UNIVERSITI PUTRA MALAYSIA

# THE EFFECT OF DIFFERENT FEED FORMULATION ON BODY WEIGHT GAIN, FEED INTAKE AND STRESS PARAMETER IN GOAT

MUHAMMAD SAIFUL AZRI BIN ROSLEE

# THE EFFECT OF DIFFERENT FEED FORMULATION ON BODY WEIGHT GAIN, FEED INTAKE AND STRESS PARAMETER IN GOAT

**MUHAMMAD SAIFUL AZRI BIN ROSLEE**

A project paper submitted to the

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## CERTIFICATION

It is hereby certified that we have read this project entitled "The Effect of Different Feed Formulation on Body Weight Gain, Feed Intake and Stress Parameter in Goat", by Muhammad Saiful Azri bin Roslee and in our opinion it is satisfactory in terms of scope, quality, and presentation as partial fulfillment of the requirement for the course VPD 4999 – Project

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## DEDICATIONS

This project paper I dedicated to:

My mom, Mawar Jaafar

a strong and gentle soul who taught me to trust in Allah and believe in hard work

My dad, Roslee Daim

for earning an honest living for us and encouraging me to believe in myself

My supervisor's newborn baby boy, Danial Imran

which literally heard my presentation and see the world on the right time,

My significant others,

Arustika Putrasakti family

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Abstrak daripada kertas projek yang dikemukakan kepada Fakulti Perubatan Veterinar untuk memenuhi sebahagian daripada keperluan kursus VPD 4999 – Projek

**KESAN PERBEZAAN FORMULASI PEMAKANAN TERHADAP PENAMBAHAN BERAT BADAN, PENGAMBILAN MAKANAN DAN PARAMETER STRES PADA KAMBING**

**Oleh**

**Muhammad Saiful Azri bin Roslee**

**2016**

**Penyelia: Dr. Hasliza binti Abu Hassim**

**Penyelia bersama: Dr. Hazilawati binti Hamzah**

Nutrisi seimbang adalah sangat mustahak terhadap kesihatan dan prestasi haiwan ternakan. Ia adalah yang terbaik sekiranya makanan tersebut dapat diformulasikan mengikut tahap produksi kambing. Walaubagaimanapun, sepanjang tumbesaran seekor kambing bermula dari peringkat anak ke dewasa, ia perlu melalui beberapa perubahan formulasi pemakanan bagi memenuhi kehendak harian mereka. Perubahan ini mampu menjadikan keadaan yang stres kepada kambing. Melalui eksperimen ini, penambahan berat badan dan pengambilan makanan digunakan bagi mengenalpasti prestasi dan ujian darah leukogram stres digunakan sebagai parameter stres sepanjang pelaksanaan

formulasi pemakanan yang berbeza terhadap kambing betina. Lapan belas ekor kambing betina yang mempunyai keadaan skor badan dan berat badan dalam anggaran 20kg telah dipilih dan dibahagikan kepada tiga kumpulan (n=16) dan diberikan formulasi pemakanan yang berbeza, Diet 1 adalah formulasi pemakanan yang telahpun dijalankan di ladang tersebut, Diet 2 adalah formulasi pemakanan mengikut keperluan saradiri dan Diet 3 adalah formulasi pemakanan bertujuan persediaan untuk pembiakan selama empat minggu. Berat badan ditimbang sebelum bermula eksperimen, Minggu ke-2 dan Minggu ke-4, pensampelan darah dilakukan sebelum bermula eksperimen dan Minggu ke-4 sebagai perbandingan. Pengambilan makanan pula dikira setiap hari. Kesemua data dianalisis secara statistik menggunakan perisian SPSS. Melalui kajian ini, kambing dari Diet 3 menunjukkan penambahan berat badan yang paling tinggi, diikuti Diet 2 dan Diet 1. Terdapat perubahan yang ketara ($p<0.05$) pada penambahan berat badan bagi setiap kumpulan. Parameter stres pada kiraan sel darah putih bagi Diet 1 menunjukkan kiraan tertinggi jika dibandingkan dengan kumpulan lain tetapi tiada perubahan yang ketara ($p>0.05$) jika dibandingkan dengan julat normal. Nisbah neutrofil:limposit untuk kesemua kumpulan adalah dalam julat normal dan tiada perubahan yang ketara ($p>0.05$). Pelaksanaan formulasi pemakanan mengikut tahap produksi adalah disarankan kerana ia meningkatkan prestasi dan mampu mengelakkan daripada stres nutrisi yang tidak seimbang.

Kata kunci: *Formulasi Pemakanan, Penambahan Berat Badan, Pengambilan Makanan, Leukogram Stres, Nisbah Neutrofil:limposit*

## ABSTRACT

An abstract of the project paper presented to the Faculty of Veterinary Medicine in partial fulfillment of the course VPD 4999 – Project.

**THE EFFECT OF DIFFERENT FEED FORMULATION ON BODY WEIGHT GAIN, FEED INTAKE AND STRESS PARAMETER IN GOAT**

**By**

**Muhammad Saiful Azri bin Roslee**

**2016**

**Supervisor: Dr. Hasliza binti Abu Hassim**

**Co-supervisor: Dr. Hazilawati binti Hamzah**

Balanced nutrition is essential for health and performance of livestock. It is best when feed is formulated according to production stages of goat. However, as the goat grows, it may undergo transition of different feed formulation to meet its daily requirement. It may lead to a stressful condition. In this study, body weight gain and feed intake were used to determine effect on performance, whereas hematological stress leucograms were used as stress parameter during implementation of different feed formulation among does. Eighteen adult does with similar body condition score and body weight approximately 20kg were selected and divided into three groups equally (n=6) and fed with different feed formulations, Diet 1 which already being practiced in the farm,

Diet 2 which formulated for maintenance requirement and Diet 3 which formulated for flushing for four weeks. Body weight was measured before implementation, Week 2 and Week 4, blood sampling was conducted before implementation and during Week 4 for comparison and feed intake was measured every day. All of the data were statistically analyzed using SPSS. Does fed with Diet 3 showed highest body weight gain and feed intake, followed by Diet 2 and Diet 1. There was significant difference ($p<0.05$) on body weight gain for all groups. Stress parameter on leucocyte counts for Diet 1 showed the highest number as compared to the other groups but no significant difference ($p>0.05$) as compared to normal value. Neutrophils:lymphocytes ratio for all groups were within normal range and no significant difference ($p>0.05$). The implementation of feed formulation according to production stages is recommended as it increases performance and prevents from nutritional stress.

