# EFFECTS OF PHYSICAL PRETREATED OIL PALM FROND ON FEED AND NUTRIENT INTAKES OF BOER GOAT

By

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A report submitted in fulfillment of the requirements for the degree of Bachelor of Applied Science (Animal Husbandry Science) with Honours

Faculty of Agro Based Industry

UNIVERSITI MALAYSIA KELANTAN

2018

## DECLARATION

I hereby declare that the work embodied in this report is the result of the original research and has not been submitted for a higher degree to any universities or institutions.

_____

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I certify that the report of this final year project entitled “Effects of Physical Pretreated Oil Palm Frond on the Feed and Nutrient Intakes of Meat Goat” by Tea Siew Tinn, matric number F14A0385 has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Animal Husbandary Science) with Honours, Faculty of Agro-Based Industry, Universiti Malaysia Kelantan.

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## ACKNOWLEDGEMENT

I am very grateful to God for giving me the strength and good health for completing this project successfully under constraint period given. Personally I would like to thank to all the people who are directly or indirectly involve throughout this project. I would like to thanks my supervisor, Madam Nor Dini binti Rusli with my deepest and sincere gratitude. Without her continuously guidance, assistant and encouragement throughout all the process in this thesis, this report would have never accomplished.

Next, an appreciation expresses to all Agropark staff Mr. Muhamad Azrul bin Mahmood, Mr. Aidil Iskandar and Mr. Wan Muhammad Abdillah for their continuous assistant and helps me and my teammates during the rearing goats and process preparation of grass samples. Special Thanks to Mr. Mohd Irwan Hakimi from Global Venture Enterprise who always supplies the needs and managed well all the equipment needed throughout this project. I would also like to thanks to Laboratory Assistant, Mr.Shamsul Amri for allowing me using the Animal Laboratory during animal feeding trial period. Not to forget, Mr. Faiz, laboratory assistant from Faculty Veterinary UMK Pengkalan Chepa and master student, Miss Mira Panadi that always helps and guides me for proximate analysis studies.

I also want to dedicate my gratitude to Universiti Sultan Zainal Abidin (UniSZA) Tembila campus for aiding and guiding in completing the ADF analysis. With this, I managed to record and tabulate data systematically. Finally, to my parent, who always support for my successfulness. Also special thanks to my friends who always support and accompany me throughout this project. I am sincerely grateful all those involved for sharing their knowledge and help in completing this project.

**Effect of Physical Pretreated Oil Palm Frond on Feed and Nutrient Intakes of Meat Goat**

## ABSTRACT

Oil palm fronds (OPF) are the by-product of the harvest fresh fruit oil plants and it is known with limited nutrient composition. The presence of high lignin in OPF can reduce the digestibility of OPF in goats. Generally, lignin affected by biochemical and physiological activities of cells and it continuous differentiate which leads to physical barrier to microbial enzymes. Thus, the OPF needs to undergo specific pretreatment and effective ways to convert into useful by-products. The purpose of study is to assess the effect of physical pretreatment of OPF by pressing method using sugarcane machine on the feed and nutrient intakes in meat goat. In the present study, feeding trial was conducted for 120 days with 3 different dietary treatments. First diet (Napier grass, commercial goat pellet) acts as control group. Second diet, treatment 1 (Napier grass, commercial goat pellet, fresh chopped OPF) and third diet, treatment 2, combination of Napier grass, commercial goat pellet and physically pressed OPF. A total of twelve (12) Boer goats were assigned into three groups based on their initial body weight. The performance of goats which in terms of theirs feed and nutrient intakes were assessed. The higher dry matter intake was observed in T1 (0.72 ± 0.10) and T2 (0.70 ±0.10) as compared to control (0.57 ± 0.11). This showed that fresh chopped OPF and physical pressed OPF can increase the appetite and palatability of meat goat. However, the most significant nutrient utilization within these treatments was T1 which possessed highly significant value in organic matter, crude protein, ether extract and acid detergent fibre. It can be concluded that physical pretreated OPF may improve feed intake of meat goat but not certainty the completely nutrient absorption for animal consume it.

Keywords: Oil palm frond, pretreatments, lignin, feed and nutrient intakes, meat goat

**Kesan Rawatan Fizikal Pelepah Kelapa Sawit terhadap Pengambilan Makanan dan Nutrien oleh Kambing Pedaging**

## ABSTRAK

Pelepah kelapa sawit (PKW) adalah produk sampingan daripada tuaian pokok kelapa sawit dan diketahui mengandungi komposisi nutrien yang terhad. Kandungan lignin yang tinggi dalam PKW boleh mengurang kebolehtelapan kepada kambing. Secara amnya, tindakbalas biokimia dan fisiologi lignin sels akan berterusan sehingga menjadi halangan fizikal kepada enzim mikrob. Oleh itu, PKW perlu menjalani rawatan specifik dan berkesan untuk menjadi produk sampingan yang berguna serta bernilai. Tujuan pengajian ini adalah untuk menilai keberkesanan rawatan fizikal PKW (dengan menekakan PKW menggunakan mesin tebu) terhadap pengambilan makanan dan nutrien kepada kambing pedaging. Dalam kajian ini, tempoh percubaan makanan telah mengambil selama 120 hari dengan menggunakan 3 jenis diet campuran yang berbeza. Diet pertama adalah kombinasi pelet kambing komersial, dan *napier* grass yang bertindak sebagai kumpulan pemalar. Diet kedua (rawatan 1) adalah kombinasi pelet kambing komersial, *napier* grass dan PKW yang dicincang oleh mesin pemotong. Manakala, diet ketiga (rawatan 2) adalah pelet kambing komersial, *napier* grass dan PKW yang ditekan oleh mesin tebu. Sejumlah dua belas ekor kambing Boer telah dipilih, dikaji dan terbahagikan kepada tiga kumpulan berdasarkan berat badan awal masing-masing. Prestasi kambing akan dinilai berdasarkan pengambilan makan dan nutrien. Kadar pengambilan bahan kering yang lebih tinggi adalah kumpulan rawatan 1(0.72 ± 0.10) dan 2 (0.70 ±0.10) berbanding dengan kumpulan pemalar (0.57 ± 0.11). Ini membuktikan PKW yang dicincang dan ditekan dapat meningkatkan selera dan pengambilan makanan kambing pedaging. Walau bagaimanapun, nilai pengambilan nutrien yang paling signifikan adalah hanya rawatan 1. Nutrien tinggi yang terdiri daripada bahan organik, protein kasar, ekstrak eter dan serat detergen asid. Secar ringkasnya, rawatan fizikal PKW dapat meningkatkan kadar pengambilan makanan tetapi pada masa yang sama tidak dapat menentukan peningkatan kadar penyerapan nutrien kepada kambing pedaging.

Kata kunci: Pelepah kelapa sawit, rawatan, lignin, pengambilan makanan dan nutrien, kambing pedaging

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| | |
|---|---|
| $H^+$ | Proton Ion |
| ADF | Acid Detergent Fibre |
| CP | Crude Protein |
| DM | Dry Matter |
| DMD | Dry Matter Digestibility |
| DMI | Dry Matter Intake |
| DP | Degree of Polymerization |
| EE | Ether Extract |
| FAO | Food and Agriculture Organization |
| $H_2SO_4$ | Sulphuric Acid |
| $H_3BO_3$ | Boric Acid |
| HCL | Hydrochloric Acid |
| KK | Kedah Kelantan Cattle |
| LM | Light Microscope |
| ME | Metabolism Energy |
| MPOB | Malaysian Palm Oil Board |
| NaOH | Sodium Hydroxide |
| NDF | Neutral Detergent Fibre |
| OPF | Oil Palm Frond |
| PKC | Palm Kernel Cake |
| RCBD | Randomized Complete Block Design |
| TEM | Transmission Electron Microscope |

## LIST OF SYMBOLS

| | |
|---|---|
| %WW | Percent by mass |
| g/day | Gram per day |
| Kg/ha | Kilogram per hectare |
| M | Molarity |
| Million ha | Million hectare |
| MJ/kg | Mega joule per kilogram |
| Wt% | Weight percent |

# CHAPTER 1

# INTRODUCTION

## 1.1 Research Background

Nowadays, global livestock industry is under great threat as there are increase numbers of human population not to mention also the great demand of meat, milk, eggs and livestock products in order to fulfill daily basis of nutrient requirement. Therefore, agricultural by-products have become the alternative feed for livestock considering the economic and environmental impacts. Crop source such as corn, wheat, cereal grain, rice bran which enough to accommodate both animal feed and human food. In Malaysia, contributes to Malaysia's economic development. The oil palm industry in Malaysia had been introduced as an ornamental in 1871 and only from 1911 when the first oil palm estate located at Tenammaran Estate, Kuala Selangor was established. The by-products from oil palm industry obtained are oil palm frond (OPF), oil palm trunk, palm kernel cake (PKC) palm oil mill effluent and so on (Yusoff *et al.,* 2000).

Oil palm frond is the largest biomass produced from palm oil industry and it is widely used as animal feed. OPF is a significant product which can support a reasonably large population of ruminants locally. The number of chopped OPF can

be produced up to 100 kg/ha dairy (DM basis) which reported by Ishida *et al*., (1997) and a total of 15 million ha harvested in 2009 (FAO, 2011). Approximately 164 million of dry matter (DM) can cultivated for every year in the world.

