SOME ENGINEERING FACTORS AFFECTING THE PREPARATION OF MORINGA RESIDUES FOR ANIMAL DIETS

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ABSTRACT

Moringa oleifera, a rapid growing tree found in a different climatic condition, the moringa is a promising tree and has the potential to become a new source of fresh forage material per unit area compared to other forage crops high productivity. Moringa produce a large amount of the residues consisting of branches and stalks which lefts over after getting moringa leaves for human use, causing environmental problems. Therefore, the main objectives of this research are to prepare moringa residues to be used as a dietary supplement for animals feed due to it's content of many nutrients, protein sources and vitamins, to decrease the cost of the feed. Meanwhile the essential factor is preventing the accumulation of these quantities and environment pollution. Some physical, mechanical properties and chemical composition of moringa residues were investigated at moisture content (8%). In order to determine engineering treatments to get the most appropriate lengths for cutting of moringa residues to be used as appropriate residues roughage for animal diets. A local manufacture hammer mill machine was used for crushing and milling the moringa residues, three different types of hammer were used in this machine to cut the right lengths. The current research focus on machine noise levels and air pollution dust particle due to crushing and milling the moringa residues for human safety. The quantity of fine particles inhaled and produced from a local hammer mill machine operator was recorded. The microbiological analysis showed the presence of microorganisms such as Bacteria, Fungi, Actinomyces and Yeasts in the moringa dust particles. The nutritional characteristics of stems (stalks) of Moringa oleifera plant with two levels of grinding (fine and coarse Moringa oleifera stems)

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(Fine MOS; from > 0.6 mm to 1.4 mm and Coarse MOS; from >1.4 mm to 6.7 mm) and clover hay (CH) were studied in a completely randomize design using: chemical composition In-vivo digestibility coefficients and feeding values determination. Results revealed that crude protein (CP) content was 12.81, 12.24 and 13.08% for (Fine MOS and Coarse MOS) and clover (CH), respectively. The MOS had high crude fiber (CF) content than CH, while recorded high ether extract (EE) 3.12% content while stems recorded low EE 1.03 and 0.94% content. The fiber fraction (NDF, ADF, ADL, cellulose and hemicellulose) of MOS content were higher than those in CH content. Fine MOS) with highest nutrient digestibility, TDN (50.72%) and DCP (8.39%), followed by coarse MOS (TDN, 48.46% and DCP, 7.12%). Meantime, intermediate values of nutrients digestibility of clover hay led to intermediate TDN and DCP values (45.41and 8.14%) respectively. The results revealed that fine grinded *Moringa oleifera* stalks had great potential as livestock feed for small ruminants holder, especially during dry season and it consider a good quality roughage compare to clover hay.

Keywords: Moringa oleifera, Physical properties- mechanical properties, chemical composition, Noise, Dust particles, Fiber fractionation, Digestion coefficients, nutritive values, sheep.

INTRODUCTION

Egypt, as one of the developing countries, face shortage of animal meat, due to poor production of animals, which led to high cost of livestock and livestock products as well. One of the ways to reduce cost of animal production in developing countries and therefore making animal protein available to people at cheaper prices is by using agricultural by-products and tropical plants to feed livestock. (**Asar *et al*., 2010).** Availability of conventional feed resources is declining as livestock populations increase especially in arid and semi-arid areas of Egypt. Fodder trees, shrubs and forage plants are indispensable sources to animal feed in Egypt, particularly in areas with dry to semidry Mediterranean climate. This because they can alleviate the feed shortages or even fill up the feed gaps in the summer. **Hashish *et al*., (1994)** studied some factors affecting the performance of chopping, crushing and grinding equipment for field raw materials. They concluded that the optimum drum speed was found 9.4 m/s for the three tested raw materials and the highest machine production rate and efficiency were obtained at low levels of moisture content of raw materials. **Imbabi, (2003)** tested the performance of a cutting machine for crop residues in the cutting process of corn stalks. The obtained results showed that the use of a serrated knife edge significantly decreased the cutting energy requirements between 8-15 % and increased the cut length of less than 5cm length by about 90%. **Morad *et al*., (2007)** investigated the performance of a crop residues chopping machine during cutting some field residues such as rice straw, corn stalks and sugarcane in terms of cutting lengths percentage, energy and cost requirements. Optimum performance was obtained at chopper drum rotating speed of 51.31 m/s, material feed rates of 0.45 ton/h for sugarcane, at residues moisture content of 5.5 % for rice straw, 8.7% for corn stalks arid 11% for sugarcane residues. **Amer *et al*., (2008)** showed that cutting energy is related to the stem mechanical properties (e.g. maximum cutting force and stem shear strength), and physical properties (e.g. stem diameter, dry matter density and moisture content). Types of cutting knife and blade edge also affect the cutting energy requirement. A serrated blade edge gives a higher cutting force and requires more cutting energy. **Abd Elmottaleb *et al*., (2009)** stated that the performance of the hammer mill was in the optimum region under the following conditions: Hammer drum speed of 44.2 m/s, concave hole diameter of 2 mm and residues moisture content of maize stalks 4.1 %, rice straw 3.4% and cotton stalks 7.4%. There has been an increasing interest in the use of Moringa as a protein source for livestock. **Asaolu *et al*., (2011). Fozia *et al*., (2012)** mentioned that *Moringa oleifera* is cultivated all over the world due to its multiple utilities. Every part of moringa is used for certain nutritional and/or medicinal propose. Besides being a good source of protein, vitamins, oils, fatty acids, micro-macro mineral elements and various phenolics, it is also reported as anti-inflammatory, antimicrobial, antioxidant, anticancer, cardiovascular, hepatoprotective, anti-ulcer, diuretic, antiurolithiatic, and antihelmintic. Its multiple pharmaceutical effects are capitalized as therapeutic remedy for various diseases in traditional medicinal system. **Odee, (1998)** stated that moringa is a fast growing tree and has been found to grow between 6–7 m in one year, in areas receiving less than 400 mm annual rainfall. **Foidl *et al*., (2001)** eliminate that moringa plant is known for its resistance to drought and diseases. Because, this tree has so many potential uses. The plant possesses many valuable properties which make it of great scientific interest. These include the high protein content of the leaves twigs and stems, the seeds contain high protein and oil contents in the seeds, the large number of unique polypeptides in seeds that can bind to many moieties, the presence of growth factors in the leaves, and the high sugar and starch content of the entire plant. Another important advantageous characteristic of moringa is high productivity of fresh material per unit area compared to other forage crops. Moringa is especially useful as a forage for cattle both economically and productively solving the problems facing cattle breeders. Its leaves and green fresh pods are used as vegetables by humans and are rich in carotene and ascorbic acid with a profile of amino acids, vitamins A, B and C, Ca, Fe and P And the advantages of using moringa as a protein resource are numerous, and include the fact that it is a perennial plant that can be harvested several times in one growing season and also has the potential to reduce feed cost. It can reach 12 m in height at maturity, yielding up to 120 tones/ha/yr when planted very densely for use as forage. **Makkar and Becker, (1997).**