Keywords: *Feed Formulation, Body Weight Gain, Feed Intake, Stress Leucogram, Neutrophils:lymphocytes Ratio*

## 1.0 INTRODUCTION

Goat is an important contributor to milk, meat and hide production in many developing countries. Generally, it can be categorized as its product namely meat and dairy goats. Goat industry plays a major role in livestock production in Asia. It had been dominated by smallholders. In 2010, Ministry of Agriculture had been reported that the population of goats is about 34% of the total ruminant sector among overall livestock industry in Malaysia. Thus, in order to ensure sustainability goat industry in the future, a long-term structured strategy is needed to be considered which includes herd health, breeding and nutritional management (Mustafa, 2010).

A balanced nutritional value is the basis of successful production. It is because even a well-planned preventive health program is unable to overcome problems which are caused by poor nutrition. Therefore, nutrition brings a paramount importance in goat industry (Sultana *et al.,* 2012). However, one of the major constraints in developing ruminant industry in Malaysia is the difficulty to provide sufficient feed in terms of quantity and quality throughout the year (Abubakr *et al.*, 2015). In order to overcome this problem, different feed formulation had been introduced according to the production stages of the goat.

Feed which includes forage and concentrate are formulated in order to meet its daily requirement. Goats should be grouped according to their nutritional needs in order to be more effectively matched feed quality and supply to animal need (Luginbuhl, 2015). Generally, diet requirement according to the production stage can

be divided into maintenance and flushing (Fillet *et al.*, 2006). A proper feed formulation is able to provide higher body weight gain and increase feed intake (Luginbuhl, 2015). However, as the goat grows from kid to adult, a transition of different feed formulation may lead to a stressful condition (Caroll, 2013).

Stress level is crucial in the livestock industry because it may affect directly on growth, reproduction, meat quality, animal welfare and disease susceptibility. Thus, it gives a potential for making a substantial economic impact. Lacking in nutritional availability is regarded as one of the stressors among goat husbandry practices, besides environmental and handling. However, specific manifestation of stress can be measured on the blood results namely concentration of white blood cells particularly on stress leucograms, total red blood cells, hemoglobin levels (Alam *et al.*, 2011) as well as blood cortisol level (Fazio *et al.*, 2000).

# 2.0 LITERATURE REVIEW

## 2.1 GOAT FARMING INDUSTRY IN MALAYSIA

Nowadays, there is a surge in demand for goat products which leads to improvement of technologies and infrastructures in goat farming. Goat farm industry has become not just for the rural farm households. It has emerged as a popular business option on many affluent entrepreneurs in many Asian countries. Some of them were importing exotic stocks and venturing into breeding on a commercial scale (Shan-Nan, 2008). For example, 210 Boer goats had been introduced to Malaysia in the year 2006 by Malaysian Agricultural Research and Development Institute (MARDI) in order to upgrade genetic quality in the farm (Mustafa, 2010).

The goat farming industry has continuously been growing as the local demand for goat meat and milk increases. According to Ministry of Agriculture and Agro-based Industry (MOA), it had been reported that the population of goats is increasing from 609 in the year 2010 into 1078 in the year 2015 in Malaysia. In addition, goat meat has been recognized as healthy food for human consumption. Goat meat is known to have less saturated fat, relatively high proportion of total unsaturated fat (Correa, 2011) and enriched with vitamin B12 that makes it a very healthy choice (Mustafa, 2010).

Recently, MOA has provided a special focus on strengthening the ruminant sector, especially goat farming by formatting strategies in order to increase the supply of good quality of goat breeds. It is envisaged that the demand for Boer breed will increase from the implementation of many commercial goat husbandry projects by the government and

private sectors (Mustafa, 2010). Indeed, the small ruminant industry requires a continuous supply of good quality breeds, a traditional system of rearing should be transformed into a modern technology-based farming and lastly, structured breeding and feeding systems must be practiced in order to develop a cost-effective, viable and sustainable goat farming industry in Malaysia.

## 2.2 MANAGEMENT OF GOAT FARM

Goat farming in Malaysia is mainly dominated by smallholders. Generally, the production systems practiced by them depend on various factors namely investment, herd size, availability of grazing areas, and availability of feed supplies which can be categorized into extensive, semi-intensive, intensive and integration with tree crops (Shan-Nan, 2008). Extensive or free range and semi-intensive systems are the most common practice among smallholders in our country.

The livestock-tree crop integrated system, where livestock is reared under tree crops like rubber, oil palm and fruit trees is also quite common recently. However, as the goat farming industry continues to grow, the production system has gradually improved towards more commercial oriented management system. Moreover, regardless of any production system, the best economic returns are realized when disease problems are at minimum level. Thus, herd health management plays an important role in the farm which includes waste management, environmental management, parasite control program, biosecurity, feeding management, drug management, disease monitor program, reproductive management, and vaccination program.

Data from a survey conducted by Jesse *et al.* (2015) suggest that 83.3% farmers in Selangor, Malaysia were aware of the existence of herd health management with 59% of them had a knowledge and practiced on feeding management on their farm. Feeding management is one of the important criteria in herd health because even a well-planned preventive health program cannot overcome problems which are caused by poor nutrition. Thus, the main goals of herd health management are to prevent the development and spread of diseases which reduce economic losses in the farms.

## 2.3 FEEDING MANAGEMENT

Feeding management is very important to ensure goat is receiving sufficient amount of nutrition with good quality feed. Generally, the composition of feedstuffs varies according to grazing situations which reflect seasonal availability and relative palatability. The daily dry matter intake of adult goats is usually ranging from three to five percent of body weight (Willis, 2013). The actual quantity of feedstuffs consumed per day will be influenced by palatability, dry matter content, digestibility, and rate of passage in the rumen. Basically, livestock feed can be divided into two different groups namely forages and concentrates.

Forages have high fiber content which is very beneficial to livestock especially goat and it can be further divided into grasses and legumes. Fiber adds bulk to feed and keeps the digestive tract functioning well. The green vegetative part of the plant provides more fiber than the other parts. However, forages tend to have low energy content (Willis, 2013). In Malaysia, forages that are commonly planted include Guinea grass, Napier

grass, and *Brachiaria* spp., meanwhile, legumes utilized for goat include *Leucaena* spp., *Gliricidia* spp., and *Morus* spp. (Sithambaram *et al.*, 2013).

