Intake, Nutritive Value and Digestibility in Holstein Heifers Fed Diets Supplemented with Peanut Hay (Arachis Hypogeal L)

Diniwe Grace Phiri

Intake, nutritive value and digestibility in Holstein heifers fed diets supplemented with peanut hay (*Arachis Hypogeal L*)

By

Diniwe Grace Phiri

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By

Diniwe Grace Phiri

Approved:

Stephanie H. Ward
(Major Professor)

Brian J. Rude
(Minor Professor)

John Blanton, Jr.
(Committee Member and Department Head)

George M. Hopper
Dean
College of Agriculture and Life Sciences

Name: Diniwe Grace Phiri

Date of Degree: May 6, 2016

Institution: Mississippi State University

Major Field: Agriculture

Major Professor: Stephanie H. Ward

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Candidate for Degree of Master of Science

This study was conducted to measure the intake; nutritive value and digestibility of peanut hay (Arachis hypogaea L.). Fourteen Holstein heifers (BW= 408 plus/minus 32 kg; Age = 15.4 months plus/minus 0.5) were randomly allocated to two diets: peanut hay (PH) and corn silage (CS) adlibtum for 26 days. The PH consisted of 66:34 forage: concentrate (F:C) and CS diet contained 57:43 F:C ratio. Peanut hay at 91.8% DM contained 8% CP, 64% NDF, 51.9% ADF and 8 % ash. DMI and CP was not different across the treatment diets ($P>0.05$). NDF and ADF intake was different between the diets with PH being greater ($P<0.01$). Feed Efficiency using the feed to gain ratio was different across the diets ($P<0.0001$). Dry matter digestibility was 75.37% for CS diet and 68.53% for PH diet. Peanut hay basal diets formulated to contain low F:C ratio can increase growth in dairy heifers.

DEDICATION

I would like to dedicate this work to my husband Lovemore Amanzi Phiri and my two sons; Shabane Emmanuel and Nathaniel.

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LIST OF ABBREVIATIONS

ADF	Acid Detergent Fiber
ADG	Average Daily Gain
BCS	Body Condition Score
BW	Body Weight
CP	Crude Protein
DM	Dry Matter
DMD	Dry Matter Digestibility
DMI	Dry Matter Intake
FE	Feed Efficiency
F:C	Forage to Concentrate Ratio
GC	Gas Chromatography
GLM	General Linear Model
IVOMD	In Vitro Organic Matter Digestibility
LSD	Least Square Difference
LSM	Least Square Means
NDF	Neutral Detergent Fiber
NRC	National Research Council
OM	Organic Matter
SD	Standard Deviation

SE	Standard Error
TDN	Total Digestible Nutrients
TMR	Total Mixed Ration
WAP	Week After Planting

CHAPTER I

INTRODUCTION

The feeding of dairy cattle poses challenges in the semiarid tropical and subtropical areas of the world due to the long dry seasons they experience. In the regions of southeast USA these are in winter/autumn. In sub Saharan Africa, this is the season of long dry periods between June and December when dairy farmers need to feed their animals and produce a considerable amount of milk for their dairy enterprise to be viable. Peanut hay also called groundnut haulms (Arachis Hypogeal L) has been used by dairy men during these critical periods.

Peanut (groundnut, Arachis hypogaea L.) is grown in the semiarid tropical and subtropical regions of the world between 40°N and 40°S. Peanut is grown in most parts of the world to produce nuts which are used for human consumption in form of snacks, candies and part of meals. In sub-Saharan Africa, peanuts provide reliable source of digestible protein (25 to 34%), cooking oil (44 to 56%), and vitamins like thiamine, riboflavin, and niacin (Savage & Keenan, 1994). Furthermore farmers grow peanut as a cash crop providing income that contributes to food security and poverty alleviation.

Peanut hay contains 55% TDN, 10.8% CP, 8.6% ash (Feedstuff Buyers guide, 2014). Peanut hay (Arachis Hypogeal L) has been fed to dairy cattle in the past decades. Even though this is the case, there have been limited research publications in this area. This view has been shared by Hill (2002) and Özygit & Bilgen (2012) who noted that although peanut hay has been fed very few research reports have been published concerning peanut hay utilization by beef or dairy cattle. In this trial the intake, nutritive value and digestibility of peanut hay in dairy heifers with effects on growth was studied.

CHAPTER II

LITERATURE REVIEW

Intake and nutritive value of peanut hay

The nutritive value of the peanut hay depends on the harvesting and storage mechanism that was followed. If the hay was properly harvested and properly stored for prevention of rain and moisture, the nutrient content of the hay is high. Hill (2002) noted that although peanut hay has been fed for several years, very few research reports have been published concerning peanut hay utilization in the beef and dairy sector. In a study by Ronning et al., whole plant peanut hay was harvested and dried for about 2 to 6 weeks, pods were removed and the hay was baled. The hay encountered minimal leaf shatter and retained the green color. This hay contained 10%, 20.9% and 8.6% of crude protein, crude fiber and ash respectively. This study compared alfalfa and peanut hay and it was reported that hay intake and milk production were the same for the dairy cows given peanut hay and alfalfa hay.