Goats are known to be docile, clean and friendly animal. They are also extremely adventurous and inquisitive, being browsers rather than grazers. Goat farming management requires less capital as compare to large ruminants' animal such cattle. Plus, they can multiply faster yet require less feed than larger animals. Goat are divided into two categories either meat goat or dairy goat. Goat milk can produce average 1-2 liters milk per day, depends on types of breed and surrounding environment parameters as well. Whereas meat goat are lean meat with low saturated fat content and an ideal choice for people that suffer from high blood pressure and heart disease. Local breeds of goats are less productive compared to imported breed. Yet, they are more hardy and well-adapted to local environment.

In this study, presented another alternative way to recycle the end by-products of OPF, which is by physical pretreatment. Physical pretreatment of OPF can be obtained by pressing with high hydraulic pressure or sugarcane pressing machine. Pressed OPF suppressed the lignincellulose surface and produce sweet scent of smell that triggers higher palatability of animal consume it. Goat required small and yet high quality of feed to improves the metabolism and production. Physical pressed OPF method can be economic input source and yet bringing high yield ruminant production by local farmers in Malaysia. In nutshell, the performances of meat goats in term of their feed and nutrient intakes were assessed.

## 1.2 Problem Statement

OPF contain low-protein (nearly 15% crude protein) but high in fiber material which is palatable to herbivore livestock (Dahlan *et al.*, 1994 ; Dahlan *et al*., 2000). In addition, the presence of high lignin of OPF can reduce the digestibility of OPF in goats. Generally, lignin genetic difference primarily expressed at cellular level and further affected by biochemical and physiological activities of cells and it continuous differentiate the cells in process called lignification. Lignification can cause physical barrier to microbial enzymes. This will eventually bring negative effect on nutritional absorption for animal consume it. Therefore, physical pretreatment was chosen to pretreat the OPF prior to feeding. This physical pretreatment is expected to break the lignocellulose bond and increase the degradability.

## 1.3 Hypothesis

Ho: μ =Physical pretreatment can increase the feed and nutrient intake of OPF in goats.

H1: μ ≠ Physical pretreatment can increase the feed and nutrient intake of OPF in goats.

## 1.4 Objectives

There are two objectives of the research which are:

1. To assess the effect of physical pretreated OPF on feed dry matter intake in meat goat.
2. To assess the effect of physical pretreated OPF on nutrient intake in meat goat.

## 1.5 Scope of Study

Goats are known excellent grazing animal after cattle for pasture management. Meat goats can convert pasture consumed into meat. So, this study was conducted a test of on different type mixture feeds on 3 different groups of meat goats. First diet (Napier grass, commercial goat pellet), second diet (fresh OPF, Napier grass, commercial goat pellet) and third diet (physical pretreated OPF using sugarcane pressing machine, Napier grass, commercial goat pellet). Twelve Boer goats at Agro Technopark, UMK, Jeli Campus were assigned in to 3 experimental groups for 4 months feeding trial. The effect of physical pretreated OPF on nutrient and feed intakes were evaluated during this feed trial.

## 1.6 Significance of Study

The study of this research is to improve the nutrient intake of meat goats on either fresh chopped OPF alone with Napier grass or physical pretreated OPF with Napier grass. Even though Malaysia is the one of the main producer of oil palm industry in Asia, feeding on small ruminant such meat goats always been a major problem to agriculture sector. This research showed on relatives on improvement pretreatment processes of OPF can increase the uptake of feed consumption of small ruminants. Abu Hassan *et al.,* (1996) and Wan Zahari *et al.,* (2003) reported that Malaysia and Indonesia have a good collaboration in order to carry out the demonstrations of nutritional value and economy OPF viability for self-efficiency dairy and meat production. In addition to that, OPF also can be alternative feed supply source for the small ruminant during the long drought season that occurs in Malaysia.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Current Issues on the Use of Agriculture by- product as Animal Feed

Utilization agriculture by-products as animal feed are an effective way to upgrade low quality substances into high beneficial food source to animals (Elferink, *et al*., 2008). This is the innovative way of changing the new use of end-uses for by-products (Panouillé, *et al*., 2007; European Commission, 2015). Plus, there has been intense research and development regarding the utilization of crop residue since mid-1970s. Nowadays farmers request and demand the concept of “clean” and “natural” feed to the domestic animals with promising pay off to these products. Ajila, *et al*.,(2012) analyzed food waste production industrialization can be divided into six categories such as crop residues, fruit and vegetables waste, starch by-products, oil industry residue, grain and legume by-products and lastly fermentative by-products.

Now, this relevance topic is supported by the European Union until 2025 fully support the concept of the zero-waste society target set the environmental burden. Not just that, the end product form animal by-product such meat, blood, bones, fat, poultry heads, feathers, horn, rumen content, carcass and others are being “reprocess” and “reuse” as animal feed and for agriculture other benefits uses. In Malaysia, palm kernel

cake (PKC) and other by-product has been successfully record average daily gain of 0.74- 76kg in crossbred cattle of Sahiwal and Frisian cattle. Plus, Malaysia successfully generated 30 million tonnes oil palm biomass yearly during the recent past year (Abdul Khalil and Rozman, 2004). However, the collection and processing of by-product vary based on one country's resources and technical equipment which aimed idea of decreasing cost of waste production.

## 2.2 Plant Cell Wall Characteristics of OPF

Figure 2.1: Oil palm frond

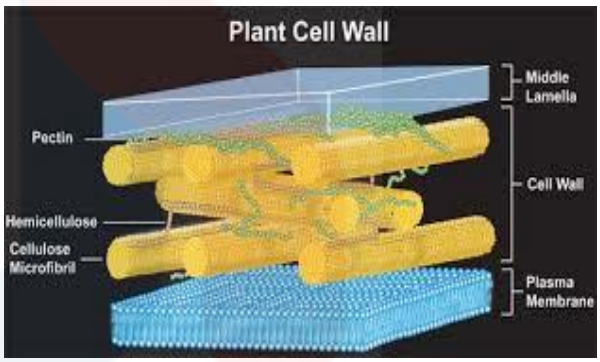


Figure 2.2: Component of plant cell wall
Source: (Carpita. N and McCann, 2000)

By using the modern technology such light microscope (LM) and transmission electron microscope (TEM), the cell wall structure and lignin distribution can be detected in various agro-waste fibers. Based on figure 2.2, the plant cells wall composed of major carbohydrates which are cellulose, hemicellulose and pectin. Based on Wan Rosli *et al*., (2007) the frond contain 86.5% holocellulose, 62.3% wt% α-cellulose, 24.2 wt% hemicellulose and 14.8% wt% lignin, imprinted that there a higher α-cellulose content as compare to trunk.

Hassan *et al*., (1994) convinced that OPF (based on figure 2.1) can be potential use as roughage source for consumption ruminant animals. It also has the quality of making into suitable textile and pulp paper manufacture in production industries. Not only just that, it can be further processed to produce fuel, chemical substances and as food as well. However, according to other studies (Hassan *et al.*, 1994 ; Liang, 2006 ; Wanrosli *et al*., 2007) OPF is limited nutrient content as it consist high amount lignin (15-56% w/w) and low degree of protein content(2-6% w/w) which is not suitable for solely intake as ruminant feed.

OPF are by-product that low-protein (nearly 15% crude protein) but contain high-fiber material that palatable to herbivore livestock (Dahlan *et al*., 2000; Dahlan *et al.*, 1994). According to Ishida and Abu Hassan, (1992) DM content of OPF is about 31.0% and 18.5% hemicelluloses. Chemical composition of OPF (% DM) such crude protein (CP), crude fibre (CF), neutral detergent fibre (NDF), acid detergent fibre (ADF), ether extract (EE), ash content and metabolism energy (ME in MJ/kg) were 4.7, 38.5, 78.7, 55.6, 2.1, 3.2 and 5.65 respectively (Wong and Wan Zahari, 1992 ; Wan Zahari *et al*., 2000). Basically, the study of this research is to analyze which mixtures feeds can be optimize the amount of nutrient intake of meat goats.

### 2.2.1 Cellulose

Cellulose is polysaccharides consist of linear chain of several hundred glucose unit and play essential component of the primary cell wall of green plants. Based on Bishop and Charles (2007), cellulose has no taste, odorless and tending to insoluble

in water with the contact angle of 20–30 degrees and most organic solvents, is chiral and is biodegradable. In addition to that, Dauenhauer *et al.,* (2016) reported that cellulose was shown characteristics to melt at higher degree of 467 °C. By treating the cellulose substances with concentrated acids, it can be chemically broken down into its monomeric sugars (Wyner, 1994). Wan Rosli *et al.,* (2004) reported that the OPF contain 62.3% α-cellulose 24.2% wt % hemicellulose and 14.8 wt% lignin suggested that a higher α -cellulose content that seen in his study.

