial change in the rumen; synchronizing nutrient digestion; and selecting forage nutrient targets for agricultural biotechnology. More than half of the nutrients consumed by ruminant animals leave the animal unutilized and undigested, and are excreted in feces, urine and gases. The in vitro gas production method can be used to examine animal waste components that impact the environment and develop appropriate mitigations.
(Aberra Melesse (2011). Comparative assessment on chemical compositions and feeding values of leaves of *Moringa stenopetala* and *Moringa oleifera* using in vitro gas production method. *Moringa oleifera* trees are the most commonly cultivated Moringa species in the tropics and subtropics which have the potential as alternative animal feed resources during dry periods of the tropics. However, the suitability and digestibility of leaves of both Moringa species in feeding ruminants and nonruminants under Ethiopian conditions is hardly documented

1.2 The objectives

-*Moringa oleifera* is multi-purpose tree, one of the fastest growing trees in the world, with high crude protein in the leaves (> 20 %).
- Raise the nutritional value of intensive diets used in the feeding of small ruminants and specifically (lamb).

- Easy to assess the intake, nitrogen utilization, and *in vivo* nutrient digestibility of MOR (*Moringa oleifera*).

- The good results with regard to moringa 22% because it is related to the asymptotic coefficient digestive coefficient diet and the control of economic cost is relatively low compared with the control diet.

CHAPTER TOW

2. LITERATURE REVIEW

2.1 *Moringa oleifera* Lam. [Moringaceae] and Species

The moringa (*Moringa oleifera*) tree, also known as the horseradish or drumstick tree, is native to the Himalayan foothills in India and Bangladesh. An adaptable plant, the Moringa is grown throughout India, Egypt, Africa, Pakistan, the West Indies, Philippines, Jamaica, Cuba and also Florida and Hawaii.(FAO, 2014)

Wherever the conditions are tropical or subtropical, this tree will thrive. There are over 13 species of the tree and all parts of the tree are used for food or medicine in various parts of the world. Seeds are eaten in some parts like peanuts. Leaves are commonly used for salads and have a very high nutrient value, packed with vitamins and antioxidants. (Sanchez *et al*.2006)

2. 2 Natural history, range, and growing conditions of moringa

Moringa oleifera belongs to the monogeneric family Moringaceae, which includes another 12 species of shrubs and trees (Verdcourt 1985; Olson 2002). The family Moringaceae includes species exhibiting a wide range of forms, from bottle trees to slender trees, sarcorhizal trees, or tuberous shrubs (Olson and Carlquist 2001). All these species are native to the Indian subcontinent, the Red Sea area, and parts of Africa, including Madagascar. Although moringais native to India and Pakistan (Verdcourt 1985; Morton1991; Duke 2001), it is widely cultivated, especially in dry tropical areas of the Middle East and Africa (Fahey 2005; Palada *et al*. 2007; Nouman *et al*. 2013) and more recently in many countries located within the tropics, like Nicaragua, because its pods, seeds, leaves, and roots are useful as fodder, vegetable, and plant growth enhancers(Kantharajah and Dodd 1991; Veeraragava 1998;Mughal *et al*. 1999; Anhwange *et al*. 2004, Sanchez *et al*.

2006; Nouman *et al*. 2012a, 2012b, 2013). Besides being consumed by humans, (Bennett *et al*. 2003; Gidamis *et al*. 2003), it is also used as animal fodder (Sanchez *et al*.2006; Nouman *et al*. 2013), a natural coagulant of turbid water (Suarez *et al*. 2003), and a source of phytomedical compounds (Anwar *et al*. 2006).Moringa is a drought tolerant plant that can be grown in diverse soils, except those that are waterlogged. Slightly alkaline clay and sandy loam soils are considered the best media for this species due to their good drainage (Ramchandran *et al*. 1980; Abdul 2007). *M. oleifera* does not grow properly under waterlogged conditions as its roots get rotten (authors' personal observation). This species can tolerate water with an electrical conductivity(EC) of 3 dS m–1 during its germination phase, while at later stages its resistance to saline water increases (Oliveira *et al*.2009). Once it has established itself, its strong antioxidant system helps it to cope with moderate saline conditions (EC: 8 dS m–1), experiencing only a mild reduction in its mineral quality (Nouman *et al*. 2012b).

Thus, moringa can be grown in versatile conditions including hot, humid, dry tropical, and subtropical regions, except for waterlogged conditions. It can perform better under marginal conditions with ample nutritional quality.

2.3 Description

Moringa (*Moringa oleifera* Lam.) is a multipurpose tropical tree. It is mainly used for food and has numerous industrial, medicinal and agricultural uses, including animal feeding. Nutritious, fast-growing and drought-tolerant, this traditional plant was rediscovered in the 1990s and its cultivation has since become increasingly popular in Asia and Africa, where it is among the most economically valuable crops. It has been dubbed the "miracle tree" or "tree of life" in popular media (FAO, 2014; Radovich, 2009; Orwa *et al*., 2009; Bosch, 2004).