In a similar study by Hawkins et al., (1957) comparisons were made between ground alfalfa with concentrate, ground peanut with molasses with a concentrate and unground peanut hay which were fed to dairy cows. This study reported that milk production was the same across the diets. The CP, TDN and digestible protein (DP) of alfalfa and peanut hay were 14%, 53% and 10% and 11%, 54% and 11% respectively. They reported a refusal rate of 5% for alfalfa, 1% for ground peanut and 21% and 22%

respectively for ground peanut hay with molasses and long peanut hay. In this study it was concluded that neither adding molasses nor grinding alone can reduce the refusal rate but a combination of both increased intake.

Chingala et al., (2013) did a study to measure the effects of feeding dairy cows diets containing lucerne hay, centrosema hay, and groundnut hay on DMI and milk production. It was reported that the NDF, CP and ash of lucerne and groundnut hay were 45% DM, 25% DM and 7% DM and 39% DM, 13% DM & 7% DM respectively for lucerne and groundnut haulm. In this study, DMI for peanut hay and lucerne was equal due to their decreased NDF content.

In the above studies, the crude protein ranged from 10-13% with Chingala et al., (2013) being on the high end at 13%. This could be attributed to residual pods that could have been left during threshing because nuts in the residual pods could increase the protein content. Overall the crude protein of peanut hay is decreased compared to the required amount (NRC) for dairy cattle as such there is need of supplementation with a concentrate to meet their daily requirement. The residual soil on the roots of the peanut hay may cause changes in the ash content of peanut hay (Hill, 2002). The variation between the studies ranges from 7 to 8.6% DM which compare well with the standard from the Buyers guide (2014) of 8.6% DM.

Peanut hay can also be incorporated as a hay base in total mixed rations (TMR). A comparison was made in a field trial in Thailand between TMR containing alfalfa and peanut hay (Rukkwamsuk et al., 2010). In this trial., 20 cows were fed alfalfa diet and 20 were fed peanut base TMR. The peanut ration contained NDF, CP, ash of 41.49%, 19.25% and 10.35%, respectively at 55.99% DM and the alfalfa ration contained 42.21%, 16.48 and 9.18 in the same order at 55.99% DM. There were no differences between the two groups in daily DMI, 4 weeks postpartum. The results further showed that milk composition did not differ between the treatments but average milk production was greater in cows fed alfalfa ration than those fed peanut hay during the 30 days postpartum.

From the literature search, few studies have been published on intake of peanut hay base diet in dairy heifers. Furthermore researches focusing on the forage to concentrate ratios of peanut hay based diets are limited.

Factors affecting quality of peanut hay

Peanut hay quality depends on several factors including harvesting, drying and storage methods, time of haulm cutting, weather conditions and absence of foliar disease. Quality of the peanut hay begins before cultivation. Wright et al., (1991) observed that the optimum dry matter of peanut haulm is reached before the optimum time for pods maturity hence the quality of the hay decreases even before the crop approaches maturity. Haulms are the top stems & leaves of the peanut plant. A study by Halevy & Hartzoola, (1988) revealed that phosphorous and nitrogen level of the peanut hay decreased 37 and 64 days respectively pre-harvest. In order to determine the optimum cutting time for peanut haulms, a study was conducted by Arsian, (2005) in which 2 cultivars were planted and from 17 weeks after planting (WAP), four haulm cuttings were done. The crude protein of the peanut hay decreased from 10.6% at 17 WAP to 8.1% at 20 weeks after planting. The study reported that the best cutting time for forage purposes was 17WAP but by this time the pods are not yet mature hence recommended 2-3 days before digging if the aim of the farmer is to obtain highest pod yield. This method of vine cutting is applicable to mechanized operations. Producers who have pure stands of annual peanut (self seeding) for forage can use this method.

The leaf to stem ratio has an effect on peanut hay quality. Peanut hay leaves are very nutritious compared to stem and roots as such leaf shatter has profound effect on hay quality. Leaf shatter can be caused by over drying and equipment in highly mechanized farms. Leaf shatter is also caused by foliar disease called leaf spot. This disease reduces the number of leaves per stem as such the leaf to stem ratio is affected. Fungicides are used in peanut production to cure this problem but this may limit the use of the vines as feed for livestock because the pesticides used in peanut production have not been legally and scientifically cleared for use in livestock feeds (Hill, 2002 & Gorbet et al., 1994). Another alternative to prevent the foliar disease is to use leaf spot resistance cultivars. This may allow the farmer to produce better quality peanut hay without using fungicides. A study by Gorbet et al., 1994 in which cuttings were made from peanut breeding lines grown without application of fungicides for forage evaluation was conducted. The lines which had two cuttings produced greater forage yield than those for single forage harvest. Furthermore, CP of 14-19.6% was observed for two cuttings and 12.5-15.1% was observed on single cuttings. Both cutting times and fungicide application have an impact on overall peanut quality.

Other studies focusing on improving herbage so that the hay output would be higher (quantity) after harvesting have been conducted. Sokote et al., 2013 conducted an experiment to find out how herbage yields are affected by intra-row spacing. The results revealed that the intra-row spacing of 10 cm yielded higher herbage than the wider spacing of 20cm and 30 cm. this realization is very important smallholder dairy farmers who may increase both the peanut yield and peanut hay in the small plot of land available.