### 2.2.2 Hemicellulose

Hemicelluloses are known to embed in the cell walls of plants, which sometimes form a network of cross-linked fibers in chains that form a 'ground' linkage. Unlike cellulose, hemicellulose is also a polysaccharide which consists of shorter chains – 500–3,000 sugar units (Gibson, 2013). In addition, hemicellulose is a branched polymer, while cellulose is unbranched polymer. It is also compromising neutral and acidic sugars in the six parts of oil palm and mainly composed of xylose. Based on Wan Rosli *et al.,*(2004) constituent sugars of the OPF were 66.6 wt% glucose, 28.9 wt% xylose, 2.2wt% mannose, 1.5 wt% arabinose and 0.9 wt% galactose which indicates that xylose was most abundant in OPF. Furthermore, xylose can be converted to xylitol, an artificial sweetener.

### 2.2.3 Pectin

In the field of botany, pectin comprised the complex structure of polysaccharides which mainly in the primary plant cell walls. It main role is to maintain the plant growth performance by extending the plant cells to binds together with component of middle lamella (Bucchan and Jones, 2000). Plus, pectin now is commercially processed as white to light brown sugar powder that function as gelling agent (Barrera *et al*., 2002; Wicker *et al*., 2003). For human diet of aspect, pectin does not give any beneficial nutrient but it works contrast towards animals such as ruminants. Generally, pectin can be 90% degradable by rumen microbes and it can also increase the energy content of forage concentrate that consumed by ruminants (Russell, 2002).

### 2.2.4 Lignin

Generally, lignin located spaces between cellulose, hemicellulose and pectin of the plant cell wall components. It plays essential as aid the process of cell maturation (Chabannes *et al*., 2001). Lignin is considered an anti-quality component in forages. Lignin genetic difference primarily expressed at cellular level and further affected by biochemical and physiological activities of cells and it continuous differentiate the cells in process called lignification. Lignification can cause physical barrier to microbial enzymes. It brings negative impact on the nutritional availability of plant fiber (Martone *et al.,* 2009).

## 2.3 OPF as Animal Feed

OPF are obtained during harvesting or pruning and felling of palms for replanting. OPF has been widely utilized as feedstuff either in the form of freshly chopped, silage, or processed into pellets and cubes. About 24 fronds are pruned per palm tree per year (MPOB, 2001). About 30 million tons of OPF is produced per year on a DM basis during the pruning and replanting activities. About 70% of the DM in the OPF is from the petiole and the rest from leaves and rachis (Zahari *et al.*, 2011). CP in leaves is higher than the petioles. But, not necessary all of the residues are suitable to be used as feedstuff for livestock.

Aside from that, in Malaysia, the practice of feeding of freshly chopped OPF has been extensively used by local farmers for feeding beef and dairy cattle. Ramli *et al*., (2005) also stated that microbial fermentation of OPF mixed with rice bran and rice husk through microbial fermentation of Japanese *koji* had enhanced the feeding value by improving the CP content. Plus, it is also able to reduce the NDF and improving the DMD of the feed, particularly with *Aspergillus awamori.* Urea and molasses treated OPF increasing the level of urea in the steamed OPF and reduced dry matter intake (DMI) and dry matter digestibility (DMD) simultaneously. By using mature Kedah-Kelantan (KK) bulls, there is an indication of about 45 % for OPF silage DMD value and decrease DMI when urea was included at 6 % of the total diet (Ishida and Abu Hassan, 1992).

Generally, freshly chopped OPF with 2-3cm are suitable for the conserved as silage for feeding the livestock. OPF must ensile under anaerobic condition. Addition of

urea and molasses in OPF silage can almost fulfill the nutrient requirement of ruminants such protein and energy. There are few studies had proven that cattle who consumed OPF silage were capable to produce more milk than those cattle fed with fresh chopped OPF (Abu Hassan *et al.,*1993 ; Ishida *et al*., 1994). However, the presence of urea can promote mold growth within the silage so addition of urea is advisable in amount of 1% to 2% only. Plus, it is generally designed for direct to replace amount of nitrogen from protein rich by product feeds. Not just that, method of steaming of OPF has capable increase the OPF digestibility as well (Goh, Tan and Lee, 2012).

### 2.4 Pretreatment Strategies of OPF

OPF are the by-product of the harvest fresh fruit oil plants and it is known with limited nutrient composition. Thus, the OPF need to undergo specific pretreatment and effective ways to convert into useful by-products. One of the functions of pretreatment especially in the bioethanol process is modifying the biomass microscopic and microscopic size into greater yield of monomeric sugars. Monomeric sugars enable to derogate energy demands and operation capital (Gupta and Verma, 2015). According to Zhang (2008) study, pretreatment stands more than 40% of the total processing cost. There were three main types of the pretreatment, namely physical pretreatment, chemical pretreatment and biological pretreatment.

### 2.4.1 Physical Pretreatment

Physical pretreatment of OPF is the process where OPF undergone some sort of physically pressed pretreatment to produce finer particles of its products. According to Palmowski and Muller (1999) milling is another alternative for the mechanical pretreatment. It reduces the OPF into smaller size to increase the surface area and the lower degree of polymerization (DP) at the same time. In addition to that, there are two researchers analyzed that a 40 mesh size of particle has slightly effective in hydrolysis rate of the OPF (Chang and Holtzapple, 2000). However, this method found to be not economically as this require continuous rise of energy source. In this study, the physical pretreatment method was used by using sugarcane machine. This method showed easier and less cost treatment on collecting pressed OPF.

### 2.4.2 Chemical Pretreatment

Chemical pretreatment is the process where OPF exposed with various type of chemical substances such as alkaline pretreatment. Alkaline pretreatment using sodium hydroxide (NaOH) is capable softening and removing the lignin content in cell wall of OPF. It is also capable to maintain the high cellulose and hemicellulose in particular preparation of pretreatment. Moreover, according to Mcintosh *et al*., (2010) ; Sills *et al*., (2011), NaOH can degrade the ester and glycosidic chains and alter the structure of lignin, causing cellulose swelling and partial decrystallization of cellulose. In many years, sodium hydroxide also has been widely studied, and it has been proven capable to break the lignin structure of the biomass, thus increasing the enzymes accessibility to

degrade cellulose and hemicelluloses (Zhao *et al*., 2008 ; Zhu *et al.*, 2010). Pretreatment of OPF using NaOH is shown to be predictable with desirability of 0.911 since it is able to increase the amount of cellulose and hemicelluloses as well as reducing the lignin contents.

Acidic pretreatment with the used of dilute sulphuric acid give out result of 85.5% glucose yield (Shevchenko *et al*., 1999; Liu and Wyman, 2003). Acidic pretreatment mechanism can degenerate the glycosidic bonds which catalyze the proton ($H^+$) in exist in aqueous solution. In addition to that, cellulose has the characteristic of both amorphous and crystalline structures that can leads to the existence of crystalline cellulose structure. The end-product of acid hydrolysis has generated numerous amounts of monomeric sugars. Latest research of the chemical pretreatment was done by Kim *et al*., (2012) stated that dilute sulphuric acid able to major amount of hemicellulose, whereas, concentrated sodium hydroxide capable removed 90% lignin.

### 2.4.3 Biological Pretreatment

Biological pretreatment is the process where the OPF undergoes non sterile condition and altered its composition by enzymatic. Biological enzymes extracted in rice husk like cellulose, xylanase, lignin peroxidase, glyoxidase and aryl alcohol oxidase which simultaneously produced during fungal treatment (Castoldi, *et al*., 2014). Whereas in OPF processing, white-rot fungi has known be most effective biodegradable lignin and increase level of breakdown of fibrous materials (Namoolnoy *et al.,* 2011). The common white-rot fungi commonly engaged for pretreatment are *Phanerochaete*

*chrysosporium*, *Ceri-poria lacerata*, *Cyathus stercolerus*, *Ceriporiosis subvermispora* and *Pleurotus ostreaus*.

In this study, the physical pretreatment was only selected and practiced throughout this project.

**2.5 Feed and Nutrient Intakes of Meat Goat**

Meat goats are categorized as small ruminant livestock production in agriculture. Meat goat production is significant in economic value as the high efficient converters from forages into quality meat in short period of time compared to cattle production. Goats are unique creature with full of curious and will acts browsers to anything that caught their attention. Goats are also known with well adapts to tropical climate due to its small size and higher ratio of body surface to body weight (Taylor, 1998). Boer goats are one of the famous breed of meat goat population in the worldwide. Boer goats are easily distinguished by its distinctive white bodies and brown heads. Boer goats are first introduced from South Africa in the early 1900s. It is categorized as polyestrous which any living creature having several estrus cycles annually or during a breeding season. Plus, Boer goats has known with fast growth rate and excellent in carcass quality. They also show high resistance to disease and low rate of mortality due to hot temperature.

Feeding is an essential element for the good raising of goats. To obtain good quality of Boer goat population depends on optimum balance of quality feed. Generally,

staple diets of ruminant mainly consist of roughages and concentrates. Roughages are important diet element as its can reduce the risk of digestive disturbance and enhance the rumen microbes activities such as Napier grass. Napier grass rather contains low protein content about 10% DM but rich in moisture. According to Moran (2011) DM contents in Napier grass can be as low as 12%, with leaves containing 16% DM and stems only 9% DM. Whereas, concentrates acts as "complete" goat feeds. It is either in form of pelleted or textured products. It is needed to fulfill balance needs of feed ratio of animal.