2.4 Morphology

Moringa is a small to medium evergreen or deciduous tree that can reach up to 10-12 m. It has a spreading open crown, typically umbrella-shaped. The roots are deep. The bowl is crooked, generally one-stemmed but sometimes forked from the base. The bark is corky and grey. The branches are fragile, drooping, bearing feathery foliage. Young twigs and shoots are shortly and densely haired, purplish or greenish white. Moringa leaves are alternate, 7-60 cm long, trip innately compound with each pinnate bearing 4-6 pairs of leaflets that are dark green, elliptical to obviate, 1- 2 cm in length. The inflorescences are 10-20 cm long, spreading panicles bearing many fragrant flowers. Moringa flowers are pentamerous, zygomorphic, 7-14 mm long and white to cream in color. The fruit is a typically 3-valved capsule, 10 to 60 cm in length, often referred to as a “pod” and looking like a drumstick (hence the name "drumstick tree"). The fruit is green when young and turns brown at maturity. The mature fruit splits open along each angle to expose the seeds. The capsule contains 15-20 rounded oily seeds, 1-1.5 cm in diameter surrounded by 3 papery wings, up to 2.5 cm long. Moringa seeds contain a large amount of oil (FAO, 2014; Radovich, 2009; Orwa *et al*., 2009; Bosch, 2004, Foidl *et al*., 2001).

2.5 Growing Moringa trees

Moriga trees grow best in temperatures between 77 and 86 degrees Fahrenheit and will tolerate some light frosts. Moringa prefers well-drained sandy or loam soil with a neutral ph. level. Though it tolerates clay soil, it cannot be water logged. Choose a sunny location for the tree. You should plant moringa seeds an inch deep, or you can plant branch cuttings in a hole that is at least one foot deep. Space multiple trees about five feet apart. Seeds sprout readily in one or two weeks, and cuttings will normally establish within this same time period. (Olson and Carlquist 2001).

2.6 Uses of Morniga

2.6.1 Food uses

All parts of moringa are consumed as food. The plant produces leaves during the dry season and during times of drought, and is an excellent source of green vegetable when little other food is available (FAO, 2014). Moringa is mainly grown for its leaves in Africa, and much appreciated for its pods in Asia (Bosch, 2004). Leaves, pods, roots and flowers can be cooked as vegetables. The roots have been used as a substitute for horseradish but may be slightly toxic. The leaves are very nutritious and rich in protein, vitamins A, B and C, and minerals. They are highly recommended for pregnant and nursing mothers as well as young children (FAO, 2014). They are generally cooked (boiled, pan-fried) and eaten like spinach or put in soups and sauces. Moringa leaves are eaten as a salad or dried and ground to make a very nutritious leaf powder. Moringa leaf powder is used for the re-nutrition of infants suffering from malnutrition. Moringa flowers are used to make tea, added into sauces or made into a paste and fried. The young pods are prepared and taste like asparagus. Older pods can be added to sauces and curries in which their bitterness is appreciated (FAO, 2014; Radovich, 2009; Orwa *et al*., 2009; Bosch, 2004). The immature seeds can be cooked in many different ways while the mature seeds are roasted and eaten like peanuts. Moringa seeds contain about 30-40% of edible oil (bean oil) which is used for salad dressing and cooking and can replace olive oil. Ben oil is resistant to rancidity and provides substantial amounts of oleic acid, sterols and tocopherols (FAO, 2014; Bailey, 2011).

2.6.2 Feed uses

Moringa leaves are a valuable source of protein for ruminants but they have a moderate palatability. They are used in smallholder rabbit farming in several African countries. Using moringa leaves in poultry, pigs and fish is feasible but only in limited amounts due to the presence of fiber and ant nutritional factors.

Moringa oil seed cake, the by-product of oil extraction, is poorly palatable to livestock and mainly used as green manure or flocculating agent in water treatments. Moringa seeds seem to be toxic to rabbits.

2.6.3 Industrial uses

Moringa oil has various industrial applications. It is used in the perfume industry as it retains readily fragrance and is not prone to rancidity, and to make paintings or lubricants (Bosch, 2004; Foidl *et al*., 2001). Moringa oil has qualities needed to be a biodiesel feedstock (Rashid *et al*., 2008). At the time of writing (December 2014), several projects to produce biodiesel from moringa seeds were under way in Asia and Africa.

2.6.4 Agricultural uses

Phythormones extracted from moringa leaves have been shown to have a growth enhancing effect on various plants, including black gram, peanut, soybean, sugarcane and coffee. Spraying moringa leaf extract on leaves increases plant production by 20-35% (Foidl *et al*., 2001).

2.7 Distribution

Moringa originated from the southern hills of the Himalayas and was introduced in many tropical and subtropical areas, particularly by migrant Asian populations (Radovich, 2009; Bosch, 2004). Moringa seed oil was valued in perfume manufacture Ancient Egypt, Ancient Greece, and thein Roman Empire (Orwa *et al*., 2009; Bosch, 2004). Moringa is now naturalized in most African countries, in the Caribbean Islands and in Central America. Moringa is an important crop in India, Ethiopia, the Philippines and the Sudan (FAO, 2014).