Digestibility of Peanut Hay

There are few published reports on digestibility of peanut hay in dairy heifers; however several studies in beef and sheep have been conducted. In a case study by Myer et al., (2009) growing beef cattle were grazed on annual peanut stands alone for 2 years (25 heifers with initial weight of 200 ± 28 kg. for first year) and 20 calves (average initial weight of 182 ± 28 lbs. for second year). In both years the animals had free access to water, mineral mix and shade. The in vivo organic matter digestibility (IVOMD) of peanut forage during grazing trials ranged from 61 to 72% (DM basis). These results compared well with the study of Gorbet et al., (1994) whose findings on IVOMD of the peanut forage samples ranged from 59.6-72%. The results also indicated that the average daily gain (ADG) for the two years was consistent and averaged 2.03 kg/day.

Another study of peanut hay digestibility was conducted in sheep by Khan et al., (2012). In this study, four adult Ramshan weathers (60 ± 25kg body weight) were given four rations of wheat straw: peanut hay at the following ratios: 700:0, 460:240, 240:460 and 0:700 g/kg DM. The study reported that in the ration where peanut hay replaced wheat straw, intake increased and apparent in vivo digestibility of DM increased with the proportion increase of peanut hay in the ration. Further research is required to understand digestibility and growth in growing dairy heifers fed peanut hay.

Harvesting & storage of peanut hay

In developed countries, peanut hay is harvested using diggers and combines harvesters. Peanut vines are plowed, the soil is mechanically shaken and vines inverted and stacked in windrows for drying. The peanuts are dried for several days and combines are used to remove the pods from the roots and stems. In sub-saharan Africa, this mechanism is practiced by commercial farmers, but smallholder farmers dig peanuts using hand hoes, the soil is shaken off the roots to expose the pods. The vines are inverted, stacked and are left in the field for drying for several days. After drying the pods are manually hand removed from the stems. The vines are then baled for livestock feed.

Both the combined harvesters and manual removal of the pods leave the roots with a considerable amount of soil which can elevate the ash content of hay (Hill, 2002). The mechanical harvesting causes leaf shatter as such reducing leaf to stem ratio of the hay. An important point to note on manual harvesting method is the time the peanut vines are left in the field after removal of the pods. A lot of farmers leave the vines for a long time which results in leaf shatter thereby reducing the leaf to stem ratio which is a critical factor for overall quality of the hay. Due to the porous nature of the peanut hay, it must be stored in a cool dry place or plastic wrapping the bales if they are left unprotected outside. Hill (2002) reported that peanut hay quality is greatly affected if the hay was harvested after rains or if the vines are not well dried. In this case molds grow on the hay which reduce the quality and may cause aflatoxicosis.

Other peanut by-products fed to cattle

Due to the increased production of peanut, farmers are left with a lot of biomass which is incorporated in the animal food chain and or incorporated back into the soil as organic matter. The products may come from the actual processing of the nuts or from the residual peanut vines in the field as hay.

Peanut meal

Peanut meal is a by-product from pressing of peanut for oil extraction. In some parts of the world it is also called peanut cake. Peanut meal is highly palatable hence it is relished by dairy cattle and other livestock species. Furthermore, Hill (2002) noted that peanut meal can be bought at an affordable price than soybean meal and cotton seed meal. On a %DM basis, peanut meal contains 6.3% ash, 52.3% CP and 77% TDN compared to 41% solvent extracted cottonseed meal which has an ash, CP and TDN of 7.0, 45.6 and 76.0 respectively and 6.5, 55.1 and 87.0 respectively for solvent extracted soybean meal (Feedstuff Buyers Guide, 2011).

In a study by Pond and Manor, (1974) on a comparison of soybean meal and peanut meal revealed that peanut meal had high concentrations of niacin, pantothenic acid, riboflavin and thiamin but low concentrations of essential amino acids; lysine, tryptophan and methionine. Due to ruminants less dependence on dietary amino acids when it is available at competitive prices with soybean and cottonseed meal, it can be utilized as a supplement for growing dairy cattle. However, the use of peanut meal must be in line with the standards on aflatoxins allowed for cattle consumption, human consumption and milk production because of recent various reports have been published on the potential presence of aflatoxins in peanut meal (Kamka,2003, Harrison et al, 1984 & NASS, 2002).

Peanut skins

This peanut by product can be found in the peanut processing plants such as blanching plants. Blanching is the process that removes the skins (testa) from the nuts. The skins can be incorporated in livestock feed. After blanching, the skins are dried. Apart from being livestock feeds the peanut skins have been used in swine waste pits for odor suppression (Newton, 1981) and as bedding for laying hen houses (Reynells et al., 1985). Peanut skins are high in fats (ether extract, EE), TDN and CP estimated at 25.5, 6.5 and 17.4 % respectively but lower in crude fiber (12.6 % DM). Because of their minimum availability due to low volume production, their utilization in cattle feeds is very low. The other major drawback when using peanut skins is the presence of tannins which are detrimental to livestock. Tannin binds enzymes and inhibits protein absorption rendering it unavailable to the animal (Jung & Fahey, 1981 as reported by Hill, 2002). A study by Goldtain reported that urea is effective in reversing tannin inhibition by enzymes. Other methods of reducing tannins are available including increase dietary crude protein.