Goats must consume a higher quality diet than cattle. It is because their smaller digestive tract size and the regard to their maintenance energy needs. Boer goats require nutrients for body maintenance, growth performance and reproduction. The essential nutrients are water, energy, protein, minerals and vitamins. Water is the cheapest feed ingredient and required in large amount especially tropical climate in Malaysia. Energy primarily comes from the intake of sugar and starch, for example like whole cottonseed. Cottonseeds contains 25% fat is suitable for Boer goat used as energy supplement. But if a goat consumed too much of energy, it can just only stored as fat surround internal organs. Protein plays important roles as nitrogen source for the rumen microbes and protein synthesis within the goat's body. Minerals and vitamins are only requires minimal amount for the function of optimum production (Mamoon, 2008).

The fresh OPF analyzed provide sufficient amount of metabolize energy (ME) and protein for body growth performance and maintenance for small ruminant animal such goat (Dahlan *et al*., 1993). On the other hand, Nasir *et al*., (1997) claimed that the

OPF silage is not suitable use alone to fulfill the nutrient requirement for dairy goats which required more high energy intake as compare in the OPF ME content. And the escape fermentation from the rumen (by-pass protein) is enhancing the fed low growth rates in ruminants. Moreover, there was 13-16% feed intake of pelleting OPF and this might be due to the softer and sweetish smell of it. The intake of nutrient measured in (g/day).

# CHAPTER 3

# MATERIALS AND METHODS

## 3.1 Experimental Design and Research Flow

The feed trial was conducted using randomized complete block design (RCBD). A total of twelve (12) Boer goats were assigned into three groups based on their initial body weight. The experimental design of different dietary treatments is shown in Table 3.1.

Table 3.1: Different dietary treatments based on initial body weight

| Groups (4 goats/group) | Dietary treatment | | | |
|---|---|---|---|---|
| | Napier grass (50%) | Goat pellet (30%) | Oil palm frond (20%) | Total feed (kg) |
| Control | 1.75kg | 0.75kg | None | 2.5kg |
| Treatment 1 | 1.25kg | 0.75kg | Fresh OPF/0.5kg | 2.5kg |
| Treatment 2 | 1.25kg | 0.75kg | Physical pretreated OPF/0.5kg | 2.5kg |

Research flow of this study was shown as in Figure 3.1.

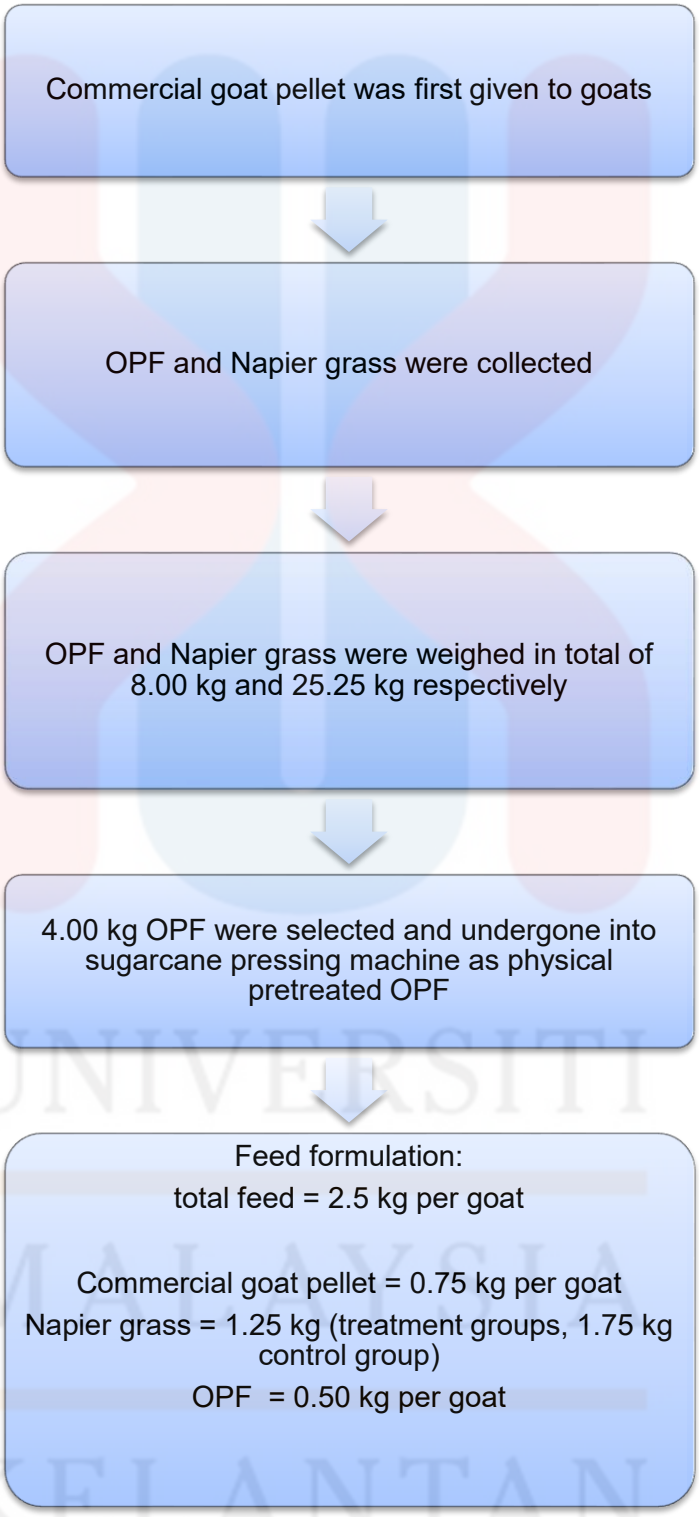


Figure 3.1: Research Flow

### 3.2 Sample Preparation

The OPF were collected from Kg Bechah Laut, Tanah Merah, Kelantan. The samples were washed carefully in order to remove unwanted foreign particles such as dirt, soil, dust and insects. Then, the washed OPF dried under the sunlight.

#### 3.2.1 Physical Pretreatment of OPF

The OPF were pressed using commercial sugarcane pressing machine to obtain pressed OPF and the juice. In the present study, pressed OPF also known as physical pretreated OPF was used in the goat diet.

### 3.3 Experimental Site and Animals

The period time for the feed trial was 4 months starting from 5 July 2017 until 30 October 2017. This trial was conducted at Agro Technopark, UMK, Jeli Campus. The animals were housed in individual pen 2 m above the ground. This trial was conducted in three stages including 30 d adaptation period, 120 d feeding trial and 7 d digestibility trial.

### 3.4 Experimental Diet

During adaptation period, twelve (12) Boer goats were given Napier grass and fresh chopped OPF. After 30 d adaptation period, 4 kg OPF was weighed and pressed daily with sugarcane machine pressing machine. Another 4 kg OPF was weighed and chopped with chopper machine as fresh chopped OPF daily. Then, both pressed and fresh chopped OPF were then mixed together with 25.25kg Napier grass to feed twelve (12) Boer daily.

### 3.5 Proximate Analysis of Feed Samples

Proximate analysis is a method to determine the quantitative of the macronutrient in feed and it is based on the Weende analysis which was discovered in 1860 by Hennerberg and Stohmann in Germany. Proximate analysis is important for this study and applied to determine content of dry matter, ash, crude protein, crude fibre, and acid detergent fibre. Proximate analysis of 6 feed samples of commercial goat pellet, napier grass, fresh OPF, pressed OPF, fresh OPF with napier grass, pressed OPF and napier grass conducted based on standard analytical method (AOAC, 1990).

#### 3.5.1 Preparation of Sample for Proximate Analysis

Feed samples were prepared and dried at 60 ˚C for 24 hours. After that, the samples were grinded by using blender. Then, all samples were stored in air tight container.

### 3.5.2 Determination of Dry Matter (DM)

Empty containers were first weighed using electronic balance (w1). Next, each sample was weighed approximately 2.0 g (w2). Then, all samples were put into force air oven for drying at 110˚C for 24 hours (AOAC, 1995). Dry weight (w3) took on the next day to determine DM content and the loss of feed samples.