Besides, industrial by-products are also being an alternative to ensure sufficient amount of feed available for livestock. The major local materials used are crop and agro-industrial residues namely rice bran, palm kernel cake, oil palm frond, sago as well as broken rice. In Malaysia, palm kernel cake has been successfully used in ruminant industry and it contains 15-17% crude protein and 16% crude fiber, but low in amino acid lysine (Loh, 2010). There is a study conducted by Moore *et al.* (2002) shows that there was no difference in final live weight and total volatile fatty acids in the rumen of goats fed for by-products of wheat middling, soy bean hull and corn gluten as compared to hay diet.

Concentrates are processed feed that can be further divided into energy and protein based. It must be added as a supplement into feed formulation of the goat. Concentrate has high energy content, about 20% crude protein and 18% crude fiber. It can be made up from various ingredients namely corn, oat, and sugar beet. Protein concentrate which has at least 20% crude protein but often high in energy content. It can be made up from plant or animal origin for such as soybean meal, cottonseed meal and blood meal (Willis, 2013). However, a higher amount of concentrate may lead to increase production of lactic acid and severe decline in rumen pH which resulting in metabolic acidosis in goat (Saun, 2002). Thus, a proper amount of dietary forage to concentrate ratio must be considered to avoid losses in the herd.

In ruminant digestive system physiology, the goat has a four-chambered stomach which three of them contain microbes that break down the feed. Thus, by providing the microbes with a balanced nutrient supply of energy, protein, fiber, minerals, and vitamins, fermentation is promoted. Feed provided must contain a correct proportion of every nutrient. According to Solaiman (2011), for proper feeding management practice, livestock herd should be divided into groups namely growing kids, pregnant does, nursing does, and herd sires. Each group must have a similar body weight to ease feeding management as well as to determine its maintenance requirement.

However, additional nutrients are needed for growth, pregnancy, and production of milk and meat. Thus, flushing is recommended in breeding does in order to meet their high requirement of energy. Flushing is generally starting about one month prior to breeding to increase body weight, ovulation rate, and litter size. During flushing, the level of energy offered is increased throughout the breeding season until approximately 30 to 40 days after removing of buck, to allow adequate implantation of the fetus in the uterus. Body condition score is used to determine whether flushing will be of benefit to breeding does because good body condition will tend not to respond towards flushing (Luginbuhl, 2015). Therefore, the goal of flushing is to increase feed intake and body weight of does so that they are fitted for breeding purpose.

## 2.4 EFFECT OF FEED FORMULATION ON PERFORMANCE OF GOAT

Goats should be grouped according to their nutritional needs to be more effectively matched feed quality and supply to animal need. The high nutritional group involves

weanling goats, does during last month of gestation, high lactating does and yearling, meanwhile dry does and buck are considered as low nutritional group (Luginbuhl, 2015). Thus, as the goat grows from kid to adult, it undergoes a transition to different feed formulation in order to meet its requirement to ensure higher feed intake and body weight gain.

According to the study conducted by Yusuf *et al.* (2014), an inclusion of the sufficient amount of forage into the diet significantly improved the performance of Boer goat in term of feed intake, weight gain, feed efficiency and live weight. It is also corresponding to the study conducted by Rahman *et al*. (2014), feed intake and body weight gain are increases when pre-weaning goats were fed with a high amount of soy waste. Soy waste contains high crude protein and energy which suits to the requirement of the pre-weaning goat. Furthermore, feed intake and body weight gain of livestock are commonly used as indicators to evaluate quantity and quality of feed provided on the farm.

Higher body weight gain may bring many benefits as the animal may reach an ideal body condition score which fits for breeding and obtains market weight earlier. There are various factors influence body weight gain in goat namely genetic, health status, nutrition, and management system of the farm (Christopher, 2002). Feed intake in the animal is controlled by its satisfaction to meet energy requirement. A variety of gastrointestinal hormones namely glucagon-like peptide, peripheral hormone peptide YY and ghrelin have effects on feed intake by promoting satiety. Ghrelin is secreted by

abomasal and ruminal tissues in a goat to serve as metabolic signals which alter energy intake (Cheeke *et al.,* 2010). Thus, if a good quality feed is being provided, feed intake of the animal is high and vice versa.

However, in order to obtain higher production level on the farm, feed supply must meet the daily requirement. Feed can be formulated to alter the amount of energy and protein contents according to specific goat production stage rather than simply fed without considering daily requirement which commonly practiced by smallholders (Shan-Nan, 2008). Nevertheless, by implementing new feed formulation into regime may bring a stressful condition to the goat (Carroll, 2013). Thus, it is a need to assess performance and stress parameters upon practices different feed formulation.

## 2.5 EFFECT OF DIFFERENT FEED FORMULATION ON STRESS PARAMETERS

Stress can be defined by a phenomenon which is often reflected in the failure to achieve its genetic potential (Dobson *et al.*, 2000). Stress will be viewed as a biological response to either a perceived or real threat to the health and welfare of an animal which associated with husbandry practices namely weaning and sudden diet changes (O'Loughlin, 2011). In addition, maintaining a state of homeostasis requires the proper function of all physiological processes within the body include an immune system which is influenced by numerous factors namely environmental conditions, pathogen exposure, genetic make-up, animal temperament as well as nutrient availability or lack thereof (Carroll, 2013).

Generally, the effect of stress due to nutritional imbalance can be appreciated behavioral, hormonal, and hematological responses. The behavioral response includes reduce feed intake, dull and depressed, increase lying time, and isolate individually from a herd. The hormonal response involves thyroxin, triiodothyronine, cortisol, and electrolytes concentration meanwhile hematological response includes hemoglobin level, total red blood cells and stress leucograms (Gupta *et al*., 2013).

Stress may lower the immunity of an individual animal resulting in illness. Stress hormones like glucocorticoids and catecholamines play an important role in the host following exposure to stress, lead to immunosuppression through anti-inflammatory mechanisms. The trafficking of neutrophils, monocytes, dendritic cells, natural killer cells and T and B lymphocytes are altered in ruminant (Burton *et al.,* 2005). In addition, according to Padgett *et al*. (2003), lymphocytes, macrophages and natural killer cell functions are inhibited and molecular expression of pro-inflammatory cytokines and chemokines are down-regulated during stress condition resulting in increasing the likelihood of developing an illness. There are two pathways implicated in stress-induced immune alteration which is sympathetic-adrenal-medullary (SAM) axis and hypothalamic-pituitary-adrenal (HPA) axis (O'Loughlin, 2011).