Moringa grows from sea level up to an altitude of 600 m but it can be found up to 1000 m in the Himalayas, up to 1350 m in East Africa, and even up to 2000 m in Zimbabwe (Radovich, 2009; Bosch, 2004). Moringa does well where average temperatures are high, ranging from 25 to 30°C. Low temperatures and frost can kill the plant back to ground level but regrowth occurs quickly once the temperatures increase. Moringa grows better where annual rainfall is

about 1000–2000 mm. However, moringa is tolerant of drought and survives where rainfall is as low as 400 mm, though foliage production under such conditions is reduced. Moringa has low tolerance of water logging. It thrives in full sunlight. Moringa does well on a wide range of soils, with pH ranging from 4.5 to 9, provided they are well-drained (Radovich, 2009; Bosch, 2004). Moringa has some salt tolerance (up to 3 dS/m during germination and 8 dS/m once well established) (Nouman *et al*., 2014; Oliveira *et al*., 2009).

India is the main exporter of moringa: canned leaves, fresh fruits (1.2 million in India), oil and leaf powder (Radovich, 2009). In Africa, leaves are the main product for local trade (Bosch, 2004).

2.8 Palatability

The palatability of moringa is average. Compared to several shrub and tree species in Cuba and Venezuela, moringa leaves were only moderately consumed by cattle, sheep and goats (Garcia *et al*., 2008c; Garcia *et al*., 2008d; Toral Perez *et al*., 2008). However, when used as sole supplement or included into a concentrate in growing goats diets, the DMI of *moringa oleifera* leaves was comparable or higher to that of leucaena (*Leucaena leucocephala)* or gliricidia (*Gliricidia sepium)* (Ndemanisho *et al*., 2007; Asaolu *et al*., 2012).

2.9 In vitro

In vitro method provides a quick and easy way to calculate organic matter digestibility, monitor microbial change in the rumen.in vitro techniques, which are conducted outside of the animal system but simulate the digestion process. Generally, in vitro techniques are those based on measuring either fermentation residues or products. The former measures the unfermented residue remaining after in vitro incubation of a feed with rumen fluid. This approach involves collecting fluid by hand from the rumen of a ruminant that has been fitted with a rumen fistula. (Tilley and Terry 1963)

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Experimental site:

The experiment was conducted at the farm of Animal Production Department, College of Agriculture, Sudan University of Sciences and Technology, Shambat.

3.2 Experimental diet:

Moringa leaves (*moringa olifeira*) was harvested at about 10cm from the base of the plant with sickle (Amaglo *et al*., 2007; Reyes Sanchez *et al*., 2006; Foidl *et al*., 2001). They were chopped into smaller pieces using cutlass and wilted for 3 days. *Moringa oleifera* leaves were harvested at pre-bloom stage from the Moringa Plantation at the farm and sundried for five days. The dried leaves were ground with hammer mill to obtain *Moringa oleifera* Leaf Meal (MLM).

3.2.1 Experimental rations:

The moringa leaves was done as the follows: Concentrate ration without moringa (control (T)), Concentrate ration contain moringa (22 %(T1)), Concentrate ration contain moringa (25 %(T2)), as:

Table 1: The Control Ration Contents (T) Ration

Control ration	%	Energy	Cp	ca	fiber	Total \ton
Sorghum	26	858	3.44	0.01	0.64	260
Wheat barn	24.5	613	4.12	0.04	3.14	0
Groundnut cake	12	340	6	0.07	1	120
Groundnut hulls	17	294	0.97	0.15	11	170
Molasses	18	376	0.63	0.11	0	180
Lime stone	1.5	0	0	0.55	0	15
Slate	1	0	0	0	0	10
Gross	100	2.472	15	950	15.956	755
(Energy /cp)%						48

Table 2: (Moringa 22%) Ration Contents: (T1) Ration

(Maringa 22%) ration	%	Energy	cp	ca	fiber	Total \ton
Sorghum	10	330	1	0.1	0	50
Wheat barn	24	600	4	0	3	220
Groundnut cake	5	142	3	0.3	0	0
Moringa leaves	22	601	6	0.31	3	150
Ground nut hulls	10	173	1	0	6	0
Moringa hulls	15	391	0	0.15	3	150
Molasses	12	245	0	0.08	0	120
Lime stone	1	0	0	0.37	0	10
Slate	1	0	0	0	0	10
Gross	100					
(Energy/cp)%						166

Table 3: (Moringa25%) Ration Contents: (T2) Ration

(Moringa25%) ration	%	Energy	Cp	ca	fiber	Total \ton
Sorghum	9	297	1.19	0	0.22	90
Wheat barn	24	600	4.04	0.04	3.12	240
Groundnut cake	4	133	2	0.02	0.39	40
Moringa leaves	10	173	0.57	0.09	6.45	100
Groundnut hulls	25	683	6.4	0.36	3.65	250
Moringa hulls	15	391	0.43	0.14	3.47	150
Molasses	11	225	0.39	0.07	0	110
Lime stone	1	0	0	0.37	0	10
Slate	1	0	0	0	0	10
Gross	100	2482	15	1	17	1000
(Energy/ cp)%						165.3

3.3 Chemical Analysis:

Dried samples of moringa leaves (ML) and experimental diets were ground and passed through a 2mm sieve before analysis. The CP of each of the samples was determined using the automated Keldahl method (AOAC 1995). The dry matter was determined by drying at 60c for 48hours in an oven while ash was measured by burning further at 500ac for 4 hours. The neutral detergent fiber (NDF) and acid detergent fiber (ADF) composition were analyses using the method described by Goering.