% DM = (w3-w1)/w2 x 100

Where,

% DM = percentage of dry matter

w1 = Weight of empty container

w2 = Weight of approximately 2.0 g sample

w3 = Weight of dried sample

### 3.5.3 Determination of Ash Content

According to Shareef (2015), empty crucible was weighed and recorded. Next, the samples in each crucible were weighed and recorded (± 1.0 g). The crucible is put in the furnace at condition at 550˚C for 4 hours. After that, took it out the crucibles from furnace and leaved it cool before enter them into desiccator for 20 minutes. Then, all

crucibles were weighed and recorded. Lastly, the weight of the crucible was calculated. The following formula were used to determine the total ash content in the samples,

% Ash = (w3 –w1)/ w2 x 100

Where,

% Ash = Percentage of ash

w1 = Weight of the empty crucible

w2 = Weight of the sample approximately 1.0 g

w3 = Weight of the crucible with ash

### 3.5.4 Determination of Ether Extracts (EE) content / Crude Fat (CF) content

Based to Shareef (2015), aluminum cups were started being heat at 103˚C for 30 minutes and dried in desiccators for 20 minutes to cool off before start to determine the EE content. Each sample was weighed with a precision of 1.5 g (Only 4 decimal places were taken for the weight reading when recording). Next, the “MAINS” was pressed while make sure switch on the lamp. The temperature was set accordingly to suitability of solvent used which can achieve 3-5 drops per second. Proper program from 1-9 was selected and checked the time setting for boiling/ rinsing/ recovery/ pre-drying on the Control Unit. Then, the water tap was opened for reflux condensers. Thimbles were then prepared to attach on adapters. The following is the calculation of percentage CF as bellows,

% EE = (w3 –w1)/ w2 x 100

Where,

% EE = Percentage of EE/ Crude fat

w1 = Weight of the empty crucible

w2 = Weight of the sample approximately 1.5 g

w3 = Weight of the crucible with ash

### 3.5.5 Determination of Crude Protein (CP) content

The determination of CP content was achieved by using Kjeldahl method (Shareef, 2015). The equipment‘s method included were Grehardt Kjeldatherm and Grehardt Vapodest. Three parts had undergone for Kjeldahl methods namely, digestion, distillation and titration. For digestion parts it took one hour in condition of 400˚C. 1.0 g of sample was weighed by using analytical balance and switched off the air condition to avoid the error in the reading value. Then, it was put in the digestion tube. 10 mL of distilled water, 2 kjeldahl tablet and 12 mL sulphuric acid were put into digestion tube. Before inserting the digestion rack, the digestion block was turned on of Gerhardt Kjeldatherm and heated to reach 400˚C for pre-heating. Vaporization can be prevented by attach tightly between the fume manifold and digestion tube before turning the $H_2SO_4$ aspirator completely.

Then, the pre-heated was being reset the digestion block from 40 ˚C to 250 ˚C for 30 minutes. After another 30 minutes, the temperature was reset back the

temperature to 400 ˚C. In one hour later, the digestion rack was removed and moved into rack holder which locates inside the fume chamber for cooling. Distillation process was then run three times for cleaning purpose. Next, 40% of NaOH was placed in alkali tank of Gerhardt Vapodest distillation unit. Then, 80 mL of distilled water was added and 50mL 45% NaOH diluted the digested sample. After that, 30 mL of was added into receiver flask. 250mL Erlenmeyer titration flask was placed and receiving platform while fill in with 4% boric acid ($H_3BO_3$) with indicator then add into receiver solution task. Then, each digestion tube was attached to distillation unit and the samples distilled for 5 minutes. Soon, the receiving flask was removed from the unit for titration process.

For the part of titration, the $H_3BO_3$ was treated with standard 0.1 M HCL to reach pink colorization end point. Each volume of HCL used for titration was recorded and tabulated. The following formula used for determination of CP content in the sample,

% N = (T- B) x N x 14.007 x 100 x Weight of sample (mg)

% CP = %N x F (6.25)

Where,

% N = Percentage of nitrogen in the sample

T = Volume of titrant used for feed sample

B = Volume of titrant used for blank sample

N = Normality of titrant

% CP = Percentage of CP

F = Conversion factor for nitrogen to protein

### 3.5.6 Determination of Crude Fiber (CF) content

Based to Shareef (2015), Gerhardt Fibretherm was used to determine CF content of each sample. Firstly, Fibrebags were dried with 1 hour in Memmert oven and cooled in the desiccators for 30 minutes. Then, FibreBags were weighed to get the value of m1. FibreBags with glass spacers were inserted into the carousel. About 1.0 g of sample was weighed and put into Fibrebags along with glass spacers to get the m2 value. Next, the samples were defatted by washing them along with the glass spacers and carousel three times with 40 mL of petroleum ether in three times. Then, it is further dried for about 2 minutes before the two phases washing tale places.

For first phase, after solution start to boil, FiberBags and samples were boiled in 260mL of 0.13M sulphuric acid ($H_2SO_4$) for 30 minutes. Then, the FibreBags with sample were rinsed by hot water to remove the acid. For second phase, each sample was boiled with 330mL of 0.11M sodium hydroxide (NaOH) solution for 30 minutes after the solution started to boil. FibreBags and sample were then rinsed by hot water again. Again, the alkali was removed by rinsing three times with hot water. The FibreBags were removed from the carousel. The glass spacers were removed out carefully from the FibreBags without bringing out any samples.

Memmert oven then applied to dry the FibreBags for 105 ˚C at 4 hour and were put into desiccators with 30 minutes for cooling purpose. To prepare for the incineration process, the crucibles were incinerated for 600 ˚C inside the Carbolite furnace for 30 minutes. Each crucible was inserted by FibreBags and weighed to get m3 values. The crucible for blank FibreBags was weighed to get the value m6. Next, all of the crucibles along with the FibreBags were incinerated inside the Carbolite furnace for 4 hours at 600 ˚C.

After that, the crucibles were left overnight for cooling. The crucibles along with the ash were weighed to get m4 values. The blank FiberBags ash and the crucible used for the blank were weighed to get value m7. The values of ash from the blank FibreBags (m5) were determined from the value of m6 and m7. The following formula were used to determine the % CF of the samples,

m5 = m7- m6 ; %CF= (m3-m1-m4-m5) x 100m2

Where,

%CF = Percentage of CF

m1= Weight of FiberBags (g)

m2= Initial sample weight (g)

m3= Incinerating crucible and dried FiberBags after digestion (g)

m4= Incinerating crucible and ash (g)

m5= Blank value of the empty FiberBags (g)

m6= Incineration crucible (g)

m7= Incineration crucible and ash of the empty FiberBags (g)

### 3.5.7 Determination of Acid Detergent Fibre (ADF) content

Gerhardt Fibretherm can be used to determine ADF content of each sample. The all steps process is similar to CF analysis yet different in solution used. Firstly, Fibrebags were dried with 1 hour in Memmert oven and cooled in the desiccators for 30 minutes. Then, FibreBags were weighed to get the value of m1. Ask for the blank FibreBag was weighed as m5 in parallel to the regular analysis by blank determination (FibreBag without sample). While waiting, for the process of drying the fibrebags, ADF solution were prepared. ADF solution were make from 20.0 g N-cetyl-N,N,N-trimethyl-ammoniumbromide which diluted with 1.0 L of sulphuric acid ($H_2SO_4$).

FibreBags with glass spacers were inserted into the carousel. About 1.0 g of sample was weighed and put into Fibrebags along with glass spacers to get the m2 value. Glass spancers were then put into the FibreBags and both together were inserted in the carousel. 360 mL ADF solution were put into a beaker. Boiling stone and as an anti-foam agent decahydronaphthalene was added. The handling tool was attached to the carousel and the carousel gently lowered into the beaker using the ADF solution. The carousel was rotated for about 1 minute so that the FibreBags were completely filled with the solution.

Then, the extraction beaker was placed on the preheated hotplate and brought to boil by setting it full (took about 3 -5 minutes). As soon as the solution started to boil the heating power was reduced. Simmer gently for 60 minutes, the samples were floated freely in FibreBags. This can be helped by gently rotating the carousel with the handling tool or by soft swirling the beaker. Exactly 60 minutes after boiling starts, the beaker was removed from the hotplate and lifted the carousel out of the beaker using the handling tool. The solution was then slowly drained from the FiberBags.

The samples were washed 3 – 5 times with hot water (about 100 mL) till they are free of detergent. Then, the FibreBags together with the glass spacer were taken out of carousel. The spacers were removed from the FiberBags and rinsed carefully with water. Each drained FiberBag was then put into a crucible, which has been pre-ashed at 600 ˚C and weighed (value m6 for the balance protocol). Then, it was placed into a drying chamber at 105 ˚C for minimum 4 hours or overnight and FiberBag and crucible after digestion and drying is value m3. Last but not least, the samples residue together with the Fiberbags was incinerated at 600 ˚C for a least 4 hours or overnight. After incineration, the each crucible was left to cool in the drying chamber for 30 minutes and afterwards in the desiccator to cool down to ambient temperature. Then, it was then weighed and value m4 obtained for the weighing protocol.

The ADF content is the non-soluble part remaining after boiling in the acid detergent solution reduced by the content of ash. Thus, it is calculated as follows:

$$\% \text{ ADF} = \frac{((m3 - m1) - (m4 - m5)) \times 100}{m2}$$

Blank value = m7 – m6

Where,

m1 = Weight of FiberBag (g)

m2 = Initial sample weight (g)

m3 = Weight of crucible with dried FibreBag and sample residue after digestion (g)

m4 = Weight of crucible with ash (g)

m5 = Blank value of empty FiberBag (g)

m6 = Weight of crucible (g)

m7 = Weight of crucible with ash of the empty FibreBag (g)

### 3.6 Evaluation of Goat Performance

Disease and parasite infection are serious constraints affecting goat performance and production. So, physical examinations are necessary that includes general observation, drugs injection, weight feed refusal and last but not least the every body movements of goats were practiced regularly. General observation meaning performed regular checkup on each part of goat's body. For instance, everting the lower lid of the eye and examining the colour of conjuctival mucosa. In general, paler or white membrane correlate with vary degree of anemia, which correlate with burden of blood-sucking parasites.