Peanut silage

Peanut silage is produced when whole plant of peanut are uprooted (manually or mechanically) for pod harvest and are ensiled after shaking to remove soils. Removal of the soil is important so as not to interfere with the mineral content of the silage. In a study by Johnson et al., (1979) discovered that the peanut silage contained 31.5%, 15.4%, 96.5% and 57% of DM, CP, EE and NDF respectively. The study also revealed that intake was 14% greater for heifers fed a 50:50 ration of peanut silage: corn silage than those fed corn silage alone. Another study by Staples et al., (1997) which used perennial peanut silage on lactating dairy cows reported that increase peanut silage in the diets to replace corn silage resulted in three fold increase in dry matter intake (DMI). In this study overall cow performance was not affected even when 70% of the corn silage was replaced with peanut silage in the diet containing 50% concentrate.

Summary and project justification

Peanut hay has a great potential to be used as a livestock feed. Producers and many smallholder farmers in developing countries use it as a source of feed during the critical dry months when other sources of hay are not available. Due to the increase in its use especially in developing nations where dairy enterprises are growing at alarming rates, further research on its utilization in dairy is paramount. Considerable research has been conducted in beef herds and in lactating dairy cows but few in the growing dairy heifer. This study therefore seeks to achieve the following objectives:

1. Determine the optimum voluntary DMI of peanut hay supplemented with corn silage and concentrate in Holstein growing heifers;
2. Measure the effects of intake on growth of growing Holstein heifers;
3. Determine digestibility of peanut hay diets.

CHAPTER III

MATERIALS AND METHODS

Experimental design

A completely randomized block design was employed where by 14 Holstein heifers (BW= 408 ± 32 kg; Age = 15.4 ± 0.5 mos) were randomly assigned to one of two diets: Corn silage based (PH, n=7) and peanut hay based (PH, n=7). The experiment was conducted for 26 days with the first 5 days for acclimatization to the diets and the last 21 days for data collection

Animals and Treatments

Fourteen Holstein heifers were housed at the Heifer Research Unit of Mississippi State University and used for both the voluntary intake and digestibility experiment. The stall was equipped with Calan gates (American Calan, Inc., Northwood, NH) to allow measurement of individual feed intake. Heifers were weighed before and every week during the experiment using the livestock platform scale. Peanut hay and corn silage were the main forages used during the trial. Random core samples of the hay and silage were taken and subjected to proximate analysis (Table 1).

Voluntary dry matter intake and nutrient analysis

Heifers housed in free stalls equipped with Calan gates were fed bermudagrass for 10 days to acclimatize themselves to the experimental conditions and meet their maintenance requirement. After acclimation period, the heifers were randomly assigned to the treatments. The heifers were offered diets in excess of their voluntary intake during the 3 weeks DMI period. The daily amount of hay offered and refused (orts) were measured for determination of intake and the feed and orts were sampled weekly. All the feed and orts samples were ground through a 2 mm sieve in a Thomas Wiley Mill® (Thomas Scientific, Philadelphia, PA) after which the ground materials were analyzed for DM, CP, NDF, ADF and ash. For the DM analysis, 2.0 g of the sample were weighed into a crucible and oven dried at around 100^{o}C for at least 24 hours then reweighed to determine amount of moisture lost. Ash analysis was conducted in the same way for weighing and oven heating however, the samples after DM analysis were placed in a muffle furnance at 550 ^{o}C for at least five hours until white ash formed then cooled and weighed to determine the ash content. The CP of the samples were determined by using the Kjeldahl Nitrogen method by (AOAC, 2000) in which the determined Nitrogen was used to calculate CP concentration. NDF and ADF fractions of the samples were determined using the Van Soest detergent procedure of forage analysis where the samples were digested in either neutral detergent or acid detergent solutions, (Goering and Van Soest 1970; Van Soest et al., 1991). The DM analysis of the orts was conducted in a similar manner. All the animals were individually weighed at weekly intervals in order to estimate the average daily gain (ADG, kg/day) and the feed efficiency (FE, kg feed/kg gain).

Digestibility

The same heifers used during the voluntary intake experiment were used for the digestibility trial. The n- alkane method of digestibility analysis was used as stipulated by (Russell et al., 2000) and (Dove and Mayes, 2006). Feed samples were collected on day 26 and oven dried at 55 degrees Celsius and ground in the Wiley mill (2-mm screen; Arthur H. Thomas, Philadelphia, PA) prior to analysis. Rectal samples of feces were taken from each animal once daily from d 25 to 28, dried, and ground prior to analysis. A sample of 0.1 g of feces/feed was placed in a 4-mL GC vial onto which 50 µL ISTD was added. 2 mL of 1 M KOH in ethanol was added. The mixture was heated in 90°C water bath for 4.5 h until clear and was cooled to warm temperature (50-60ºC). 2 mL heptane, 0.6mL of distilled water was added and the mixture was shaken vigorously. The top layer was then transferred to another 4-mL GC vial and was allowed to evaporate to dryness using the solvent evaporator. After evaporation, the vial containing top layer was reconstituted with 0.3 mL of heptane with warming and applied to a silica gel cartridge. The vial was washed with 0.1 mL heptane and applied to the same cartridge. The cartridge was washed with 2.4 mL of heptane into the third GC vial and was allowed to evaporate to dryness. After evaporation the vial was reconstituted with warming in 0.25 mL of n-dodecane and the mixture was transferred to a 2 mL GC vial and was inserted in the GC machine for GC analysis.