The present study aims at investigating the effect of varied grinding (fine and coarse) of *Moringa oleifera* stalks (stems and petioles) on chemical analysis, digestion coefficients and feeding values comparing to clover hay (*Trifoliumalexandrinum*) (CH) as basic feeds for small ruminants.

MATERIALS AND METHODS

Experiments were carried out using a local hammer mill machine at Agricultural Engineering Research Institute, *(AEnRI)*. Nutrition experiments and its analyses executed at Animal Nutrition Research Department, APRI. The stalks (stems and petioles) of *Moringa oleifera* were harvested around the experimental site; the fine and coarse leaves and stems of the plants were separately pooled each other and on open door-dried to constant moisture levels, and there after bagged for experimental procedures.

Materials and Methods

Materials:

In this study, crushing and milling operations were carried out on moringa stalks, the specifications of the moringa crop residues were presented as follows:

Physical properties of moringa stalks:

Samples were taken from three different positions: bottom, middle and top portion of each stalk to determine length, diameter and number of branches. The average diameter of each sample was determined by an electronic digital caliper.

Mechanical properties of moringa stalks:

Determine the necessary mechanical transactions to get the most appropriate lengths for cutting waste moringa plant to gain advantage of high nutritional value. The digital force gauge (model: FGN-50) was used to measure penetration resistance and shear strength for moringa stalks, at three measure positions (bottom, middle and top regions).

Chemical composition:

The chemical composition of fine *Moringa oleifera* stems (FMOS) and coarse *Moringa oleifera* stems (CMOS) were determine at laboratory of Animal Production Research Institute, APRI.

Equipment:

1- Hammer mill machine:

A local hammer mill machine was used for crushing and milling the moringa residues (Figs.1 and 2). The technical specifications of the machine are shown in Table (1).

2- Hammer types:

Three different types of hammer were used in the crushing and milling process to get the appropriate stalks cutting length: Flat blade impact hammer (fig.2A), modified blade impact hammer (Fig. 2B) and impact crusher hammer (Fig. 2C).

A- Flat blade Impact hammer:

Six hammer knives used in this machine (125×40×6mm) length, width and thickness respectively.

B- Modified flat blade Impact hammer:

The knives were modified increase cutting edge to increase the shear strength the knives were made of a flat steel edge angle of 45 degrees on the longitudinal axis of the hammers.

C- Impact crusher hammer

Rotor dimensions: stem100 mm, hammer (40×40×25mm) length, width and thickness respectively.

Table (1): The technical specifications of the hammer mill machine.

Item	Specification
Make	Local manufacture
Type	Laboratory hammer mill
Hammer number Hammer mass (g) Hammer length (mm) Hammer width (mm) Hammer thickness (mm)	6 1875 125 40 6
Concave holes diameters (mm)	2
Clearance between knife and concave (mm)	4
Power source	Single phase electric motor, 1.84kW,220 V, 2000 rpm

The power was transmitted from the source to the drive shaft by a v-belt (13×900 mm) and pulleys, diameters of pulleys (7, 10 and 15 cm). Feeding was performed manually.

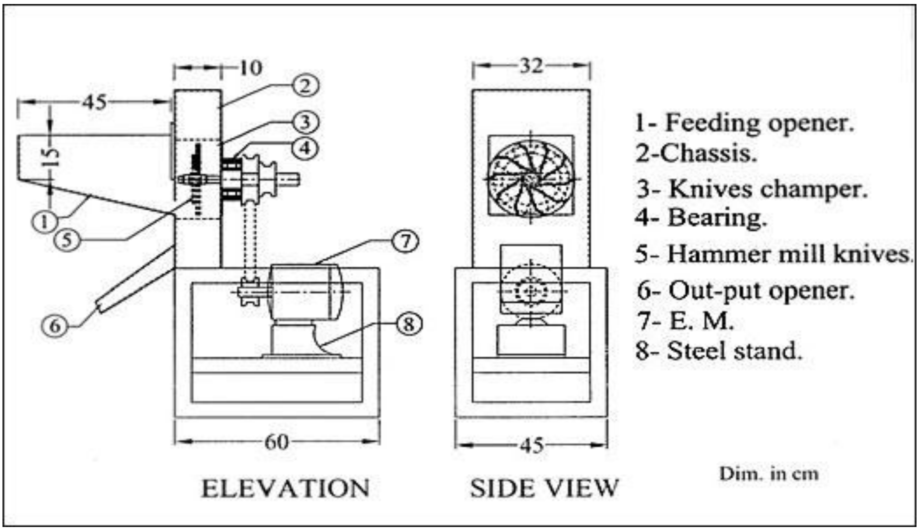

Fig. (1): local hammer mill machine.