The perception of a stressor on cerebral cortex triggers neurological impulses which alert hypothalamus to stimulate the activation of the autonomic nervous system (ANS). Due to that, rapid synthesis of catecholamines, epinephrine and norepinephrine occurs and eventually SAM axis is activated (Sapolsky *et al.,* 2000). Catecholamines play

a major role in alteration of immune functions includes cytokine production, cell proliferation, and cytolytic activity. Epinephrine is secreted from the adrenal medulla and entered the peripheral circulatory system and bound to specific adrenergic receptors which abundantly present on immune cells. Meanwhile, norepinephrine is mediated by the rapid alterations of white blood cell numbers after the onset of activity related to stress (O'Loughlin, 2011).

Failure of the SAM axis to resolve stressor activates HPA axis. The initiation occurs through a series of different stimuli including activation of the limbic system in case of psychological stress (Herman *et al.,* 2005). Then, it follows by secretion of corticotrophin- releasing hormone (CRTH), adrenocorticotrophic hormone (ACTH) and glucocorticoids namely cortisol (Chrousos *et al.,* 2004). In domestic livestock including goat, excessive concentration of glucocorticoids are related to reducing a rate of reproduction, suboptimal growth, and immune-suppression that could increase susceptibility towards disease (Carrol, 2013). Therefore, the concentration of cortisol in blood is widely being used as an indicator of stress among animals.

Other than blood cortisol level, stress leucograms are also being used as stress parameter in animals by conducting differential white blood cells count. Stress leucogram is characterized by reducing in lymphocytes count or lymphopenia and increasing in mature neutrophils count or neutrophilia. Lymphopenia is due to redistribution into lymphoid tissues meanwhile, neutrophilia is due to decreased adherence to the vascular endothelium, which inhibits margination and increases circulating time. Monocytosis and

eosinopenia can also be observed (Wood, 2014). Therefore, it is a good practice to evaluate the performance of livestock and assess stress parameter in order to avoid unnecessary stress condition occurs in animal thus, its welfare is being prioritized.

## 3.0 MATERIALS AND METHODS

### 3.1 BACKGROUND OF STUDY

This study is conducted at Tok Seri Buak Agrofarm, Labu, Negeri Sembilan. It is listed as one of Ladang Angkat, Faculty of Veterinary Medicine, UPM. In this farm, it consisted of 300 goats with mixed breeds including Saanen, Boer cross, and Jamnapari with 70% of them were breeder. All goats are fed with Napier grass which is planted by the owner at the land nearby, local plants which include *Macaranga sp*. and *Mallotus sp*., soy waste and concentrate.

### 3.2 EXPERIMENTAL DESIGN

In this study, Boer cross breeders aged one-year-old and approximately weighing about 20kg with almost similar body condition score of 2 out of 5 were selected and divided into three groups. Each group was consisted about six does and fed with Diet 1 (Control) which already being practiced on the farm, Diet 2 which formulated for maintenance requirement, and Diet 3 which formulated for flushing. All of the diets were consisted of *Pennisetum purpureum* (Napier grass), *Mallotus sp.* (Balik Angin), *Macaranga sp.* (Lebar Daun), soy waste and concentrate with different proportions. Diet

2 and Diet 3 were formulated by using Pearson Square method. The proportions of feed for every group were stated in Table 1.

At the beginning of the experiment, a proper physical examination was conducted for every doe. Then, does were put into individual pen and blood sampling and body weight were measured and recorded for baseline data. Then, they were fed according to the assigned feed formulation for four weeks. Body weight was measured before implementation, at Week 2 and Week 4, whereas blood sampling was conducted before implementation and at Week 4 for comparison as for feed intake, the measurement was done every day.

| | **Control** | **Experimental** | |
|---|---|---|---|
| | **Diet 1 (g)** | **Diet 2 (g)** | **Diet 3 (g)** |
| *Pennisetum purpureum* | 1500 | 1400 | 1370 |
| *Mallotus sp.* | 490 | 460 | 460 |
| *Macaranga sp.* | 490 | 460 | 460 |
| Soy waste | 910 | 930 | 880 |
| Concentrate | 110 | 250 | 330 |

**Table 1: The proportion of ingredients in Diet 1, Diet 2 and Diet 3.**

## 3.3 MEASUREMENT OF BODY WEIGHT GAIN

Before starting of the experiment, body weight for each doe was measured by using a measuring scale. Body weight was measured again at Week 2 and Week 4 in order to calculate body weight gain after feeding with different feed formulation. The readings were recorded and tabulated for comparison. Then, from the data, average daily gain was calculated and recorded to further evaluate effectiveness of feed formulation. The body weight gain and average daily gain was calculated by using this formula:

$$Body\ weight\ gain\ (kg) = Final\ body\ weight\ (kg) - Initial\ body\ weight\ (kg)$$

$$Average\ daily\ gain\ \left(\frac{g}{day}\right) = \frac{Body\ weight\ gain\ (g)}{Experimental\ period\ (days)}$$

## 3.4 FEED INTAKE CALCULATION

The amount of feed offered by the farmer every day was measured (Diet 1), which approximately every doe was fed about 3.5kg per day per animal. Then, based on availability of feed supply in the farm, the feed was formulated according to maintenance (Diet 2) and flushing (Diet 3) requirements by using Pearson Square method. The feeding regime practiced in this farm is twice daily. Every morning on the next day, the feed left over was measured to calculate feed intake. All data were recorded.

## 3.5 BLOOD SAMPLING

Blood samplings were carried out at the beginning of experiment and at Week 4. During sampling, the does were brought to the crush and properly restrained before blood was collected. Blood samples were collected by venipuncture of the jugular vein. Prior to the vein puncture, the area for blood collection was swabbed with 70% alcohol. Then, approximately 10ml of blood was drawn out using a 21-gauge needle (Venoject®) into EDTA tube for hematological study.

## 3.6 LABORATORY ANALYSIS

Blood samples were analyzed at Clinical Pathology Laboratory, Universiti Putra Malaysia, Serdang, Selangor.

### *3.6.1 Complete blood count*

The MS4-Hematology Cell Analyzer was used to perform complete blood count. The packed cell volume (PCV) was determined using micro-hematocrit centrifuge.

### *3.6.2 Blood morphology (Stress leucograms)*

Routine thin and smooth blood smears were made from the blood in EDTA tube before the white blood cell (WBC) count was carried out. The smears were air dried and stained with Diff-Quick stain for 3 minutes. Excess stain was removed by allowing slow running tap water onto the smears. The slides were then being immersed in phosphate buffer solution of pH 7.2 for another 30 minutes.