3.4 The digestion in the laboratory:

Conducted in the Department of Plant Nutrition, Faculty of Animal Production, University of Khartoum. Digestion in the lab is divided in two sections:

1. Microbial digestion.
2. Enzymatic digestion.

3.4.1 Microbial digestion:

To provide an environment ideal for viable micro-organisms inside the lab the following solutions:

3.4.1.1 Big metal solution (1):

(1.8 grams of sodium di-Hypo phosphate +1.7 grams of potassium Hypo phosphate + 250 ml of distilled water).

3.4.1.2 Small metal solution (2):

(1.5 grams of calcium chloride + 1.4 magnesium chloride +0.7cobolt chloride +0.07 iron chloride + 100 ml distilled water)

3.4.1.3 Organizer solutions (3):

(8.7 grams of sodium bi carbonate + 1g ammonium bicarbonate +250 ml of distilled water).

3.4.1.4 Directory solution (4):

(Rezazoren) add points.

3.4.1.5 Solution (5):

(0.285 grams of sodium sulfate +47 ml of distilled water).

3.4.1.6 Solution (6):

(0.2 grams of sodium hydroxide + 50 ml of distilled water).

* Add 2 ml of solution 6+ solution 5.

The final composition of the solution:

In a large-sized power (2-liter) flask Place 474 ml of distilled water from the solution +237 from the solution(1) + 1.2 ml from solutions (2) +237 ml of solution (3) + 4 points from the solution (4) +1.2 ml of solution 5+ rumen fluid by 1 to 4

Then exposing the liquid carbon dioxide to expel oxygen and convert the center of anaerobic.

In the tube digestion put 0.5 grams of the sample +40 ml of the final solution and close the tube tightly and put it in a water bath temperature of 40 ° C for 48 hours and then filtered converts sludge into the test tube again.

3.5.2 Enzymatic digestion:

In a flask large size put 860 ml of distilled water +100 ml hydrochloride +2 grams enzyme pepsin +4 grams stimulate tablet. Add each remaining 40 ml of solution enzymatic and place it in a water bath for 48 hours and 40 ° C. Then

descriptive about sludge to dish empty then placed in the drying oven for 18 hour and then weight remaining.

Digestive coefficient =

$$\frac{\text{Sample weight- remaining}}{\text{Sample weight}} \times 100$$

3.5 Statistical analysis:

The least significant differences (LSD) was used to tests for significant between means.

CHAPTER FOUR

4. THE RESULTS

4.1 The rations of experimental

Results are obtained after chemical analysis and digestive coefficient of the components of the three diets (T1) with a high protein content compared with the (T) diet and (T2)

In the digestion coefficient the (T) diet is with the highest digestive coefficient of (83.38%) followed by a diet (T1) (81.54%) and diet (T2) (77.52%).

Table 4: The effect of Moringa leaves and hulls meal on digestibility

Parameter	treatments			Level of sig
	25%molm(T2)	22%molm(T1)	Control(T)	
Digestibility	$77.52^{c \pm}$ 0.580	$81.54^{b \pm}$ 0.100	$83.38^{a \pm}$ 0.380	**

4.2 Nutrition analysis:

The following table show nutrition analysis of moringa olifeira(Fresh leaves, Dried leaf and Pods) .