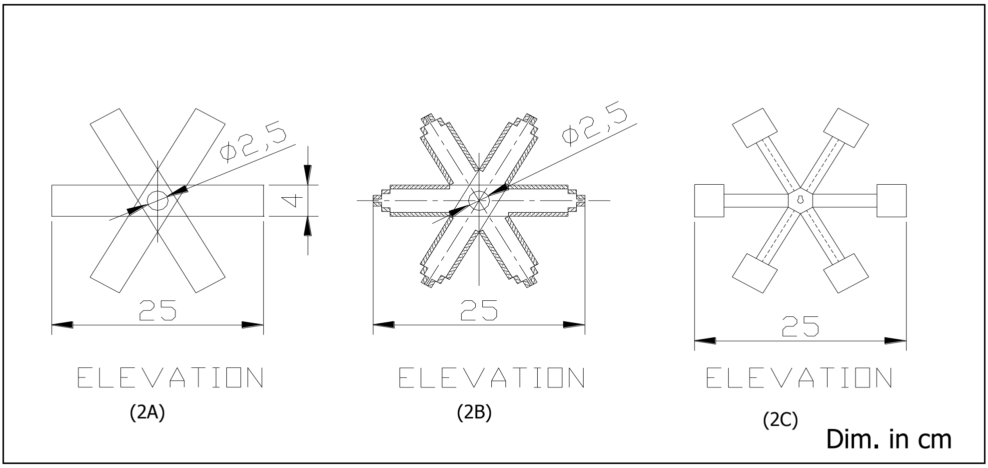

Fig. (2): Three different types of hammer.

A-Flat blade impact hammer, B- modified blade impact hammer and C- impact crusher hammer.

Drum speed

Three drum speeds (10.5, 10.9 and 11.5 m/s) and machine concave hole diameter of 2 mm were used.

Methods:

A local hammer mill machine was used for crushing and milling, the moringa stalks residues at moisture content (8%).

Product output particle sizes:

Sieves (0.6, 1, 1.4, 2.8, 3.35 and 6.7 mm) were used for measuring particle sizes of the machine output product (ASAE 2001). The total weight of samples and the mass of each product categories were weighed using digital scale with an accuracy of 0.01g. The percent of each fraction was determined.

Power requirements:

Total consumed power (kW) under working load was determined by using a national super clamp meter, type 700K, range (0-700).

Machine productivity:

The testing time of the experiment was recorded by a stop watch. The machine productivity was calculated (kg/h) for each rotor hammers.

Measuring the dust inhaled during the operation:

The personal dust sampler (PS- 43: Japan) was used to measure dust inhaled ($\mu g/m^3$) per labors during operations. The suction flow rate of the dust sampler was adjusted to be at 1.5 L/min, before the beginning of work the filter was weighed then weigh at the end of working day, to determine the different between the two weights.

Microbial determination:

Samples moringa dust was microbiogically analyzed for densities of bacteria, fungi, and actinomycetes. Total count technique was employed to enumerate the groups of microorganisms (page, et al., 1982). Petri dishes were incubated at 28°C for 5 days for fungi and actinomycetes and 3 days for bacteria. In agricultural microbiological department, soil, water and environment research Institute, ARC. The following media (g/l) were used for determination and counting of the microbial biomass.

A- Martin media (Martin, 1950)

For total count of fungi:

Glucose, g/L	10.0
Peptone, g/L	05.0
KH2PO4, g/L	0.50
Rose Bengal, g/L	0.03
Agar, g/L	20.0
PH	6.8

B- Jensen media (Allen, 1957)

For total count of actinomycets:

Glucose, g/L	2.0
Casein, g/L	0.20
Ca2HPO4, g/L	0.50
MgSO4, g/L	0.50
FeCl2.6H2O	traces

C- Nutrient Agar (Atlas, 2004)

Beef extract, g/L	3.0
Yeast extract, g/L	1.0
Peptone, g/L	5.0
Agar, g/L	20.0
PH	7.0

Noise level:

Machine noise levels during the operation were measured by a digital sound meter, (SL-130), (range 30-130dB).

Metabolism trials:

This study was conducted at the privet farm of Suez governorate and being in good contact with, Animal Nutrition Research Department, APRI. Three Rahmani rams were used in (3X3) Latin Square design to evaluate the experimental tested ingredients through three metabolism trials for 14 successive days, 7 days as preliminary period then 7 days for feces collection in the metabolic cages. Digestibility trails were conducted, using acid insoluble ash (AIA) method according to van Keulen and young (1977). The quantitative collection of hard feces, and feed refusals for the next seven days had specified for digestibility estimation. Sub samples (20% of feces and urine) were taken once daily and frozen until analyses. Chemical analyses of tested ingredients and urine were applied according to AOAC (2005). Values of the total digestible nutrients (TDN) and digestible crude protein (DCP) were calculated according to the classic formula of Maynard et al. (1978) on a dry matter basis (DM). Cell wall was analyzed for neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL). Hemicellulose and cellulose were determined by difference according to Van Soest (1994).

Data Analysis

Data were analyzed using the general linear model procedure of SAS (2004). Means were separated by Duncan's Multiple Range test (Steele and Torrie, 1980). One way ANOVA procedure used to analyze data following the next model: $Y_{ij} = \mu + A_{ij} + e_{ij}$.

Where: μ is the overall mean of Y_{ij}, A_{ij} as the treatment effect; e_{ij} is the experimental error

RESULTS AND DISCUSSION

Several parameters affecting the performance of cutting the moringa stalks were studied. Some of these parameters are related to the cutting devices; the obtained results throughout the several stages of laboratory and field experiments are presented and discussed in this paper.