Statistical analysis

Intake and growth measurements were analyzed using the Mixed Procedure of SAS, but DMD was analyzed using PROC GLM (SAS 9.4, SAS Inst. Inc., Cary, NC). In this model, treatment and day or week were the independent variables and day or week was used as a repeated measure, when appropriate. All term interactions were tested. Statistical significance on any effects or interactions was declared at $P < 0.05$.

CHAPTER III

RESULTS AND DISCUSSION

Nutritive value of peanut hay based diets

In the current study the CP, NDF, ADF and ash of peanut hay at 91.8% DM were 8% CP, 64% NDF, 51.9% ADF and 8 % Ash. These results compare well with findings from the standard Feedstuff Buyers Guide (2014) which pegged the CP of peanut hay at 8.6%. Due to the decrease in CP of peanut hay that does not meet the NRC requirements for dairy cattle; peanut hay must be incorporated as a hay base in total mixed rations (TMR). The current study mixed peanut hay, corn silage and concentrate mix when forming the PH and CS TMRs. In the current study, the PH diet contained numerically increased amount of peanut hay than the CS ration. Though statistically there were no differences between the diets, the CS ration had numerically increased in NDF and ADF due to increase in corn silage (Table 1).

Heifers fed CS diet did not have different CP intakes ($p < 0.85$) compared with those on PH diet. The results are not similar to the findings of Kendall et al., (2009) and Voelker et al., (2002) who reported increased CP intakes on CS diets attributing this to diet composition and increased DMI of the CS diets. The diet composition holds true for this current study as it has been established that the PH diet had numerically increased DMI. No interactions between diet*Day of study were observed on both DMI (P=0.25) and CP (P=0.06) NDF (P=0.28) and ADF (P=0.24).

Dry Matter Intake

DMI intake data is presented on Table 2 and Figure 1. The DMI was not different across the treatment diet (P=0.08). NDF and ADF intake was different between the diets, PH fed heifers had greater intakes (P<0.01). The results of chemical analyses of the diets showed that CS diet had numerically greater NDF and ADF (48.79 and 46.39, 30.46 and 28.96; respectively). One thing to note is that while the CS diet had greater concentrations of NDF and ADF, the PH heifers consumed more NDF/ADF, without an increase in DMI. Though DMI was not different across the treatments but the PH diet exhibited tendency for greater DMI than CS diets. The increase in NDF and ADF intakes in PH diets can be attributed to the increase of more kg of feed consumed by heifers on the PH diet, though DMI was not different (9.75 vs.8.67). Since NDF is one of the best intake determinants in dairy cattle feeding (Krizsan et al. 2010) it is possible that the increased NDF (hemicellulose, cellulose, and lignin) in the PH diet increased the feed retention time in the rumen reducing the space for the next feeding hence reduced DMI in PH diet was recorded. Corn silage is used in most dairy rations due to its stability and higher fermentable carbohydrates hence its use reduces the inclusion of other forages in a diet (Weiss et al., 2002). These findings contradict the finding of other researchers (Martinez et al., 2009) who reported decreased intakes in high forage diets but are in tandem with findings from Soita et al., (2005) who reported increased intakes for high forage diets. A reduced DMI across treatments diet was recorded in the first week of the trial as the heifers were acclimating themselves to the new diet and the diets were low moisture TMR. To increase moisture and intake, water was added to the diet and an increase (P<0.05) in intake was observed in week 2 of the trial. These results contradict the findings of Felton and Devrie (2010) who reported a decrease in DMI with addition of water to high moisture TMR (less than 60% DM). The findings of Felton and Devrie, (2010) further reported that addition of water did not reduce sorting of feed offered but rather increased the behavior of which was also observed in this trial.

Growth Parameters and Feed Efficiency

Data on all body measurements parameters are presented on Table 3 and Figures 2, 3, and 4. Week of study had an effect on the parameters especially BW (P=0.01), BCS (P=0.01) and ADG (P=0.01). In week 1, heifers lost weight (-1.14 kg/d) while gaining in week 2 (4.18 kg/d). The general loss of weight for heifers in week 1 could be attributed to the struggle by the heifers to access feed during training period. Calan gates automated system was used during the trial. This could have affected DMI as some other heifers failed to open the Calan gates for longer period of time reducing the DMI which affected the BW and ADG in week 1. No interaction was observed between Week*Diet on all the parameters. Feed Efficiency using the feed to gain ratio was different across the treatments diets (P<0.0001). PH diets showed tendency for less feed efficiency as it required a lot of feed to gain 1 kg body weight than CS diets, though feed efficiency was also low in the heifers fed CS diets (10.44 vs. 6.54; P < 0.01). This has a greater impact on farm productivity since 50% of farm costs are channeled to feed (USDA-ERS, 2011) hence a greater requirement for further research on peanut hay diets manipulations for improvement of feed efficiency to determine a desirable diet that will be highly efficient for producers.