Table 5: The Analysis of Fresh leaves, dried leaf and Pods

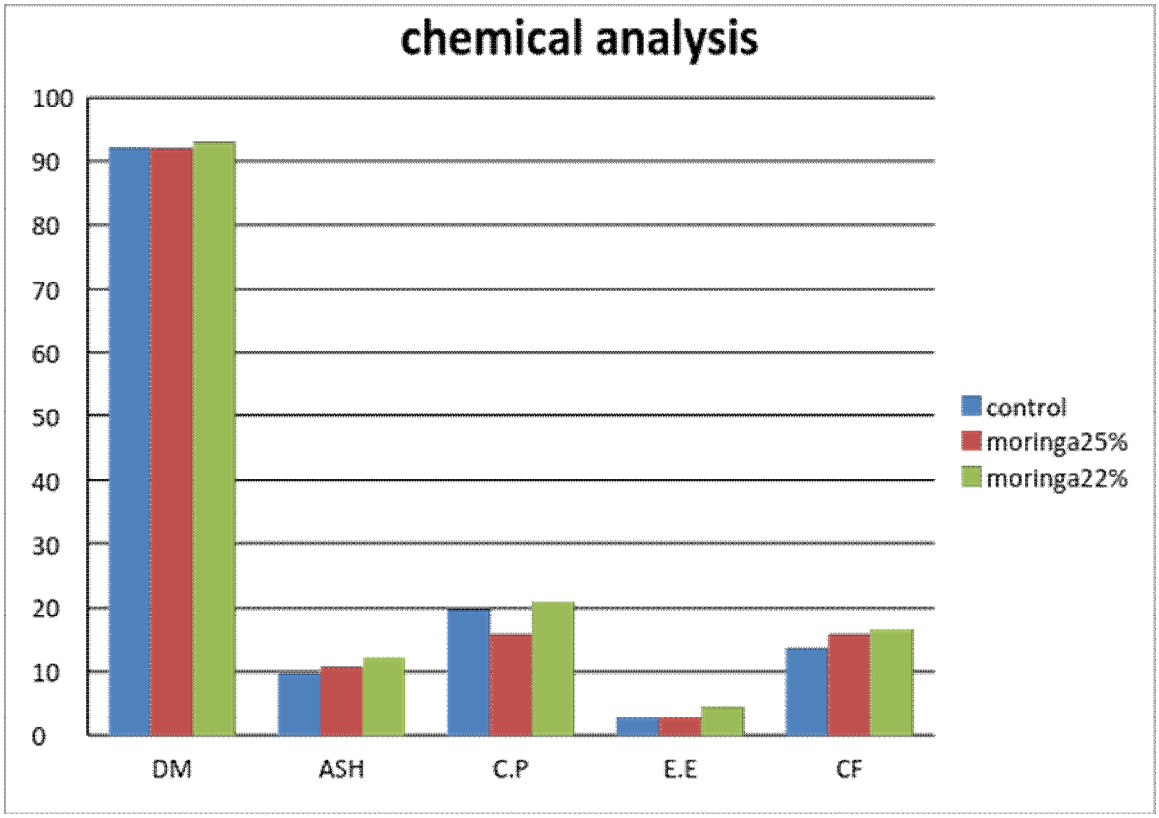
Nutrition analysis	Fresh leaves (per 100g)	Dried leaf (per 100g)	Pods (per 100g)
Moisture%	75	7.5	86.9
Calories	92	205	26
Protein(g)	6.7	27.1	2.5
Fat (g)	1.7	2.3	0.1
Carbohydrates (g)	13.4	38.2	3.7
Fiber (g)	0.9	19.2	4.8
Minerals (g)	2.3	0	2
Calcium (mg)	440	2003	30
Magnesium (mg)	24	368	24
Phosphorous (mg)	70	204	110
Potassium (mg)	24	1324	24
Copper (mg)	1.1	0.6	3.1
Iron (mg)	0.7	28.2	5.3
Oxalic acid (mg)	101	0	10
Sulfur (mg)	137	870	137

4.3 Chemical analysis of rations (T, T1, T2)

Table 6: Show chemical analysis of rations (T, T1, and T2):

No	Dm	Ash	Cp	Ee	Cf	Me \ mj \kg
T	92.1	9.87	20.18	2.8	13.6	7.47
T1	93	12.18	21.48	4.6	16.4	8.216
T2	92	10.7	16.28	2.8	15.8	7.356