Physical properties of moringa stalks:

A random sample of moringa stalks residues was taken to obtain some physical properties data such as stem length, diameter, Number of branches of moringa stems. The average of length and Number of branches were 42.5 cm and 10.22 respectively. Standard deviations were 2.8, 2.79 and 3.02 for top Stem diameter, middle Stem diameter and bottom Stem diameter, respectively. The Moisture content was 8 % .The obtained results are presented in Table (2).

Table (2): Average values of some physical properties of moringa stalks residues

Characteristics	position	Range	Average
Stem diameter, mm	top	1 – 11.82	4.01 ±
	middle	2.12 – 13.40	5.79 ±
	bottom	4.49 - 16	7.91 ±
Stem length, cm		14 - 71	42.5 ±
Number of branches		6 – 18	10.22 ±
Moisture content, %		8 %	

Mechanical properties of moringa stalks:

The mechanical properties of moringa stalks residues are done to determine both of penetration resistance and shear strength of different positions of the various stalk regions (bottom, middle and top). This procedure is done for proper selecting of cutting material and its technical specifications. Average values of shear strength are; top 238.2 N, middle 271.7 N and bottom 343.7 N respectively. Penetration resistance average values are; top 78 N, middle 114.7 N and bottom 143.7 N respectively, (Table 3). These results are due to the mature of bottom parts of stem set up firstly then, the next ones (middle and top) so the diameter of bottom parts is bigger than the middle and top ones. Accordingly the forces needed to overcome the big diameter must be the biggest.

Table (3). Average values of some mechanical properties of moringa stalks:

Positions	Shear strength (N)	Penetration resistance (N)
Top part of the stem	238.2	78
Middle part of the stem	271.7	114.7
Bottom part of the stem	343.7	143.7

Effect of hammers type and machine drum speed on the Particle sizes.

The data illustrated in Table (4) show that the Particle size distribution. It is found the hammer types have high effect on Particle size distribution, where the impact crusher hammer gives the highest fine particles (< 0.6 mm) and the lowest values of coarse particles (> 6.7 m) at modified blade hammer speeds. And by increasing the hammer speed increases the values of fine particles and decreases the values of coarse particles. Accordingly, the impact crusher hammer at hummer speed of 11.5 m/s records the highest and lowest values of fine particles 19.2% and coarse particles

6.3% respectively. Data presented on Table (4) clear the most effect on shredder MWD recorded by impact crusher hammer. Impact crusher hammer give the lowest MWD 2.55 mm at hammer speed of 11.5 m/s where in, flat blade impact hammer recorded the highest reading of MWD. It speeds by 10.5, 10.9 and 11.5 m/s were 3.1, 3.08 and 2.59 mm respectively for flat blade impact hammer. 10.5, 10.9 and 11.5 m/s were 3.3, 3.02 and 2.66 mm respectively for modified blade impact hammer. And 10.5, 10.9 and 11.5 m/s were 2.7, 2.66 and 2.55 mm respectively for impact crusher hammer.

Table (4): Effect of hammers type and drum speed on the Particle size distribution at moisture content of (8%).

Hammer type	Drum speed m/s	Particle size distribution (%)							
		<0.6 mm	0.6 -1 mm	1-1.4 mm	1.4-2.8 mm	2.8-3.35 mm	3.35-6.7 mm	>6.7 mm	MWD* mm
Flat blade impact hammer	10.5	8.8	10.2	6.6	32	7	24	11.4	3.10
	10.9	15	15	7	29	8	23	3	3.08
	11.5	19	17	7.2	23.5	3.3	22	8	2.59
Modified blade impact hammer	10.5	8.2	7.8	5	33	8.5	21.8	15.7	3.30
	10.9	14.8	8.5	5.6	32.5	6.7	18.8	13.1	3.02
	11.5	19	10	7.4	31.8	6	14	11.8	2.66
Impact crusher hammer	10.5	16.2	18.3	6	18	15	17.5	9	2.70
	10.9	18.2	19.8	7.5	17.2	14	16	7.3	2.66
	11.5	19.2	21.5	10	16.5	13.2	13.3	6.3	2.55

*Mean weight diameter (M.W.D)

Chemical composition:

The proximate composition of fine (FMOS) and coarse (CMOS) *Moringa oleifera* stems (MS) and clover hay (CH) is shown in Table (5). Obtained results indicated that MOS contained high protein, EE and ash had high OM, CF and NFE compare to CH. These obtained results are in accordance with Makkar and Becker (1997), Reyes Sa´nchez *et al*. (2006) and Mahmoud (2013). Concerning fiber fraction exception hemicellulose, MOS had the highest values of all fiber fractions (CMOS and fine MOS) followed by CH which had the lowest values. The mean NDF, ADF and ADL values of coarse MOS were higher (63.71, 48.78 and 12.42%) than those of fine MOS (61.85, 47.03 and 11.24%), while these corresponding values are the lowest values in CH (40.71, 32.70 and 8.13%). The results are in accordance with Makkar and Becker 1997, Reyes Sa´nchez *et al*. 2006 and Mahmoud, 2013 for NDF, ADF and ADL, respectively. It is important to realize that the chemical composition of Moringa can vary considerably mainly depending on the amount of smaller branches and twigs included along with the leaves in the leaf meal. This is shown by Fujihara *et al*. (2005), who analyzed different fractions of *Moringa oleifera* (leaves, seed cake, soft twigs, and bucks). The leaves and seed cake had a CP content of approximately 25 to 30 % while leaves with soft twigs had a CP content of 19.5 %. The CP content of soft twigs alone was yet somewhat lower but this fraction can be used for animals with lower nutrient requirements. Forages with less than 8 % CP on DM basis are defined by Leng (1990) as low quality forages. So, the CP content presented in Table (5) shows that the MS used in this experiment is high quality forage like clover hay.