Dry Matter Digestibility

DMD is greatly influenced by the F:C ratio, type of ingredients used and diet composition. In the current study, there was no differences between the two diets (P=0.274) but a numerically increased DMD percentage was observed in the CS diet (75.37% v. 68.53%, respectively). These findings are in agreement with other researchers (Voelker et al., 2002 & Martinez et al., 2009) who reported similar percentages of DMD of PH and CS diets but with increased percentage in the CS diets. The work of Lechartier et al., (2009) contradicts these findings as they reported increases in DMD of diets containing lower NDF content. In the current trial the diet that contained increased NDF (CS diet) had numerically greater DMD percentage. This brings a conclusion that the ingredients used when formulating the TMR have a great effect on the DMD. The PH diet contained increased amount of peanut hay (64% NDF) that could have increased retention time in the rumen due to high forage NDF compared to the CS diet which contained increased amount corn silage (39%NDF) leading to reduced retention time in the rumen. The form and type of forages used in the TMR; amount of hay versus amount of silage could have a great impact on DMD than the F:C ratio alone. The DMD values observed in this current study (75.37% v. 68.53%, respectively) compares well with other digestibility studies (Gorbet et al., 1994) that reported DMD in the ranges of peanut forage ranging from 59.6 to 72% DM. These studies used the in vivo organic matter digestibility (IVOMD) and the current study has used the alkane method of DMD.

Conclusion and future perspectives

Results from the study has revealed that peanut hay based diets if formulated to contain CS can increase growth in dairy heifers. Smallholder dairy farmers in sub-

Saharan Africa where peanut hay is utilized should include concentrate and other forage source, especially corn silage to maximize productivity. Further research in lactating dairy cattle should be promoted. Since research publications for peanut hay utilization in dairy heifers are minimal, efforts can be to link up with Universities in Sub-Saharan Africa to do research in purely peanut hay diets with greater focus on improving feed efficiency.

Table 1 Ingredient and chemical composition of the treatment diets on a dry matter basis

	High Forage Diet	Low Forage Diet
Corn Silage[1], %	48.05	54.55
Peanut hay[2], %	28.57	16.88
Grain Mix[3], %	23.38	28.57
Dry Matter, %	56.19	53.42
Crude Protein, %	11.37	11.96
Neutral Detergent Fiber, %	46.39	48.79
Acid Detergent Fiber, %	28.96	30.46
Ash,%	6.68	7.02

[1] Corn Silage = 92.17 % DM, 8.6 % CP, 39 % NDF, 19.9% ADF and 3.7 Ash
[2] Peanut Hay = 91.87 % DM, 8.0 % CP, 64.0 % NDF, 51.9% ADF and 8.0 Ash
[3]Grain Mix = 96.34 % DM, 17.7 % CP, 32 % NDF, 9.3% ADF and 7.7 Ash

Table 2 Dry matter and nutrient intake and digestibility of high and low forage diets with peanut hay fed to Holstein heifers.

Parameter	Diet		SE	***P*** -Value		
	PH	CS		Diet	Day	Diet*Day
DMI, kg/d	9.75	8.67	0.40	0.08	<0.01	0.25
CP, kg/d	0.36	0.37	0.02	0.85	<0.01	0.06
NDF, kg/d	2.37	1.93	0.11	0.01	<0.01	0.28
ADF, kg/d	1.83	1.25	0.07	<0.01	<0.01	0.24
OMI, kg/d	9.48	8.57	0.37	0.10	0.01	0.24
DMD, %	68.53	75.37	3.09	0.27	….	….

Table 3 Mean body measurements on BW, heart girth, BCS, wither height, ADGs and Feed efficiency of the heifers by treatment diet and week of study

	Diet		SE	*P*-Value		
Item	PH	CS		Diet	Week	Diet*Week
BW, kg	418.5	432.1	12.7	0.46	0.01	0.78
Girth, cm	178.4	180.3	1.68	0.44	0.01	0.26
WH, cm	132.7	131.1	1.26	0.40	0.71	0.54
BCS	2.75	2.84	0.04	0.16	0.01	0.59
ADG, kg/d	1.18	1.46	0.27	0.48	0.01	0.74
Feed Efficiency	10.44	6.54	1.4093	<0.0001	0.44	0.48