4.3.1 The chemical analysis of rations:



4.3.2 The energy analysis of rations

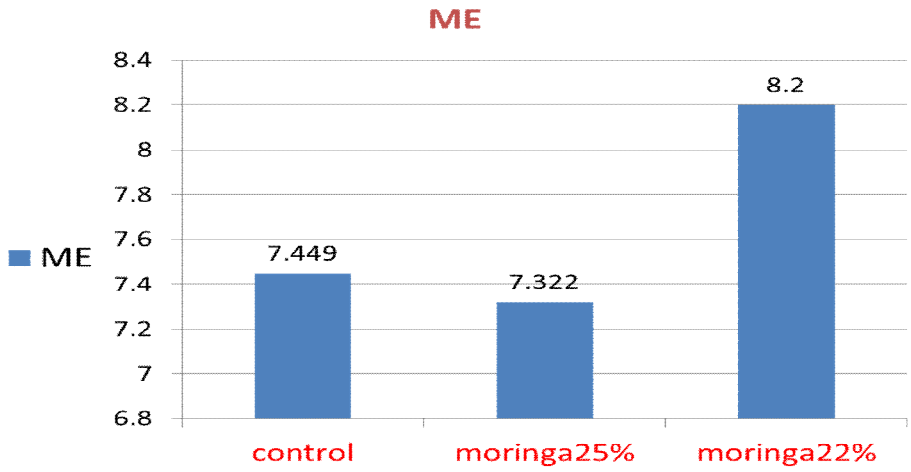
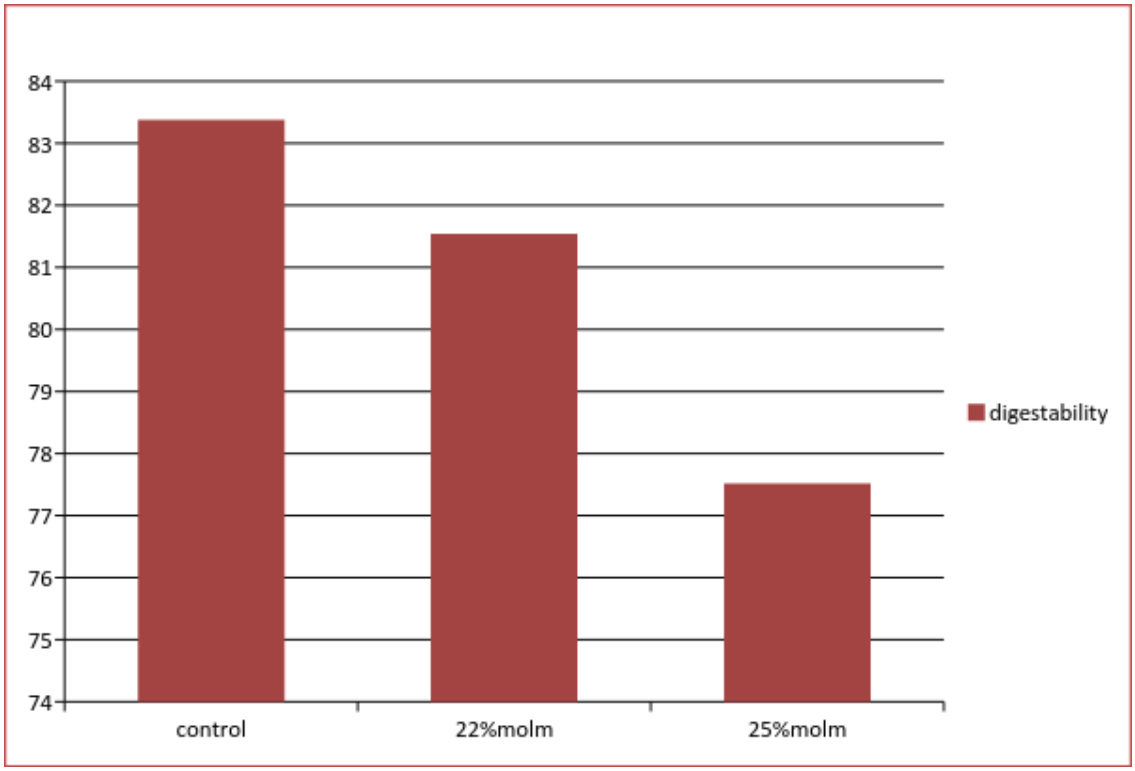


Table 7: The following table shows the digestive coefficient

Diets	Digestive coefficient
T	83.38
T1	81.54
T2	77.52

4.4 The digestibility of (T, T1, T2)



CHAPTER FIVE

5. Discussion

The method of in vitro digestion methods task in animal feed because it saves time and effort and reduce costs and are able to know the digestive coefficient diets assigned by feeding them and taking appropriate decisions to continue or modification. The moringa feeds are (T1) and (T2) with high digestibility coefficient, namely diet (T1)81.54 digested was where the asymptotic coefficient digestion (T) 83.38% of moringa feeds .Then the diet T1is the burning Bush the best digestive coefficient is higher than the digestive coefficient (T2)who were 77.52 .So it is best to use his jam with lower cost and high digestibility coefficient and the rate of protein (21.48%) higher than the rate of feed (T)20.18%.The digestive coefficient(81.54%) .(21.48%) protein rate and lower cost for all of these reasons the diet (T1) is best for jam.

Ruminants have a four-compartment stomach .the rumen is the largest compartment, where millions of bacteria grow under anaerobic conditions. These bacteria are responsible for the digestion of fiber and are the reason why ruminants can consume a wide variety of by product feedstuffs derived from the processing of plants for human food. The nutritive value, of an animal feed is determined predominately by its digestibility and intake, in turn; determine the feeds productive performance, such as to support milk synthesis or muscle growth. However studies with live animals (in vivo) to determine the digestibility of feeds are time-consuming, laborious, and expensive and require large quantities of feed.such experiments are not suited for the rapid and routine feed evaluations undertaken by commercial laboratories that provide feed in formation to livestock producers and feed manufacturers. (Makkar Hps, Blummel m, Becker k . 1995.)

The in vitro system helps to better quantify nutrient utilization, and its accuracy in describing digestibility in animals has been validated in numerous experiments.

The in vitro can be used to predict animal performance at a much lower cost. (Tilley JM, Terry RA. 1963.)

Conclusion and Recommendations

Conclusions

In this research, is considered T1 diet is the best because it is the same coefficient digestive higher than a T2 diet and with coefficient of digestive asymptotic to control diet and with the cost of production is less than control diet so economically farms use T1of it with a coefficient of digestive high and the cost of producing the best less.

Recommendations

1. Further research on diets containing concentrated on the plant moringa oliefera .
2. The use of other parts of the plant moringa in the installation of feed concentrates seeds and stems.
3. The use of intensive diets containing different proportions moringa to reach a ratio optimization.
4. Feeding large ruminants (cow's milk and fattening) focused on diets containing moringa to reduce production costs and increase revenue and produce high-quality product, and in particular dairy and meat production.
5. Encourage scientific research to learn more about the nutritional impact of moringa.
6. Encourage scientific research to learn more about the said effect of moringa.