Table (5): Chemical composition and fiber fraction of tested ingredients.

Item	Feedstuffs		
	Fine MOS	Coarse MOS	CH
Chemical composition			
DM	92.75	93.40	91.30
OM	92.85	92.83	91.40
CP	12.81	12.24	13.08
CF	40.10	41.62	37.65
EE	1.03	0.94	3.12
NFE	39.54	38.03	37.55
Ash	7.15	7.17	8.60
Fiber fraction			
NDF	61.85	63.71	40.71
ADF	47.03	48.78	32.70
ADL	11.24	12.42	8.13
Cellulose	35.79	36.36	24.57
Hemicellulose	14.82	14.93	8.01

Fine MOS: fine moringa oleifera stems, Coarse MOS: coarse moringa oleifera stems and CH: Clover hay. DM: Dry matter, OM: Organic matter; CF: Crude fiber; CP: Crude protein; EE: Ether extract, NFE: Nitrogen free extract, NDF: neutral detergent fiber, ADF: Acid detergent fiber and ADL: Acid detergent lignin.

Effect of hammer type at different speed on the power requirements (kW):

Table (6) shows the effect of hammer type on the power requirement at moisture content (8 %), it is fount that by increasing hammer speed power requirement increase so, the flat impact hammer gives speed of 10.5 m/s give the lowest power requirement (1.49 kW) where in impact crusher at 11.5 m/s hammer speed give the large power requirement (1.77 kW) . also ,by increasing hammer speed from 10.5 m/s to 11.5 m/s the requirement increased by 4.7% ,8.5% and 9.6 %. Flat blade impact hammer, modified blade hammer and impact crusher hammer respectively it is cleared that the hammer types have fair by effect on power requirement.

Table (6) Effect of hammer type at different speed on the power requirements (kW)

Hammer type	Drum speed (m/s)	Power (KW)
Flat blade impact hammer	10.5	1.49
	10.9	1.58
	11.5	1.65
Modified blade impact hammer	10.5	1.30
	10.9	1.38
	11.5	1.42
Impact crusher hammer	10.5	1.60
	10.9	170
	11.5	1.77

Effect of hammer type and drum speed on the machine productivity:

Table (7) shows the hammer type effect on the machine productivity at moisture content (8%). Data show that Modified blade impact hammer recorded the highest production (8.5 kg/h) followed by flat blade impact hammer (6.3 kg/h) at 11.5 m/s and Impact crusher hammer (5.7kg/h) at 11.5 m/s power requirement (1.77 kW) respectively. Also Table shows that increasing hammer speed increasing productivity. Modified blade hammer gives the highest productivity and Impact crusher hammer gives the lowest productivity. And, by increasing hammer speeds the productivity increases so, the increasing hammer speeds from 10.5 m/s to 11.5 m/s for productivity increases from 7.9%, 8% and 8.8% of Flat blade impact hammer, Modified blade impact hammer and impact crusher hammer respectively. With regard to the M.W.D., its observed that the impact crusher hammer outputs lowest M.W.D., and lowest productivity. It means that the material preoccupant at more time to produce finest particles

Table (7) Effect of hammer type on the machine productivity.

Hammer type	Speed (m/s)	Productivity (kg/h)
Flat blade impact hammer	10.5	5.8
	10.9	6
	11.5	6.3
Modified blade impact hammer	10.5	7.8
	10.9	8.1
	11.5	8.5
Impact crusher hammer	10.5	5.2
	10.9	5.4
	11.5	5.7

The impact of the cutting and crushing process of moringa stalks on healthy Operator.

The quantities of dust inhaled by operators were measured, during machine operation, the personal dust devise was used. The quantities of dust inhaled by operator were 88 (mg/m^3), 220 (mg/m^3) and 60 (mg/m^3), produce by Flat blade impact hammer, Modified blade impact hammer and Impact crusher hammer respectively. (Table 8) According to (NMAOH 2000) air pollution with dust particles more than (9.2 mg/m^3) is considered harmful for a human. Comparing the results of the tested crushing moringa stalks residues. It is clear that crushing moringa stalks residues pollute air with dust quantities above 9.2 mg/m^3.

Table (8): Effect of hammer type on the quantity of fine particles, which inhaled by operators.

Hammer type	Quantity of fine particles (mg/m^3)
Flat blade impact hammer	88
Modified blade impact hammer	220
Impact crusher hammer	60
Stander pollution	9.2

Microbiological analysis of air pollution:

In the present study the analysis of microbial indicators associated fine particles of moringa as shown in Table (9). Total viable bacteria associated moringa recorded in three replicates were 40, 17, 21 cfu/g. at the dilution of (105), total fungi associated fine particles were 24, 70, 30 cfu/g. at the dilution of (103), total Actinomyces were 7, 6, 3 cfu/g. at the dilution of (104) and total Yeasts 30, 30, 50 cfu/g. at the dilution of (103). The aerodynamic diameter (dae) is a critical factor for evaluating of respiratory exposure to fungal particles. Bacteria, Actinomyces and Yeasts have aerodynamic diameter size < 5 µm, which can penetrate into lung tissue. On the other hand, Alternaria has aerodynamic diameter > 5 µm that can deposited in the upper respiratory tract. Allergic trinities and asthma are resulted from exposure to particles >5 µm. (El-Gindy, 2001).found that, fungi species in hay and grains are implicated in asthma and allergenic alveolitis.

Table (9): Total count of bacteria, fungi, Actinomycetes and yeasts (cfu/gm/ml)

Species	Count cfu / gm/ml	Av.	Dilution
Total Bacteria	40 – 17 – 21	26	105
Total Fungi	24 – 70 – 30	42	103
Total Actinomyces	7- 6- 3	6	104
Total Yeasts	30 – 30 – 50	37	103

Fig. (3) Total microbial count cfu/ml (bacteria, fungi, and actinomycetes).