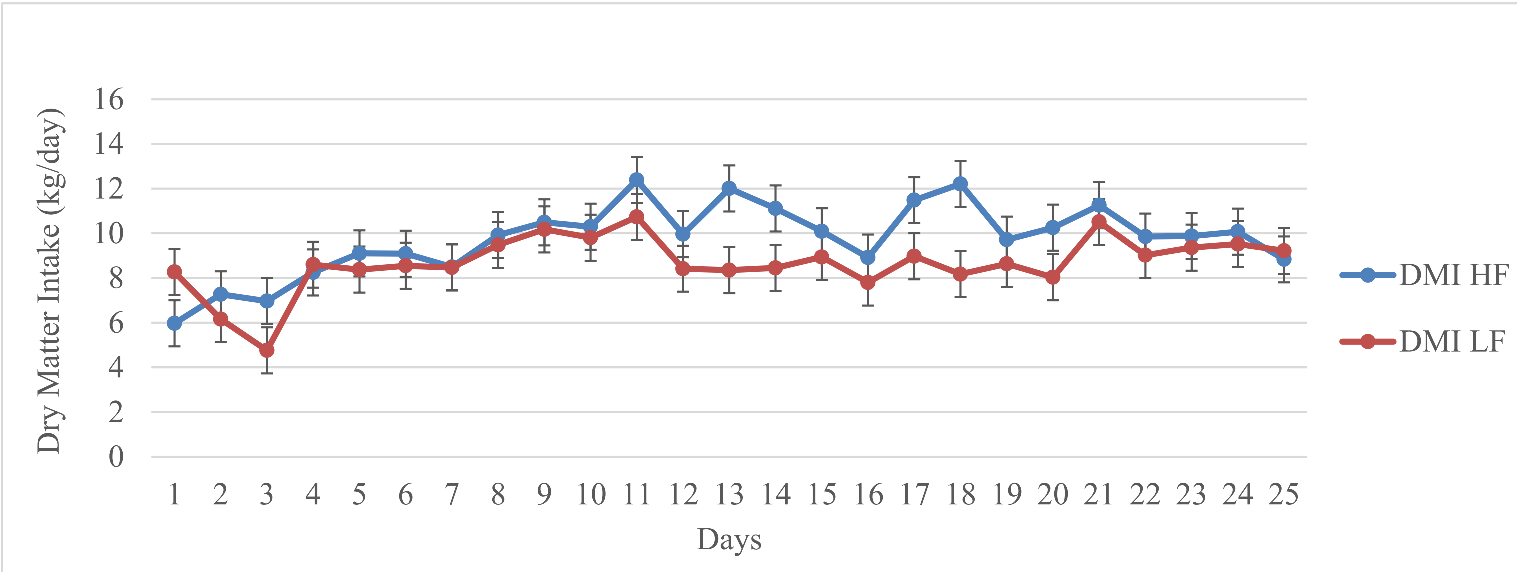

Figure 1 Average daily dry matter intakes (kg/d) of Holstein heifers fed either Peanut Hay or Corn Silage

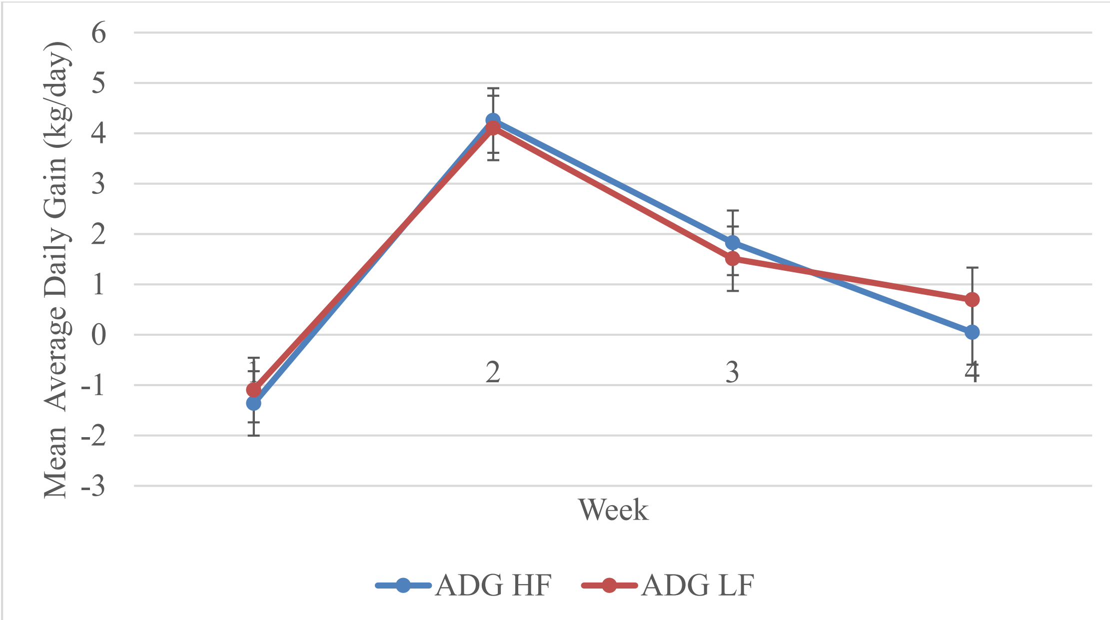

Figure 2 Average daily gain of Holstein heifers fed either Peanut Hay or Corn Silage