References

- Afuang, W. ; Siddhuraju, P. ; Becker, K., 2003. Comparative nutritional evaluation of raw, methanol extracted residues and methanol extracts of Moringa (*Moringa oleifera* Lam.) leaves on growth performance and feed utilization in Nile tilapia (*Oreochromis niloticus* L.). Aquaculture Res., 34 (13): 1147-1159
- Amaglo, n. k. ; timpo, g. m. ; ellis, w.o. ; bennett, r. n., 2007. effect of spacing and harvest frequency on the growth and leaf yield of moringa (*moringa oleifera* lam.), a leafy vegetable crop. ghana j. hort., 6: 33-40
- Aregheore, E. M., 2002. Intake and digestibility of *Moringa oleifera*–batiki grass mixtures by growing goats. Small Rum. Res., 46 (1): 23-28
- Asaolu, V. ; Binuomote, R. ; Akinlade, J. ; Aderinola, O. ; Oyelami, O., 2012. Intake and growth performance of West African Dwarf Goats fed *Moringa oleifera*, *Gliricidia sepium* and *Leucaena leucocephala* dried leaves as supplements to cassava peels. J. Biol. Agric. Health Care, 2 (10): 76-88
- Bakhashwain, A. ; Sallam, S. M. A. ; Allam, A. M., 2010. Nutritive value assessment of some Saudi Arabian foliages by gas production technique *in vitro*. JKAU: Met., Env. & Arid Land Agric. Sci. 21 (1) : 65-80
- Bennett, r. ; mellon, f. ; foild, n. ; pratt, j. ; dupont, m. ; perkins, l. ; kroon, p., 2003. profiling glucosinolates and phenolics in vegetative and reproductive tissues of the multi-purpose tree *moringa oleifera*. j. agric. food chem., 51 (12): 3546-3553
- Bosch, c. h., 2004. *moringa oleifera* lam. in: grubben, g. j. h.; denton, o. a. (eds). prota (plant resources of tropical africa / ressources végétales de l'afrique tropicale), wageningen, netherlands
- Foidl, n. ; makkar, h. p. s. ; becker, k., 2001. the potential of *moringa oleifera* for agricultural and industrial uses. in: what development

potential for moringa products ? october 20th - november 2nd 2001. dar es salaam

- Gadzirayi, c. t. ; mupangwa, j. f., 2014. the nutritive evaluation and utilisation of *moringa oleifera* lam. in indigenous and broiler chicken production: a review. greener j. agric. sci., 14 (1): 15-21
- Garcia, D. E. ; Medina, M. G. ; Clavero, T. ; Cova, L. J. ; Dominguez, C. ; Baldizan, A., 2008. Nutritional characterization of six fodder species foliage with emphasis in their polyphenolic profiles. Revista Científica, FCV-LUZ, 18 (2): 188-196
- Gutierrez, P. ; Rocha, L. ; Reyes Sanchez, N. ; Paredes, V. ; Mendieta Araica, B., 2012. Ruminal degradation rate of *Moringa oleifera* foliage in Reyna cattle using *in sacco* technique. La Calera, 12 (18) : 37-44
- Kakengi, A. M. V.; Shem, M. N.; Sarwatt, S. V., Fujihara, T., 2005. Can *Moringa oleifera* be used as a protein supplement for ruminants?. Asian Aust. J. Anim. Sci., 18 (1): 42-47
- Makkar, h. p. s. ; Becker, k., 1997. nutrients and antiquality factors in different morphological parts of the *moringa oleifera* tree. j. agric. sci., 128 (3): 311-322
- Mendieta-Araica, B. ; Sporndly, E. ; Reyes-Sánchez, N. ; Norell, L. ; Sporndly, R., 2009. Silage quality when *Moringa oleifera* is ensiled in mixtures with Elephant grass, sugar cane and molasses. Grass and Forage Sci., 64 (4): 364–373
- Moyo, B. ; Masika, P. J. ; Hugo, A. ; Muchenje, V., 2011. Nutritional characterization of Moringa (*Moringa oleifera* Lam.) leaves. African J. Biotech., 10 (60): 12925-12933
- Murro, J. K. ; Muhikambele, V. R. M. ; Sarwatt, S. V., 2003. *Moringa oleifera* leaf meal can replace cottonseed cake in the concentrate mix fed with Rhodes grass (*Chloris gayana*) hay for growing sheep. Livest. Res. Rural Dev., 15 (11)