Drugs injection acts as barrier to resist unwanted disease and increase immune system. Anthelmintics (dewormers) drugs were injected regular for every goat and each dose applied was the 10% of body weight of each goat. If there were excess in weight feed refusal, it could be there was injury on its mouth or it is the early sign where the goat is sick. Poor body movements (lameness) in goat may be associated with overgrow hoof making it difficult to move freely towards feed provided. Thus, hoof trimming was practiced to prevent further contagious foot rot and abscess.

### 3.6.1 Feed Intake

Throughout the 120 d feeding trial, daily feed offered and refused were weighed and recorded for individual goat. Daily feed were measured as the difference of the amount of feed offered and feed refused. The sample of feed offered and refused were collected every day from each goat for dry matter analysis to determine daily DMI. DMI determined based on dry matter basis as shown in the following equation:

DMI (kg) = feed offer (kg) x DM feed offer (%) - feed refused (kg) x DM feed refused (%)

### 3.6.2 Nutrient Intake

Nutrient intake determined for dry matter, ash, ether extract, crude protein, crude fibre and acid detergent fibre and calculated based on the following formula:

Nutrient intake (g/d) = Daily DMI (g) x Nutrient content in feed (%)

### 3.7 Statistical Analysis

All the data were analyzed using SPSS version 23 (2015). Data of feed intake and nutrient intake were analyzed by the Analysis of Variance (ANOVA) at 95% confidence interval. If there were significant differences, the data were compared using Duncan Multiple Range Test.

# CHAPTER 4

# RESULTS

## 4.1 The Chemical Composition of Basal Diet

Table 4.1 shows the chemical composition of 6 sample basal diet. Commercial goat pellet consists of 89.05 ± 0.11% DM, 5.01 ± 0.20% ash , 15.21 ± 0.33% CP, 3.96 ± 0.02% EE and 16.98 ± 0.41% CF. Napier grass consists of 26.41 ± 0.71% DM, 3.16 ± 0.35% ash, 13.91 ± 0.52% CP, 1.53 ± 0.10% EE and 35.50 ± 0.23% CF. Fresh OPF consists of 25.97 ± 0.62% DM, 1.98 ± 0.08% ash, 9.30 ± 0.24% CP, 0.63 ± 0.14% EE and 48.40 ± 0.66% CF. Pressed OPF consists of 29.91 ± 0.61% DM, 2.89 ± 0.39% ash, 10.66 ± 0.19% CP, 1.65 ± 0.46% EE and 40.75 ± 0.34% CF. Fresh OPF + Napier grass consists of 24.27 ± 0.69% DM, 1.36 ± 0.06% ash, 9.23 ± 0.19% CP, 0.82 ± 0.19% EE and 22.60 ± 1.11% CF. Pressed OPF + Napier consists of 33.03 ± 0.43% DM, 0.21 ± 0.24% ash, 6.14 ± 0.02% CP, 0.19 ± 0.03% EE and 27.71 ± 0.57% CF.

Table 4.1: Chemical composition of basal diet (commercial goat pellet, napier grass, fresh OPF, pressed OPF, fresh OPF + napier grass, pressed OPF + napier grass)

| Feed sample / Proximate analysis | Commercial goat pellet | Napier grass | Fresh OPF | Pressed OPF | Fresh OPF + Napier grass | Pressed OPF + Napier grass |
|---|---|---|---|---|---|---|
| DM (%) | 89.05 ± 0.11 | 26.41 ± 0.71 | 25.97 ± 0.62 | 29.91 ± 0.61 | 24.27 ± 0.69 | 33.03 ± 0.43 |
| Ash (%) | 5.01 ± 0.20 | 3.16 ± 0.35 | 1.98 ± 0.08 | 2.89 ± 0.39 | 1.36 ± 0.06 | 0.21 ± 0.24 |
| CP (%) | 15.21 ± 0.33 | 13.91 ± 0.52 | 9.30 ± 0.24 | 10.66 ± 0.19 | 9.23 ± 0.19 | 6.14 ± 0.02 |
| EE (%) | 3.96 ± 0.02 | 1.53 ± 0.10 | 0.63 ± 0.14 | 1.65 ± 0.46 | 0.82 ± 0.19 | 0.19 ± 0.03 |
| CF (%) | 16.98 ± 0.41 | 35.50 ± 0.23 | 48.40 ± 0.66 | 40.75 ± 0.34 | 22.60 ± 1.11 | 27.71 ± 0.57 |

Note: OPF, oil palm frond; DM, dry matter; CP, crude protein; EE, ether extract; CF, crude fibre.

## 4.2 The Mean of Total Dry matter Intake (DMI) between Treatments

Table 4.2 shows the mean of DMI between different treatments. Both T1 (0.72 ± 0.10 $^{b}$) and T2 (0.70 ± 0.10 $^{b}$) were significantly higher ($P < 0.05$) than control (0.57 ± 0.11 $^{a}$). However, there were no significant difference ($p > 0.05$) between T1 and T2.

Table 4.2: Mean of total dry matter intake (DMI) between treatments

| Treatment | Total DMI (kg/day) |
|---|---|
| Control | 0.57 ± 0.11 $^{a}$ |
| T1 | 0.72 ± 0.10 $^{b}$ |
| T2 | 0.70 ± 0.10 $^{b}$ |

Note: OPF, oil palm frond.

$^{ab}$ Means in the same row with different superscripts are significant different at 5% level ($P < 0.05$) by Duncan Multiple Range Test.

Control : Commercial Pellet + Napier
T1 : Commercial Pellet + Napier + OPF
T2 : Commercial Pellet + Napier + Pressed OPF

### 4.3 The Mean of Nutrient Intake between Treatments

Table 4.3 shows nutrient intake between different treatments. It was found that OM and ADF intakes in both T1 and T2 were significantly higher ($p < 0.05$) than control. However, there were no significant difference ($p>0.05$) between T1 and T2. CP and EE intake in control and T1 were significantly higher ($p < 0.05$) as compared to T2. However, between control and T1 did not differ significantly ($p > 0.05$). CF intake in T2 was significantly higher ($p < 0.05$) than control and T1. However, there were no significant difference ($p > 0.05$) between control and T1.

Table 4.3 Mean of nutrient intake between treatments

| Parameter | Control | T1 | T2 |
|---|---|---|---|
| OM | 549.54 ± 10.97 $^{a}$ | 702.37 ± 9.50 $^{b}$ | 683.58 ± 9.50 $^{b}$ |
| CP | 83.74 ± 1.41 $^{b}$ | 86.14 ± 1.22 $^{b}$ | 71.52 ± 1.22$^{a}$ |
| EE | 16.27 ± 0.30 $^{b}$ | 16.07 ± 0.29 $^{b}$ | 13.19 ± 0.29 $^{a}$ |
| CF | 146.55 ± 2.64 $^{a}$ | 145.82 ± 2.29 $^{a}$ | 160.35 ± 2.29 $^{b}$ |
| ADF | 244.24 ± 5.80 $^{a}$ | 358.26 ± 5.01 $^{b}$ | 364.91 ± 5.01 $^{b}$ |

Note: OM-organic matter, CP-crude protein, EE-ether extract, CF-crude fibre, ADF-acid detergent fibre.

$^{a\,b}$ Means in the same row with different superscripts are significant different at 5% level ($P < 0.05$) by Duncan Multiple Range Test.

Control : Commercial Pellet + Napier
T1 : Commercial Pellet + Napier + OPF
T2 : Commercial Pellet + Napier + Pressed OPF

# CHAPTER 5

# DISCUSSION

## 5.1 Chemical Composition of Basal Diet

Meat goats are highly selective feeding animal with some morphological, physiological inherent in strategy to utilize the available feed resources (Morand-Fehr, 2003). Goats in general have a preference for dry feed in pelleted form rather than flour form (Morand-Fehr, 2003; Bateman *et al.,* 2004). The main reason is that goat possess upper respiratory tract by the consumption and inadequate inhalation of fine, dry feeds. The same preference goes to young goat (Bateman *et al*., 2004) as well as adults (Morand-Fehr, 2003) and also the fact that pelleted diets enable rapid eating rate. As might be expected, pelleted feed acts as complementary nutrient to goat diet as it is balanced formulated with energy, protein, minerals and as well other nutritional requirements of goat at all stages of age.

Table 4.1 shows commercial goat pellet consists of 89.0 % DM, 5.0 % ash, 15.2% CP, 3.9 EE and 16.9 % CF via proximate analysis. Approximately to the nutrient content of commercial goat pellet share quick resemble to previous study of Haddad (2005). Specifically, Haddad (2005) stated that goat pellets consists of 87.0 % DM, 10.0 % ash, 12.5 % CP and 20.0 % CF. Goat pellet improve the increases rate of gain and control

coccidiosis disease (Smith and Sherman, 1994; Daugschies and Najdrowski, 2005; Chartier and Paraud, 2012). Increasing uptake concentrates (goat pellet) in meat goat diets can result in increase of carcass quality and ideal optimal growth weight (Ryan *et al.*, 2007; Haddad, 2005, Urge *et al*., 2004).