Bacteria	Actinomycetes	Fungi

Noise level:

The current study investigated the noise level resulted, as one of air pollutants. Noise levels during the operation were 54 dB, 62 dB and 90 dB during operating Flat blade impact hammer, Modified impact hammer and Impact crusher hammer respectively, as shown in (Table 10). According to (WHO 2015) declared, "Worldwide, noise-induced hearing impairment is the most prevalent irreversible occupational hazard,

Table (10): Effect of hammer type on the noise level (dB).

Hammer type	Noise level (dB)
Flat blade impact hammer	54
Modified blade impact hammer	62
Impact crusher hammer	90

Digestion coefficients and nutritive values:

Results in Table (11) for digestion coefficients were significant (P<0.05) differences among three tested Ingredients for all digestive nutrients except digestible crude protein. The highest digestibility nutrients (DM, OM, CP, CF, NFE, NDF, ADF and hemicellulose) were scored with fine *moringa oleifera* stalks followed by coarse *moringa oleifera* stalks then clover hay with significant differences between treatments. This can be explained on the basis of that *moringa oleifera* stalks contained the highest proportion of OM, EE and NFE, cellulose and hemicellulose compared to clover hay (Table 5), while clover hay contained CP (13.08%) higher than *moringa oleifera* stalks (12.24 and 12.81%) and consequently had the highest contents of CF and its fractions especially ADL compared with clover hay as shown (Table 11) which caused a good impact on digestion and nutritive values of fine *moringa oleifera* stalks (fine MOS). In general, the higher digestibility values of most nutrients obtained of all tested ingredients may be attributed to the effect of feeding such high quality roughages (CH and MOS) which provided stimulatory factors to rumen cellulolytic and other bacteria. The presence of high fiber, particularly lignin, content limits intake and reduces digestibility (Jung *et al*. 1997 and Nordheim-Viken 2009) given the negative relationship of intake and digestibility with fiber and lignin content of the feed (Moore and Jung 2001 and Casler and Jung 2006). However, the values of cell wall NDF components are below the range of 600–650 g/kg DM suggested as a limit above which intake of tropical feeds by ruminants would be limited (Van Soest *et al.* 1991). These factors resulted in some changes in digestive function which led to increasing the availability and utilization of nutrients in the rumen and could have a significant impact on digestion and nutritive values of experimental tested ingredients. Results of nutritive values (Table 11) revealed that TDN and DCP values for experimental tested ingredients appeared to be more affected by nutrients digestibility and concentrate roughages ratio. It was noticeable that (fine MOS) with highest nutrient digestibility, TDN (50.72%) and DCP (8.39%), followed by coarse MOS (TDN, 48.46% and DCP, 7.12%). The results are in accordance with finding by Balgees *et al.,* 2015) Meantime, intermediate values of nutrients digestibility of clover hay led to intermediate TDN and DCP values (45.41and 8.14%) respectively. .In these respect, Mahmoud (2013) and Jelali and BenSalem (2014) concluded that daily and alternate distribution of moringa leaves had similar effect on digestibility and feeding value in sheep than soybean meal

Table (11): Digestibility coefficients % of tested ingredients.

Item	Feedstuffs			
	Fine MOS	Coarse MOS	CH	+ SE
Digestibility coefficients%				
DM	73.90^{a}	68.32^{b}	69.88^{b}	1.35*
OM	78.07^{a}	74.60^{b}	75.92^{b}	1.32*
CP	65.50^{a}	58.22^{b}	62.20^{b}	1.21*
CF	54.32^{a}	53.45^{a}	45.80^{b}	1.43*
EE	67.75^{a}	64.17^{b}	68.20^{b}	1.15*
NFE	48.05^{a}	46.61^{b}	47.67^{c}	1.08*
NDF	67.14^{a}	65.16^{b}	60.35^{c}	1.17*
ADF	65.20^{a}	63.09^{b}	58.66^{c}	1.09*
Cellulose	75.18^{a}	73.08^{b}	68.64^{c}	1.30*
Hemicellulose	73.52^{a}	69.71^{b}	56.31^{c}	1.26*
Nutritive values, %				
TDN%	50.72^{a}	48.46^{b}	$45.1^{4\,c}$	1.14*
DCP%	8.39^{a}	7.12^{b}	8.14^{a}	0.32*

Fine MOS: fine moringaoleifera stems, Coarse MOS: coarse moringa oleifera stems and CH: Clover hay.DM: Dry matter, OM: Organic matter; CF: Crude fiber; CP: Crude protein; EE: Ether extract, NFE: Nitrogen free extract, NDF: neutral detergent fiber, ADF: Acid detergent fiber and ADL: Acid detergent lignin.

**a, b and c: Means in the same row with different superscript are significantly different (P<0.05).*

CONCLUSION

Increase finesse increase power requirement for mean weight diameter for all type of hammer. Accordingly, it could be concluded that by increasing hammer speed from 10.5 m/s to 11.5 m/s the requirement increased by 4.7%, 8.5% and 9.6 %. Flat blade impact hammer, modified blade hammer and impact crusher hammer respectively. It is cleared that the hammer types have fair by effect on power requirement. The most effect on shredder MWD recorded by impact crusher hammer. Impact crusher hammer give the lowest MWD 2.55 mm at hammer speed of 11.5 m/s where in, flat blade impact hammer recorded the highest reading of MWD. It speeds by 10.5, 10.9 and 11.5 m/s were 3.1, 3.08 and 2.59 mm respectively for flat blade impact hammer. 10.5, 10.9 and 11.5 m/s were 3.3, 3.02 and 2.66 mm respectively for modified blade impact hammer. And 10.5, 10.9 and 11.5 m/s were 2.7, 2.66 and 2.55 mm respectively for impact crusher hammer.