Differential counts of WBC were carried out under a light microscope, which included percentages of neutrophils, lymphocytes, monocytes, basophils, and eosinophils under oil immersion with 100x magnification. The battlement method of counting was chosen to count the represent sample of the blood cells from the smears.

## 3.7 STATISTICAL ANALYSIS

All data were analyzed using Statistical Package for the Social Science (SPSS) version 22.0 where $p < 0.05$ indicates significant difference and $p > 0.05$ indicates no significant difference for the results.

## 4.0 RESULTS

### 4.1 BODY WEIGHT GAIN

Final body weight after fed with different feed formulation for four weeks was showed the highest on Diet 3, followed by Diet 2 and Diet 1 (Figure 1).

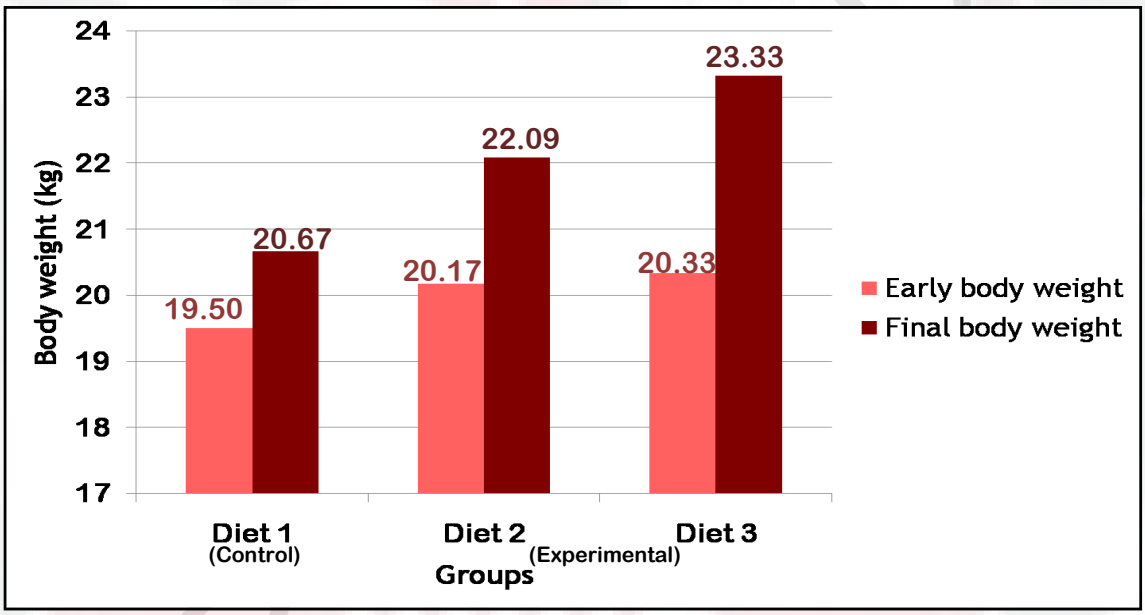



**Figure 1: The comparison of body weight gain for Diet 1, Diet 2 and Diet 3.**

Then, body weight gain showed the highest on Diet 3 which was 3.00kg, followed by Diet 2 which was 1.92kg and Diet 1 which was 1.17kg. There was a significant difference ($p<0.05$) for body weight gain for all diets. Thus, from this data average daily gain was further evaluated (Figure 2). Diet 3 showed the highest average daily gain which was 41.79g/day, followed by Diet 2 which was 68.97g/day and Diet 1 which was 106.07g/day.

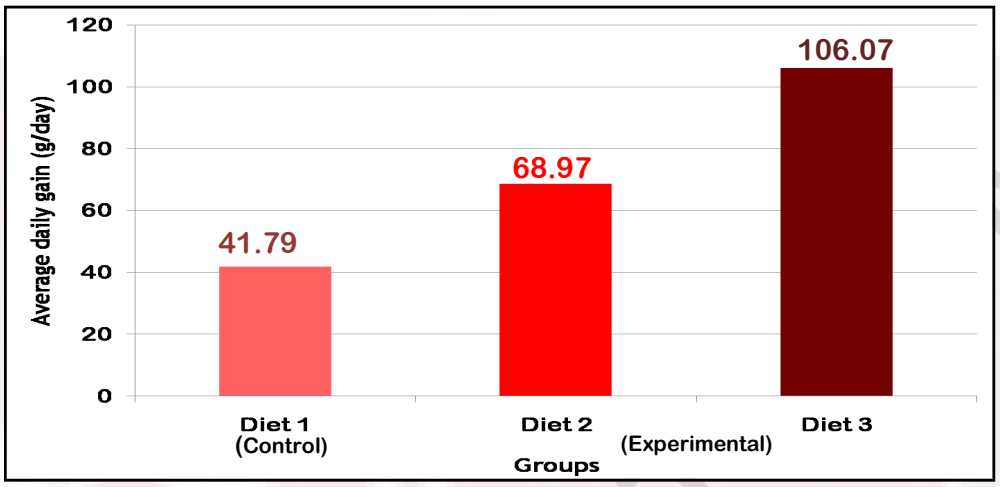



**Figure 2: The average daily gain for Diet 1, Diet 2 and Diet 3.**

## 4.2 FEED INTAKE

After four week of experimental period, Diet 3 showed the highest feed intake which was 3.3kg per day per animal followed by Diet 2 which was 2.7kg per day per animal and Diet 1 which was 2.4kg per day per animal. There was significant difference ($p<0.05$) for feed intake for all groups (Figure 3).