Napier grass (*Pennisetum purpureum*) commonly known as Elephant grass particularly suitable use as forage and can be manually or mechanically chopped and then let it dry under the sun for several hours reduce moisture content, induce appetite and improves forage utilization (Moran, 2011). Based on table 4.1, it is showed that Napier grass consists of 13.9 % CP which slightly differ to previous study of Tcacenco and Lance (1992) evaluated the CP content was 20.0%. It may be due to differ in morphological characteristics of Napier grass and based on leaf, stem and maturity stage. Leaf CP was about 17%, while stem CP was 3.6 % and suggestion optimal cultivate the Napier is at week 6 to 8 (Tcacenco and Lance, 1992).

OPF are one of most abundant agriculture by-product in Malaysia. There is a high fibre content which affects the digestibility to animal consumed it, even so, researcher acknowledged that there are inclusion data in maximize to safeguard in animal production, especially for ruminants. Based on table 4.1, fresh OPF comprises 48.4% CF. However, according to Wong and Wan Zahari (1992) stated that OPF contain 38.5% CF which lesser than result obtained. This probably due to overly matured OPF cultivated and the increases numbers of lignin cells found on the plant (Wong and Wan Zahari, 1992). And as for higher fibre generally published were good for regurgitation in goats but there is no convincing that digestibility is significant to its body absorption.

Physical pretreatment of OPF is the process where OPF undergone mechanical pretreatment into smaller size to increase the surface area and the lower degree of polymerization (DP). The end product is called pressed OPF. Based on table 4.1, pressed OPF consists of 40.8 % CF which slightly lower than fresh OPF (48.4 % CF). This might be due to mechanical process by the sugarcane pressing machine making the slightly reduces in lignin numbers of it. Even so with the compress fibre surface, the sweet fragrance smell is released into the air which triggers increase appetite of the meat goat. Pressed OPF also consists of 10.7 % CP which higher than the fresh OPF with 9.3% CP. This common phenomenon is generally proved that protein associated with undegradable fibre may be normal rumen function, setting with lower fibre with high protein roughages (Negesse *et al.,* 2001).

Table 4.1 shows basal diet combination fresh OPF and Napier grass consist higher EE content than combination pressed OPF and Napier grass with values of 0.8 % and 0.2 % subsequently. Fat source including saturated and unsaturated fats, oil, lipids protects and unprotected from ruminal biohydrogenation (Wood *et al*., 2003) and modify muscle lipid composition of ruminants (Banskalieva *et al*., 2000).

## 5.2 Total Dry Matter Intake (DMI) between Treatments

Feedstuffs commonly originate from plant extracts and forages contain varying amount of water and DM faction which composed both organic and inorganic matter. DM is an analytical indicator amount of nutrients that are available to particular food, especially in animal feed. Livestock need consume adequate amount of dry matter per

day (measured in kg/day) to maintain health and production which according to its breed, weight and stage of production.

Table 4.2 shows the mean of DMI between different treatments. Both T1 (0.72 ± 0.10 $^{b}$) and T2 (0.70 ± 0.10 $^{b}$) were significantly higher ($P < 0.05$) than control (0.57 ± 0.11$^{a}$ ). This could be due to combination of Napier grass and OPF compress higher quality forages compare to only single forage Napier grass that given to control group (Goodwin *et al*., 2002). OPF have sweet fragrance odour that trigger palatability and attract increase uptake of feed. Another reason for the increase of DMI of the feed might be due to chemical composition of higher fibre content and crude protein within these two combinations of grasses (Negesse *et al.,* 2001).

However, there were no significant difference ($p > 0.05$) between T1 and T2. This proved that pretreated OPF either freshly chopped or physically pressed OPF did not bring any positive effect on feed intake. Similarly, there is no significant rate of degradation the plant cell wall of the forage and breakdown the lignocelluose structure. Plus, there could be means that is more resistance to rumen microbes degradable to fine fermentation.

**5.3 Nutrient Intake between Treatments**

Nutrient requirements by goats need to be nutritional limitations associated with forages and other feedstuff. However, there is no sure that all constituent nutrient feed

were completely absorbed by meat goat. Given in table 4.3, clearly that its content nutrition spatial distribute and animal itself be regarded to setting of upper limit intake (CSIRO, 2007; NRC, 2007). In addition to that, differ particular age and body condition may influence the capacity of feed intake.

Based on Table 4.3, it was found that OM and ADF intakes in both T1 and T2 were significantly higher ($p < 0.05$) than control. This means that both T1 and T2 comprises significant value others nutrient such carbohydrate, proteins, fats, vitamin, lignin, cellulose and insoluble forms of nitrogen except hemicellulose as compare to control (NRC, 2007). However, there were no significant different ($p>0.05$) between T1 and T2. Freshly chopped or physically pressed OPF did not bring any fruitful result for Boer in either way. The only difference is that changed physical appearances of OPF which enable trigger the total same amount of nutrient consumption in OM and ADF intakes.

CP and EE intake in control and T1 were significantly higher ($p < 0.05$) as compared to T2. This is to shows that combination of commercial goat pellet and Napier grass (in control) and combination of commercial goat pellet and freshly chopped OPF (in T1) possessed high level of degradable and undegradable protein intake (Kawas *et al*., 1997) and with low-level supplement of fat content represent greatly proportion of the supplement to its confinement (Kawas *et al.,* 2010). However, between control and T1 did not differ significantly ($p > 0.05$). This is to shows that Boer in Control and T1 may share the similar chewing activities and assimilate sugar and starch that versus rapidly of energy supplement (Galloway *et al.,* 1993).

CF intake in T2 was significantly higher ($p < 0.05$) than control and T1. Compared with Napier grass and fresh chopped OPF, physical pressed OPF had higher-fibre digested in goats. However, there were no significant difference ($p > 0.05$) between control and T1. According to Silanikove, (2000) and Alexandre and Mandonnet, (2005) physical and chemical of high-fibre feed may not provide sufficient nutrients for cost-efficient goat production. This also may be due to the increase of fibre components and lignification that reduce the nutrient intake that required by maintenance and production (Ben Salem and Nefzaoui, 2003; Alexandre and Mandonnet, 2005).

# CHAPTER 6

# CONCLUSION AND RECOMMENDATION

## 6.1 Conclusion

Physical pretreated OPF significantly effective on feed intake for T1 and T2 whereas for nutrient intake only T1 is more significant as compare to control and T2. The higher dry matter intake was observed in T1 (0.7240 ± 0.10) and T2 (0.700 ±0.10) as compared to control (0.5732 ± 0.11). However, the most significant nutrient utilization within these treatments was T1 which possessed highly significant value in organic matter, crude protein, ether extract and acid detergent fibre in sequence reading of 702.37 ± 9.50 $^{b}$, 86.14 ± 1.22 $^{b}$, 16.07 ± 0.29 $^{b}$ and 358.26 ± 5.01 $^{b}$. This showed that fresh chopped OPF and physical pressed OPF can increase the appetite and palatability of meat goat. Even so, with freshly chopped pretreated OPF give the higher fruitful result in nutritive intake of all as compare to control and T2.

## 6.2 Recommendation

Biological pretreatment on oil palm frond is highly recommended to be chosen and practice for feed and nutrient intakes of Boer goat. Biological pretreatment is the process where the OPF undergoes non-sterile condition and altered its composition by enzymatic. White-rot fungi is known be most effective biodegradable lignin and proven capable to break the lignin structure of the biomass, not to mention its ability increasing the enzymes accessibility to degrade cellulose and hemicelluloses. It is more accessible to Boer goat to uptake the feed along with fully assimilate its nutrient of oil palm frond. Further research is necessary for the extension utilization of the excessive agriculture by-products in more significant way and brings additional income to the agriculture sector as well.

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## APPENDIX A

## SSPS Analysis

Table A.1: Duncan's multiple range tests for chemical composition of basal diet

**Estimated Marginal Means**

**1. Grand Mean**

| Dependent Variable | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| Organic_Matter | 645.161 | 5.781 | 633.819 | 656.503 |
| Crude_Protein | 80.466 | .743 | 79.008 | 81.924 |
| Ether_Extract | 15.175 | .174 | 14.832 | 15.517 |
| Crude_Fibre | 150.906 | 1.393 | 148.174 | 153.638 |
| Acid_Detergent_Fibre | 322.471 | 3.051 | 316.486 | 328.455 |

**2. Treatment**

| Dependent Variable | Treatment | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound |
| Organic_Matter | 1 | 549.535 | 10.969 | 528.016 | 571.055 |
| | 2 | 702.370 | 9.500 | 683.733 | 721.006 |
| | 3 | 683.577 | 9.500 | 664.940 | 702.213 |
| Crude_Protein | 1 | 83.736 | 1.410 | 80.970 | 86.502 |
| | 2 | 86.141 | 1.221 | 83.745 | 88.536 |
| | 3 | 71.522 | 1.221 | 69.126 | 73.918 |
| Ether_Extract | 1 | 16.268 | .331 | 15.619 | 16.917 |
| | 2 | 16.067 | .287 | 15.504 | 16.629 |
| | 3 | 13.189 | .287 | 12.627 | 13.751 |
| Crude_Fibre | 1 | 146.555 | 2.642 | 141.371 | 151.739 |
| | 2 | 145.816 | 2.288 | 141.327 | 150.306 |
| | 3 | 160.347 | 2.288 | 155.858 | 164.836 |
| Acid_Detergent_Fibre | 1 | 244.238 | 5.788 | 232.883 | 255.593 |
| | 2 | 358.265 | 5.013 | 348.431 | 368.098 |
| | 3 | 364.910 | 5.013 | 355.076 | 374.743 |

**Post Hoc Tests**

**Treatment**

**Homogeneous Subsets**

**Organic_Matter**

Duncan[a,b,c]

| Treatment | N | Subset 1 | Subset 2 |
|---|---|---|---|
| 1 | 354 | 549.5355 | |
| 3 | 472 | | 683.5766 |
| 2 | 472 | | 702.3697 |
| Sig. | | 1.000 | .185 |

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 42596.710.
a. Uses Harmonic Mean Sample Size = 424.800.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
c. Alpha = .05.