Fine and medium grinded *Moringa oleifera* stalks had great potential as livestock feed for small ruminants holder, especially during dry season and it consider a good quality roughage compare to clover hay.

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REFERENCES

Abd Elmottaleb, A. F.; W. A., EL Daiisiian and L. Bejo (2009). Optimization of milling farm residues using a local hammer mill. Misr J. Ag. Eng., 26(3) 1172-1189.

Allen, O. N. (1957). Experiments in soil bacteriology. ed., Burgess pub. Co., Minn eapolis, PP. 1171.

Amer Eissa A. H.; A. H. Gomaa; M. H. Baiomy and A. A. Ibrahim (2008). Physical and mechanical characteristics for some agricultural residues. Misr J. Ag. Eng., 25(1): 121-146.

AOAC (2005). Official methods of analysis 18th ed., Association of official analytical chemists, Washington, DC, U.S.A.

ASAE (2001). Methods of determining and expressing fineness of feed materials by sieving. American Society of Agricultural Engineering Standards 45th ed. S 319.3, Joseph, Mich.

Asaolu, V. O.; R. T. Binuomote; J. A. Akinlade; OyelamiandK. And O.,Kolapo (2011). Utilization of Moringa oleifera fodder combinations with Leucaena leucocephalaan Gliricidiase pium fodders by West African Dwarf goats. Int. J. Agric. Res. 6(8): 607-619.

Asar, M. A.; O. Mona; H. M., Yakout and A., Safoat, (2010). Utilization of corn-cobmeal and faba bean straw in growing rabbits diets and their effects on performance, digestibility and economical efficiency. Egypt. Poult. Sci. 30: 415-442.

Atlas, R. M. (2004). Handbook of Microbiological Media.3rd ed., CRC Press LLC, Bo Ca Raton, Florida, USA., PP. 2056-2080.

Balgees A.; A. Elmnan and M. F. El amin (2015). Nutritive Characteristics of Seeds, stems, leaves and seed cake of *Moringa oleifera* Tree. Global J. Sci. Res, Vol. 3, No 4.

Casler M.D. and H.J.,Jung (2006). Relationship of fibre, lignin and phenolics to in vitro fibre digestibility in three perennial grasses. Anim Feed SciTechnol. 125:151–161.

El-Gindy, A. M.; M. A. Gad alaa; M. A. Baiomy and Mosa, Sahar E., (2001). A study on The Effect of Threshing Mechanization Systems on Environmental Pollution. Journal of environmental science, vol. 3 No. (2) pp. 415-435.

Foidl N., H. P. S. Makkar and K. Becker (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.

Fozia F.; R. Meenu; T. Avinash; Kh. Abdul and F. Shaila (2012). Medicinal Plants Research J. 6 (27): 4368-4374.

Fujihara, A.; S. Fajemilehin and A. Omojola (2005). The egg quality characteristics of layers fed varying dietary inclusions of Siam weed (*Chromolaenaodorata*) leaf meal (SWLM). Int. J. Poult. Sci., 4: 752–757.

Hashish, A. E.; M. A. Hassan and A. F. El-Mottaleb (1994). Some factors affecting performance of chopping, crushing and grinding equipment for field raw-materials. Misr J. Ag. Eng., 11 (3):669-682.

Imbabi, A. T., (2003). Improving a crop residues cutting machine for environment preservation. Misr. J. Agr. Eng., 20 (3): 783-805.

Jelali, R. and H., Ben Salem (2014). Daily and alternate day supplementation of *Moringa oleifera* leaf meal or soybean meal to lamb receiving oat hay. J. Livestock Science, 168:184.

Jung H.G.; D.R. Mertens; A. J., Payne (1997). Correlation of acid detergent lignin and klason lignin with digestibility of forage dry matter and neutral detergent fiber. J Dairy Sci. 80: 1622–1628.

Leng, R. (1990). Factors affecting the utilization of poor quality forages by ruminants, particularly under tropical conditions. Nutr. Res. Rev. 44: 277–303.

Mahmoud, A.E.M. (2013). Effect of feeding on *moringa oleifera* stems on productive performance of growing lambs. Egyptian J. Nutrition and Feeds, 16(2): 281-292 (Special Issue).

Makkar, H.P.S. and K. Becker (1997). Nutrients and anti-quality factors in different morphological parts of the *Moringa oleifera* tree. Agric. Sci. Camb. J., 128: 311– 332.

Martin, J. P. (1950). Use of acid, Rosa Bengal and streptomycin in the plate method for estimating soil fungi. Soil science, 69, 215-232.

Maynard, L. A.; U. K. Loosli; H. F. Hintz and R. G. Warner (1978). Animal Nutrition. (7th ed.) Mcgraw. Hill Book Co., New York.

Moore K. J. and H.G. Jung (2001). Lignin and Fiber Digestion J. Range Management Vol. 54, No. 4: 420-430.

Morad, M. M; M. A. Aranout; O. A. Omar and H. I. Ahmed (2007). Effect of mechanical chopping and adding different farm residues on soil physical properties and wheat yield. Zagazig J. Agric. Res., 34 (4): 781-804.

Nordheim-Viken, H. and H. Volden (2009). Effect of maturity stage, nitrogen fertilization and seasonal variation on ruminal degradation characteristics of neutral detergent fiber in timothy (phleumpratense L.). Anim. Feed Sci. Technol. 149: 30-59.

Nordic Meeting on Agricultural Occupational Health (2000). Swedish University of Agricultural Sciences in Alnarp, Sweden, from 25-27 September.

Odee; D. (1998). Forest biotechnology research in dry lands of Kenya: the development of Moringa species. Dry land Biodiversity 2: 7 - 8.