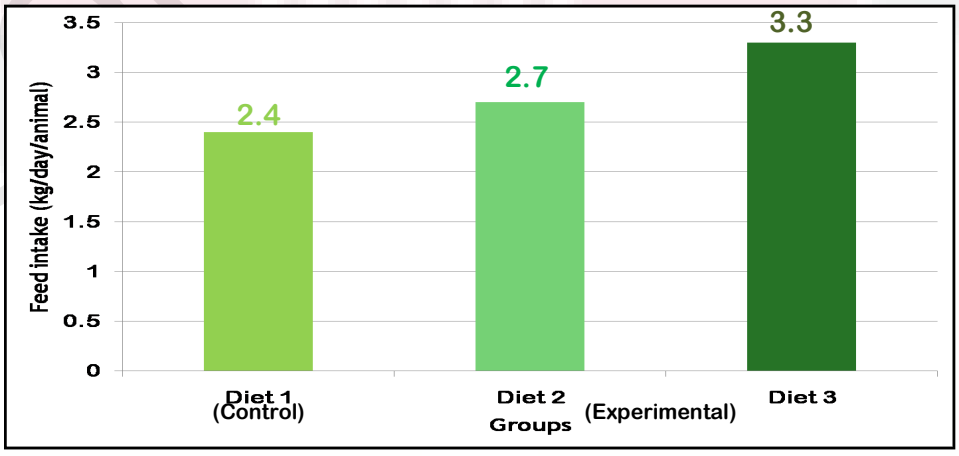
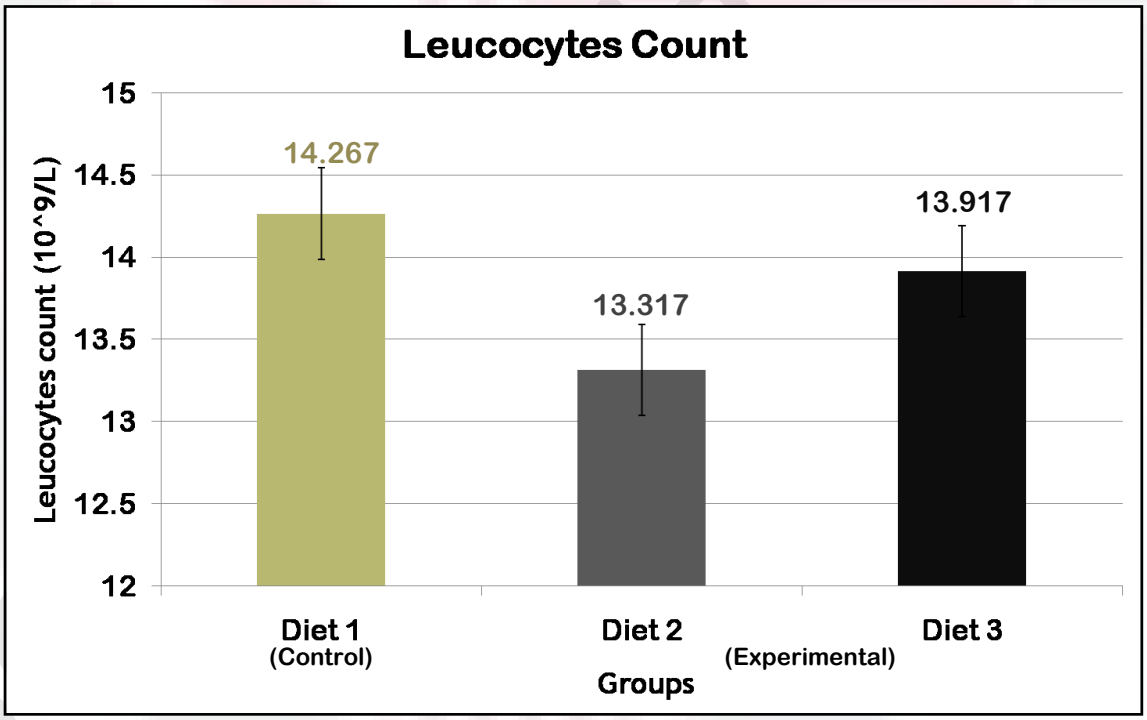



**Figure 3: Feed intake for Diet 1, Diet 2 and Diet 3.**

## 4.3 BLOOD PARAMETERS

In order to appreciate hematological changes on stress parameter, leucocytes count, neutrophils and lymphocytes count were very beneficial. Then, N:L ratio can be evaluated from neutrophils and lymphocytes count which widely used as stress indicator in livestock. The leucocytes count showed the highest on Diet 1, followed by Diet 3 and Diet 2. There was no significant difference ($p>0.05$) of leucocytes count for all groups as compared to normal limit of caprine leucocytes count (Figure 4).




*Normal value of leucocytes count for goat is $13x10^9/L$

**Figure 4: Leucocytes count for Diet 1, Diet 2 and Diet 3.**

The neutrophils and lymphocytes count for all groups were within normal range of caprine neutrophils and lymphocytes count (Figure 5).

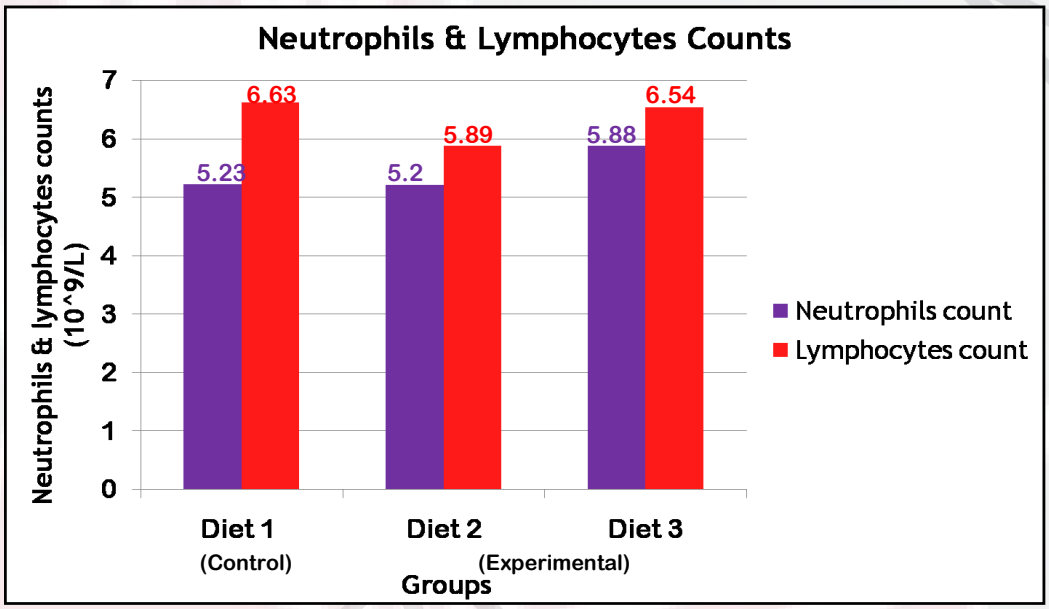



**Figure 5: The neutrophils and lymphocytes counts for Diet 1, Diet 2 and Diet 3.**

Neutrophils:lymphocytes ratio for all groups were within normal range. There was no significant difference ($p>0.05$) for all groups on neutrophils:lymphocytes ratio (Figure 6).