**Crude_Protein**

Duncan[a,b,c]

| Treatment | N | Subset 1 | Subset 2 |
|---|---|---|---|
| 3 | 472 | 71.5221 | |
| 1 | 354 | | 83.7360 |
| 2 | 472 | | 86.1407 |
| Sig. | | 1.000 | .187 |

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 703.828.
a. Uses Harmonic Mean Sample Size = 424.800.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
c. Alpha = .05.

**Ether_Extract**

Duncan[a,b,c]

| Treatment | N | Subset 1 | Subset 2 |
|---|---|---|---|
| 3 | 472 | 13.1890 | |
| 2 | 472 | | 16.0667 |
| 1 | 354 | | 16.2679 |
| Sig. | | 1.000 | .638 |

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 38.777.

a. Uses Harmonic Mean Sample Size = 424.800.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

c. Alpha = .05.

**Crude_Fibre**

Duncan[a,b,c]

| Treatment | N | Subset 1 | Subset 2 |
|---|---|---|---|
| 2 | 472 | 145.8162 | |
| 1 | 354 | 146.5548 | |
| 3 | 472 | | 160.3469 |
| Sig. | | .829 | 1.000 |

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 2471.744.

a. Uses Harmonic Mean Sample Size = 424.800.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

c. Alpha = .05.

**Acid_Detergent_Fibre**

Duncan[a,b,c]

| Treatment | N | Subset 1 | Subset 2 |
|---|---|---|---|
| 1 | 354 | 244.2383 | |
| 2 | 472 | | 358.2647 |
| 3 | 472 | | 364.9099 |
| Sig. | | 1.000 | .374 |

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 11859.171.

a. Uses Harmonic Mean Sample Size = 424.800.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

c. Alpha = .05.

Table A.2: Duncan's multiple range tests for mean of total dry matter intake (DMI) between treatments

**Estimated Marginal Means**

**1. Grand Mean**

Dependent Variable: Total Dry Matter

| Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|
| | | Lower Bound | Upper Bound |
| .666 | .006 | .654 | .677 |

**2. Treatment**

Dependent Variable: Total Dry Matter

| Treatment | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| Treatment Control (Pellet + Napier) | .573 | .011 | .551 | .595 |
| Treatment 1 (Pellet + Napier + OPF) | .724 | .010 | .705 | .743 |
| Treatment 2 (Pellet + Napier + P.OPF) | .700 | .010 | .681 | .719 |

**Post Hoc Tests**

**Treatment**

**Homogeneous Subsets**

**Total Dry Matter**

Duncan[a,b,c]

| Treatment | N | Subset | |
|---|---|---|---|
| | | 1 | 2 |
| Treatment Control (Pellet + Napier) | 354 | .5732 | |
| Treatment 2 (Pellet + Napier + P.OPF) | 472 | | .7002 |
| Treatment 1 (Pellet + Napier + OPF) | 472 | | .7240 |
| Sig. | | 1.000 | .103 |

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = .045.
a. Uses Harmonic Mean Sample Size = 424.800.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
c. Alpha = .05.

Table A.3: Duncan's multiple range tests for mean of nutrient intake between treatments

**Estimated Marginal Means**

**1. Grand Mean**

| Dependent Variable | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| Organic matter | 645.161 | 5.781 | 633.819 | 656.503 |
| Crude protein | 80.466 | .743 | 79.008 | 81.924 |
| Ether extract | 15.175 | .174 | 14.832 | 15.517 |
| Crude fibre | 150.906 | 1.393 | 148.174 | 153.638 |
| Acid detergent fibre | 322.471 | 3.051 | 316.486 | 328.455 |

**2. Treatment**

| Dependent Variable | Treatment | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound |
| Organic matter | Control | 549.535 | 10.969 | 528.016 | 571.055 |
| | T1 | 702.370 | 9.500 | 683.733 | 721.006 |
| | T2 | 683.577 | 9.500 | 664.940 | 702.213 |
| Crude protein | Control | 83.736 | 1.410 | 80.970 | 86.502 |
| | T1 | 86.141 | 1.221 | 83.745 | 88.536 |
| | T2 | 71.522 | 1.221 | 69.126 | 73.918 |
| Ether extract | Control | 16.268 | .331 | 15.619 | 16.917 |
| | T1 | 16.067 | .287 | 15.504 | 16.629 |
| | T2 | 13.189 | .287 | 12.627 | 13.751 |
| Crude fibre | Control | 146.555 | 2.642 | 141.371 | 151.739 |
| | T1 | 145.816 | 2.288 | 141.327 | 150.306 |
| | T2 | 160.347 | 2.288 | 155.858 | 164.836 |
| Acid detergent fibre | Control | 244.238 | 5.788 | 232.883 | 255.593 |
| | T1 | 358.265 | 5.013 | 348.431 | 368.098 |
| | T2 | 364.910 | 5.013 | 355.076 | 374.743 |

**Post Hoc Tests**

**Treatment**

**Homogeneous Subsets**

**Organic matter**

Duncan[a,b,c]

| Treatment | N | Subset 1 | Subset 2 |
|---|---|---|---|
| Control | 354 | 549.5355 | |
| T2 | 472 | | 683.5766 |
| T1 | 472 | | 702.3697 |
| Sig. | | 1.000 | .185 |

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 42596.710.
a. Uses Harmonic Mean Sample Size = 424.800.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
c. Alpha = .05.

**Crude protein**

Duncan[a,b,c]

| Treatment | N | Subset 1 | Subset 2 |
|---|---|---|---|
| T2 | 472 | 71.5221 | |
| Control | 354 | | 83.7360 |
| T1 | 472 | | 86.1407 |
| Sig. | | 1.000 | .187 |

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 703.828.
a. Uses Harmonic Mean Sample Size = 424.800.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
c. Alpha = .05.

**Ether extract**

Duncan[a,b,c]

| Treatment | N | Subset 1 | Subset 2 |
|---|---|---|---|
| T2 | 472 | 13.1890 | |
| T1 | 472 | | 16.0667 |
| Control | 354 | | 16.2679 |
| Sig. | | 1.000 | .638 |

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 38.777.
a. Uses Harmonic Mean Sample Size = 424.800.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
c. Alpha = .05.

**Crude fibre**

Duncan[a,b,c]

| Treatment | N | Subset 1 | Subset 2 |
|---|---|---|---|
| T1 | 472 | 145.8162 | |
| Control | 354 | 146.5548 | |
| T2 | 472 | | 160.3469 |
| Sig. | | .829 | 1.000 |

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 2471.744.
a. Uses Harmonic Mean Sample Size = 424.800.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
c. Alpha = .05.

**Acid detergent fibre**

Duncan[a,b,c]

| Treatment | N | Subset 1 | Subset 2 |
|---|---|---|---|
| Control | 354 | 244.2383 | |
| T1 | 472 | | 358.2647 |
| T2 | 472 | | 364.9099 |
| Sig. | | 1.000 | .374 |

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 11859.171.

a. Uses Harmonic Mean Sample Size = 424.800.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

c. Alpha = .05.

## APPENDIX B

B.1: Napier grass and oil palm frond

B.2: Chopper

B.3: Sugarcane pressing machine

B.4: Daily cleaned and changed fresh water supply to goats

B.5: Daily weighed feed refusal and take samples

B.6: Each goat was trimmed using clipper

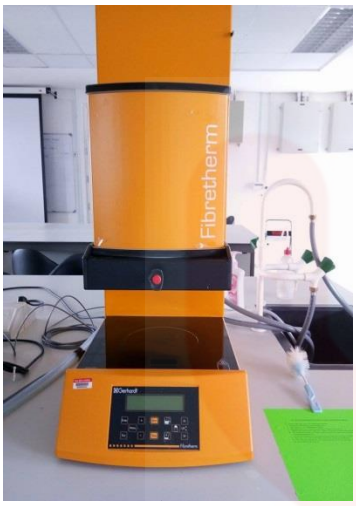

B.7:N-cetyl-N,N,N-trimethyl-ammoniumbromide, sodium lauryl sulphate, potassium dihydrogenphosphate


B.8: Sodium dihydroxide phosphate, Kjedhal catalyst tablet, sodium hydroxide pellets


B.9: EDTA disodium salt, di-sodium tetraborate, 2-ethoxyethanol


B.10: Boric acid, D (+) - glucose anhydrous

B.11: Sulphuric acid, sodium hydroxide pellets, petroleum ether




B.12: Kjedhal Fibretherm

B.13: Desiccator

B.14: Electronic balance


B.15: Soxhlet extraction


B.16: Kjedhal Vapodest


B.17: Oven