☒ Ndemanisho, E. E. ; Kimoro, B. N. ; Mtengeti, E. J. ; Muhikambele, V. R. M., 2007. *In vivo* digestibility and performance of growing goats fed maize stover supplemented with browse leaf meals and cotton seed cake based concentrates. Livest. Res. Rural Dev., 19 (8): 105
☒ Ndemanisho, E. E. ; Kimoro, B. N. ; Mtengeti, E. J. ; Muhikambele, V. R. M., 2007. *In vivo* digestibility and performance of growing goats fed maize stover supplemented with browse leaf meals and cotton seed cake based concentrates. Livest. Res. Rural Dev., 19 (8): 105
☒ Nouala, F. S. ; Muetzel, S. ; Hoffmann, E. ; Becker, K., 2009. Feed intake and digestion by two cattle breeds fed of baby corn stovers and groundnut hay supplemented with graded levels of concentrate and Moringa leaves. Livest. Res. Rural Dev., 21 (10): 163

☒ Nouman, w. ; basra, s. m. a. ; siddiqui, m. t. ; yasmee, a. ; gull, t. ; cervantes alcayde, m. a., 2014. potential of *moringa oleifera* l. as livestock fodder crop: a review. turk. j. agric. for., 38 (1): 1-14

☒ Olaofe, O. ; Adeyeye, E. I. ; Ojugba, S., 2013. Comparative study of proximate, amino acids and fatty acids of *Moringa oleifer*a tree. Elixir Appl. Chem. 54: 12543-12554

☒ Oliveira, f. r. a. ; oliveira, f. a. ; guimarães, i. p. ; medeiros, j. f. ; oliveira, m. k. t. ; freitas, a. v. l. ; medeiros, m. a., 2009. emergency of seedlings of *moringa oleifera* lam irrigated with water of different levels of salinity. biosci. j., 25 (5): 66–74new forests project, 2012. establishing *moringa oleifera* tree plots for fodder production in haiti . new forests project, the international center. washington, usa

☒ Orwa, c. ; mutua, a.; kindt, r.; jamnadass, r. ; anthony, s., 2009. agroforestree database: a tree reference and selection guide version 4.0. World agroforestry centre, Kenya fao, 2014. moringatraditional crop of the month. fao

☒ Patricio, h. g.; palada, m. c.; ebert, a.w., 2012. adaptability and horticultural characterization of moringa accessions under central

philippines conditions. in: holmer, r. ; linwattana, g. ; nath, p. ; keatinge, j. d. h. (eds.), seaveg 2012: high value vegetables in southeast asia: production, supply and demand. avrdc-worldvegetablecenter, 2013

☒ Price, M. L., 2007. The Marango tree. Nota Tecnica, ECHO, 17391 Durrance road North fort Myers, FL 33917, USA

☒ Radovich, t., 2013. farm and forestry production and marketing profile for moringa. in: elevitch, c.r. (ed.) specialty crops for pacific island agroforestry. permanent agriculture resources (par), holualoa, hawai‘i

☒ Rashida, u. ; anwar, f. ; moser, b. r. ; knothe, g., 2008. *moringa oleifera* oil: a possible source of biodiesel. bioresource technol., 99 (17): 8175–8179

☒ Reyes sanchez, n.; sporndly, e. ; ledin, i., 2006. effect of feeding different levels of foliage of *moringa oleifera* to creole dairy cows on intake, digestibility, milk production and composition. livest. sci., 101 (1/3): 24-31

☒ Sarwatt, S. V.; Kapange, S. S. ; Kakengi, A. M. V., 2002. Substituting sunflower seed-cake with *Moringa oleifera* leaves as a supplemental goat feed in Tanzania. Agroforestry Systems 56 (3): 241-247

☒ Sarwatt, S. V.; Milang’ha, M. S. ; Lekule, F. P. ; Madalla, N., 2004. *Moringa oleifera* and cottonseed cake as supplements for smallholder dairy cows fed Napier grass. Livest. Res. Rural. Dev., 16 (6): 38

☒ Sengupta, A.; Gupta, M. P., 1970. Studies on seed fat composition of Moringaceae family. Fette Seifen Anstrich., 72 (1): 6-10

☒ Siddhuraju, P. ; Becker, K., 2003. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (*Moringa oleifera* Lam.) leaves. J. Agric. Food Chem., 51 (8): 2144-2155

☒ Soliva, C. R. ; Kreuzer, M. ; Foidl, N. ; Foidl, G. ; Machmüller, A. ; Hess, H. D., 2005. Feeding value of whole and extracted *Moringa*

oleifera leaves for ruminants and their effects on ruminal fermentation in vitro. Anim. Feed Sci. Technol., 118 (1/2): 47-62

- Sultana, n. ; alimon, a. r. ; haque, k. s. ; sazili, a. q. ; yaakub, h ; hossain, s. m. j., 2014. the effect of cutting interval on yield and nutrient composition of different plant fractions of moringa oleifera tree. j. food, agric. env., 12 (2): 599-604
- Tona, G. O. ; Asaolu, V. O. ; Amao, O. A. ; Akingbade, A. A., 2013. Evaluation of chemical composition and in vitro fermentation parameters of Moringa oleifera leaf meal based diets as feed for ruminants in Nigeria. Agric. J., 8 (4): 165-169
- Toral Perez, O. C. ; Iglesias Gomez, J. M., 2008. Selectivity of potentially useful arboreal species for livestock systems. Zootecnia Trop., 26 (3) :197-200