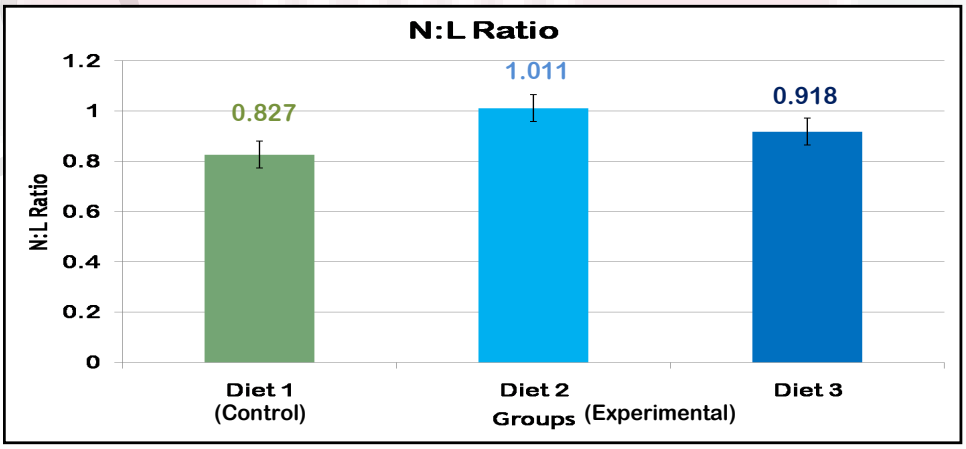



**Figure 6: The neutrophils:lymphocytes ratio for Diet 1, Diet 2 and Diet 3.**

## 5.0 DISCUSSION

The performance of the goat will be increased when the feed provided meet the daily requirement. Body weight gain and feed intake are among the indicators which frequently being evaluated in the farm. Body weight gain of the goat is influenced by various factors namely genetic, nutrition, health status and management system (Christopher, 2002). Genetically, Boer goat is having higher body weight gain as compared to our local Katjang goat even when they are providing with similar quality and quantity of feed.

Higher quality of feed will show a better body weight gain as the feed consists of required nutrients by the goat which includes energy, crude protein, fiber, fat, and vitamins. The healthy animal will show higher body weight gain as compared to the animal which suffered from ongoing condition, for example parasitic infestation. The farm that practices intensive system which provides cut and carry feeding management might show higher body weight gain of the herd as compared to the farm that practices extensive system with free ranging feeding management.

Dietary energy content in the feed is the main dietary factor which controls voluntary feed intake. In ruminant, the blood concentration of volatile fatty acids is the principal regulator of feed intake. According to Cheeke et al. (2010), propionate concentration in the liver is a major satiety signal in ruminant. Oxidation of metabolic fuels in the liver will stimulate satiety centre in the hypothalamus which directly affects

feed intake by the animal. It is also known as hepatic oxidation theory of the control of feed intake.

Generally, the leucocytes count will be increased due to several factors namely infection or inflammation or animal is in a stressful condition. During stress, various endocrine responses are involved to improve fitness of the affected individual. The first-line hormone that plays an important role in overcoming stress is glucocorticoids (Palme, 2002). Stress causes reduction in circulating lymphocytes due to redistribution from circulatory system into other body compartments.

Circulating lymphocytes adhere to the endothelial cells which lined the wall of the blood vessels and undergo transmigration from the circulatory system into body tissues for examples lymph nodes, spleen, bone marrow and skin. In this study, all does from Control Diet 1, Experimental Diet 2 and Diet 3 showed no increment in lymphocytes count.

Meanwhile, neutrophils count is increased during stress. It is also due to the effect of glucocorticoids which promotes the influx of neutrophils into the bloodstream from bone marrow. In this study, all does from Control Diet 1, Experimental Diet 2 and Diet 3 were all within the normal range for neutrophils count as well.

Thus, from neutrophils and lymphocytes counts, neutrophils:lymphocytes ratio can be analyzed. Neutrophils:lymphocytes ratio is the commonest stress indicator in livestock. It is influenced by many individual factors namely sex and age of the animal. The normal neutrophils:lymphocytes ratio for a mature doe is ranging from 0.6 to 3.6

(Mary, 2011) and the normal neutrophils:lymphocytes ratio for about one-year-old doe is ranging from 0.5 to 1.1 (Bradford, 2014). In this study, all does from Control Diet 1, Experimental Diet 2 and Diet 3 were within the normal range, thus, it indicates no stressful condition. There is a study on neutrophils:lymphocytes ratio as the stress indicator in goats during transportation by Idrus *et al.* (2010), the elevation of neutrophils:lymphocytes ratio into 1.5 to 2.5 may indicate stress among goats. Therefore, no stress is being detected within does for all of the different feed formulation within four weeks of experimental period.

## 6.0 CONCLUSION

Different feed formulation would improve the performance of the goat specifically on body weight gain and feed intake. During four weeks of the experimental period, the implementation of different feed formulation would not cause significant stress to the animals. The high quality of feed with sufficient amount of its nutrient must be considered to ensure the goats are receiving enough daily requirements. Thus, feeding management is one of the keys towards the successful livestock production system.



## 7.0 RECOMMENDATIONS

Firstly, in order to evaluate stress other than by using stress leucogram, measuring cortisol level is very beneficial because it is highly specific and sensitive. It involves changes in adrenocortical response after being introduces into a stressor. Recently, there is a test kit to measure plasma cortisol level namely Cortisol Enzyme-Linked Immunosorbent Assay (ELISA) kit, but it is costly. Thus, plasma cortisol level is good enough to support stress leucogram to evaluate stress parameter among goats.

Secondly, a longer duration of the experimental period is needed to obtain more obvious results. In this study, there is only allocated for only four weeks. In contrast to normal practices for implementation of different feed formulation, it takes about three months for each feed formulation in order to get a marked result on performance and stress parameter in the goat. However, within four weeks of study, we were also managed to get such a good result.



## 8.0 REFERENCES

Abubakr A., Alimon A. R., Yaakub H., Abdullah N., Ivan M. (2015). Effects of feeding palm oil by-products based diets on muscle fatty acid composition in goats. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4366160/. Accessed on 10 October 2015.

Alam M.M., Hashem M. A., Rahman M.M., Hossain M.M., Haque M. R., Sobhan Z., Islam M.S. (2011). Effect of heat stress on behaviour, physiological and blood parameters of goat. *Journal of Chemical Information and Modeling*, Department of Animal Science, Bangladesh Agricultural University. 53(9), 1689–1699.

Bradford, P. S. (2014). Normal values for leukogram data for adult animals. *Large Animal Internal Medicine Fifth Edition*, Elsevier. 382.