Page, A. L.; R. H Miller and D. R. Keeney (1982). Methods of Soil Analysis Part 2Chemical and Microbiological Properties. 2nd ed. American Society of Agronomy Madison P. 1159.

Reyes Sa´nchez, N.; B. Eva Sporndly and Inger Ledin (2006). Effect of feeding different levels of foliage of *Moringa oleifera* to Creole dairy cows on intake, digestibility, milk production and composition. Livestock Science 101: 24-31.

SAS (2004). SAS User's guide. SAS Institute Inc.,

Steel, R. D. and J. H. Torrie (1980). Principals and Procedures of statistics: A biometrical approach 2nd ed., McGraw Hill Book Company, New York, USA. PP. 137.

Van Soest P.J. (1994). Nutritional ecology of the ruminant, 2nd ed. J. Anim. Sci.

Van Keulen J.,and B. A. Young (1977). Evaluation of acid In soluble Ash as a natural marker in ruminant digestibility studies. J. Anim. Sci., 44(2): 282-287.

World Health Organization (WHO) (2015). Hearing loss due to recreational exposure to loud sounds a review (http://www.who.int).

الملخص العربى

بعض العوامل الهندسية المؤثرة على إعداد مخلفات نبات المورينجا لإستخدامة فى علائق الحيوان

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تعتبر شجرة المورينجا أوليفيرا شجرة سريعة النمو فى الأجواء المناخية المختلفة، وهى شجرة واعدة وتمتلك القدرة على أن تصبح مصدرا جديدا للمواد العلفية الغير التقليدة مقارنة مع غيرها من محاصيل العلف ذات الإنتاجية العالية. والمورينجا تنتج كميات كبيرة من البقايا التى تتكون من الفروع والسيقان التي تنتج بعد الحصول على أوراق المورينجا للاستخدام البشري، مما يتسبب في مشاكل بيئية. ولهذا فإن الأهداف الرئيسية لهذا البحث هي إعداد بقايا المورينجا لإستخدامها كمكمل غذائي للحيوانات نظرا لأنها تحتوى على العديد من العناصر الغذائية، ومصادر البروتين والفيتامينات وذلك لتقليل تكلفة العلف. وفي الوقت نفسه العمل على منع تراكم هذه الكميات من المخلفات وتلويث البيئة. وقد تم تجهيز بعض الخواص الفيزيقية والميكانيكية والتركيب الكيميائي لمخلفات المورينجا عند محتوى رطوبى (٨%). من أجل تحديد العوامل الهندسية للحصول على أنسب الأطوال لتقطيع بقايا المورينجا لإستخدامها كمكمل غذائى مناسب لتغذية الحيوانات. فتم استخدام ماكينة مصنعة محليا ، وذلك لسحق وطحن مخلفات المورينجا، وقد تم استخدام ثلاثة أنواع مختلفة من المطارق في هذه الماكينة للوصول لأنسب الأطوال للتغذية. وركز البحث الحالى على مستويات الضوضاء الصادرة من الماكينة وجزيئات الغبار الملوثة للهواء نتيجة لسحق وطحن مخلفات المورينجا لضمان سلامة المشغل والحفاظ على البيئة. وتم قياس كمية الجسيمات الدقيقة المستنشقة بواسطة المشغل، والمنتجة من الماكينة.

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وقد أظهر التحليل الميكروبيولوجي لهذه الجسيمات إحتواءها على كائنات دقيقة مثل البكتيريا والفطريات والأكتينوميسينات والخمائر. الخصائص الغذائية لسيقان نباتات المورينجا أوليفير مع مستويين من الطحن (الناعم) باقطار من ٠.٦ مم حتى ١.٤ مم و(الخشن) باقطار أكبر ١.٤ مم حتى ٦.٧مم ودريس البرسيم قد تم دراسة تأثيرها فى تصميم مربع لاتينى تام العشوائية على التحليل الكيماوى ومعاملات الهضم والقيمة الغذائية على الحيوانات الحية. وأظهرت النتائج أن محتوى البروتين الخام قد سجل ١٢.٨١، ١٢.٢٤ و ١٣.٠٨٪ لكل من مطحون سيقان المورينجا الناعمة والخشنة ودريس البرسيم على التوالي. سجل محتوى سيقان المورينجا نسبة عالية من الألياف الخام أعلى من دريس البرسيم، في حين سجل دريس البرسيم نسبة عالية من المستخلص الأثيرى٣.١٢%، بينما سجلت سيقان المورينجا المطحونة محتوى منخفض من المستخلص الاثيرى ١.٠٣ و٠.٩٤٪ لكل من المطحون الناعم والخشن على التوالى. كانت مكونات الالياف الذائبة فى الوسط المتعادل والالياف الذائبة فى الوسط الحمضى واللجنين والسليلوز والهيميسليلوز لسيقان المورينجا المطحونة أعلى من مثيلتها فى دريس البرسيم. سجل مطحون سيقان المورينجا الناعم أعلى قيمة هضمية فى صورة مركبات الكلية المهضومة (٥٠.٧٢%) و بروتين مهضوم (٨.٣٩%) يليها مطحون سيقان المورينجا الخشن (٤٨.٤٦% و ٧.١٢%) ، بينما سجل دريس البرسيم مرحلة متوسطة (٤٥.٤٢% و٨.١٤%) لكل من المركبات الكلية المهضومة وبروتين مهضوم على التوالى. وكشفت النتائج أن سيقان المورينجا مطحونة بدرجة ناعمة يمكن أن يستخدمها المربي بدرجة كبيرة كعلف للمجترات، خاصة خلال موسم الجفاف حيث تعتبر أعلاف خشنة ذات جودةعالية مقارنة بدريس البرسيم.