Burton, J. L., Madsen, S. A., Chang, L. C., Weber, P. S. D., Buckham, K. R., Van Dorp, R., Hickey, M. C., Early, B. (2005) Gene expression signatures in neutrophils exposed to glucocorticoids: A new paradigm to help explain "neutrophil dysfunction" in parturient dairy cows. *Veterinary Immunology and Immunopathology,* 105**,** 197-219.

Carroll, J. A. (2013). Stress effects on immunity. Livestock Issues Research Unit, Lubbock, Texas, USA. 806

Cheeke, P. R., Dierenfield, E. S. (2010). Dietary energy level. *Comparative Animal Nutrition and Metabolism*. Cambridge University Press.

Christopher, D. L. (2012). Boer goat production : progress and perspective. University of Hawai'i, Hilo, Hawai'i USA.

Chrousos, G. P., Charmandari, E., Kino, T. (2004) Glucocorticoid Action Networks : An Introduction to Systems Biology. *J Clin Endocrinol Metab,* 89**,** 563-564.

Correa, J. E. (2011). Nutritive value of goat meat. Alabama University. 14, 1–4.

Department of Veterinary Services (2010). Table 8: Nutrient requirements of goats. *Nutrient Composition of Malaysian Feed Materials and Guides to feeding of Cattle and Goats Third Edition*. Ministry of Agriculture and Agro-based Industry Malaysia, 53.

Dobson, H., Smith, R. F. (2000). What is stress? How it affects reproduction?, *Animal Reproduction Science,* 60-61, 743-52.

Fazio, E., Medica, P., Cavaleri, S., Cravana, C., Ferlazzo, A. (2000). Cortisol levels as indicator of stress in domestic goat under different housing systems, Department of

Morphology, Biochemistry, Physiology and Animal Production, Unit of Physiology, Faculty of Veterinary Medicine, University of Messina. 147–150.

Food and Agriculture Organization of United Nations (2015). Silage making for small scale farmers Food and Agriculture Organization, 16.

Filley S., Peters A., (2006). Goat nutrition feeds & feeding. Oregon State University Extension Service.

Gupta, M., Kumar, S., Dangi, S. S., & Jangir, B. L. (2013). Physiological, biochemical and molecular responses to thermal stress in goats. *International Journal of Livestock Research*, 3(2).

Herman, J. P., Ostrander, M. M., Mueller, N. K. & Figueiredo, H. (2005) Limbic system mechanisms of stress regulation: Hypothalamo-pituitary-adrenocortical axis. *Progress in Neuro-Psychopharmacology and Biological Psychiatry,* 29**,** 1201-1213.

Huda, F. A. (2015). Strategies to strengthen livestock industry in Malaysia. Economic and Social Science Research Centre, Malaysian Agricultural Research and Development.

Idrus Z., Bahyuddin N., Cheah Y.W., Soleimani A.F., Sazili A.Q., Rajion M.A., Goh Y.M., (2010). Physiological responses in goats subjected to road transportation under the hot, humid tropical conditions. *International Journal of Agriculture & Biology*, 840–844.

Jesse F. F., Abdullah, J., Muhaimin, A., Rofie, B., Tijjani, A., Lim, E., Abba, Y. (2015). Survey of goat farmers' compliance on proper herd health program practices, *5*(11), 8–14.

Loh, T. C. (2010). Livestock production and the feed industry in Malaysia. *Protein Sources for the Animal Feed Industries.* Animal Sciences Department. Universiti Putra Malaysia.

Luginbuhl, J. M. (2015). Nutritional feeding management in meat goats. North Carolina South University.

Mary, C. S., David, M. S., (2011). Leucocytes parameter. *Goat Medicine 2nd edition*. Wiley-Blackwell Publishing.

Moore, J. A., Poore, M. H. (2002). By-product feeds for meat goats: Effects on digestibility, ruminal environemnet and carcass characteristics. North Carolina State University. 1752.

Moran, J. (2005). Making quality silage. *Tropical Dairy Farming: Feeding Management for Small Holders Dairy Farmer in the Humid Tropics*, Department of Primary Industry, 83-97.

Mustafa, H. M. (2010). The prospects of Boer goats farming in Malaysia. Ministry of Agriculture and Agro-Based Industry, 400, 9–18.

O'Loughlin, A. (2011). Examination of the effect of weaning stress on the physiological and molecular regulation of immune function in circulating bovine leukocytes. National University of Ireland.

Padgett, D. A., Glaser, R. (2003) How stress influences the immune response. *Trends in Immunology,* 24**,** 444-448.

Palme, L. (2002). Hormone as indicators of stress, Domestic Animal Endocrinology, 23 (1-2), 67-74.

Rahman, M. M., Rahman, M. R., Nakagawa, T., Abdullah, R. B., Khadijah, W. E. W., Akashi, R. (2014). Effects of wet soya waste supplementation on the intake, growth and reproduction of goats fed Napier grass. *Animal Feed Science and Technology*, *199*, 104–112.

Sapolsky, R. M., Romero, L. M., Munck, A. U. (2000) How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. *Endocr Rev,* 21**,** 55-89.

Saun, R. V. (2002). Common Nutritional and Metabolic Diseases of Goats. Department of Veterinary Science, Pennsylvania State University.

Solaiman, S. G. (2011). Feeding management of a meat goat herd, (06), Retrieved from http://www.boergoats.com/clean/articles/feeding/feedingmanagement.pdf.Accessed on 23 February 2016.

Shan-Nan, L. (2008). Production increases in meat and dairy goats by technology and infrastructure improvements for Asian small-scale farmers, 29–31.

Sithambaram, S., Nizam, Q. N. H., (2013). Current status of dairy goat farming. *AADGN Country Report.* 57-65.

Sultana, S., Khan, M. J., Hassan, M. R., & Khondoker, M. A. M. Y. (2012). Effects of concentrate supplementation on growth, reproduction and milk yield of Black Bengal goats (Capra hircus), *29*, 7–16.

Willis, A. (2013). Feeds for goats. The Newton County Alternative and Sustainable Agriculture.

Wood, R. D. (2010). Leukogram abnormalities. *The Merck Veterinary Manual.*

Yusuf, A. L., Goh, Y. M., Samsudin, A. A., Alimon, A. R., & Sazili, A. Q. (2014). Growth Performance, Carcass Characteristics and Meat Yield of Boer Goats Fed Diets Containing Leaves or Whole Parts of *Andrographis paniculata,* 27(4), 503–510.