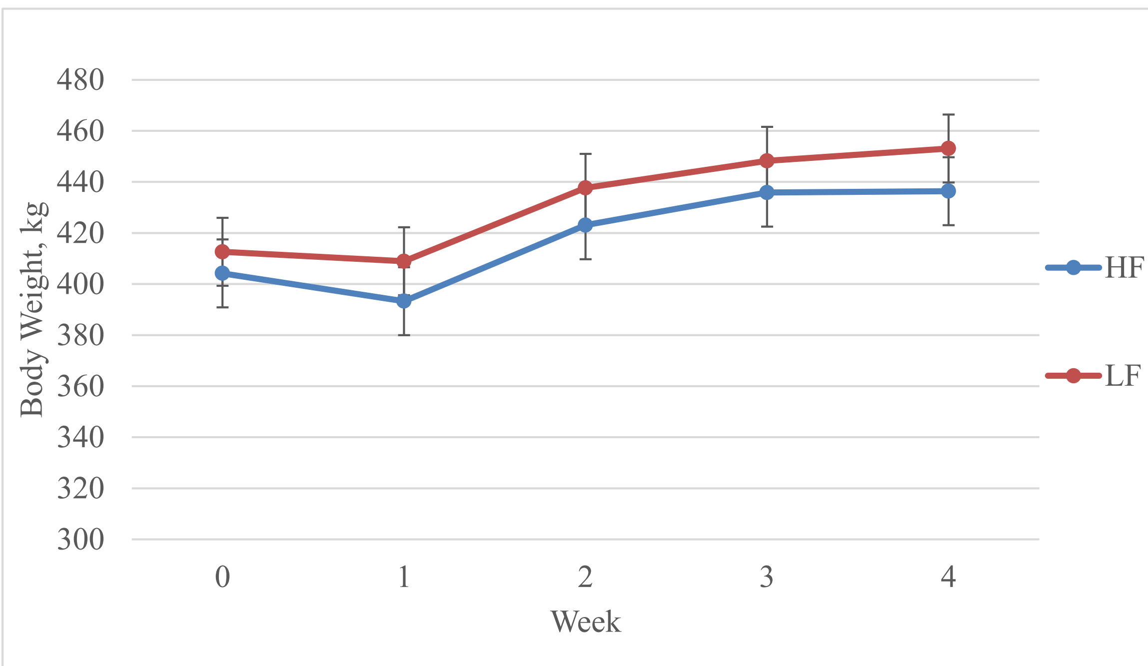

Figure 3 Mean weekly body weight for high and low forage diets with peanut hay fed to Holstein heifers.

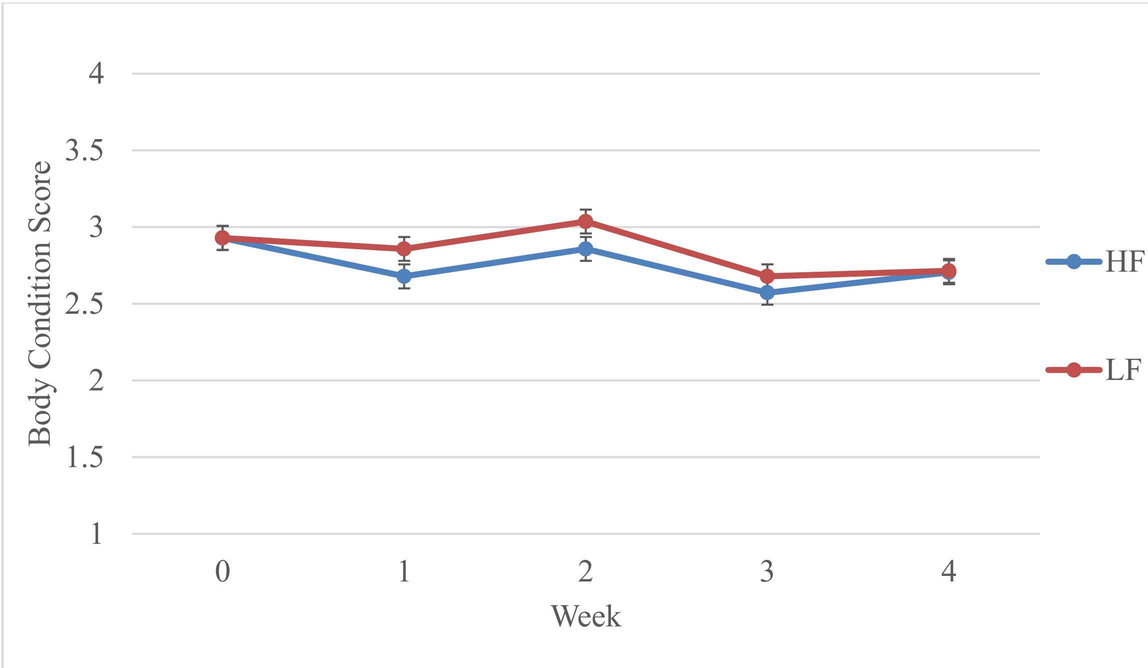

Figure 4 Mean weekly BCS (scale = 1 (thin) to 5 (fat)) of Holstein heifers fed diets with Peanut Hay or Corn Silage.

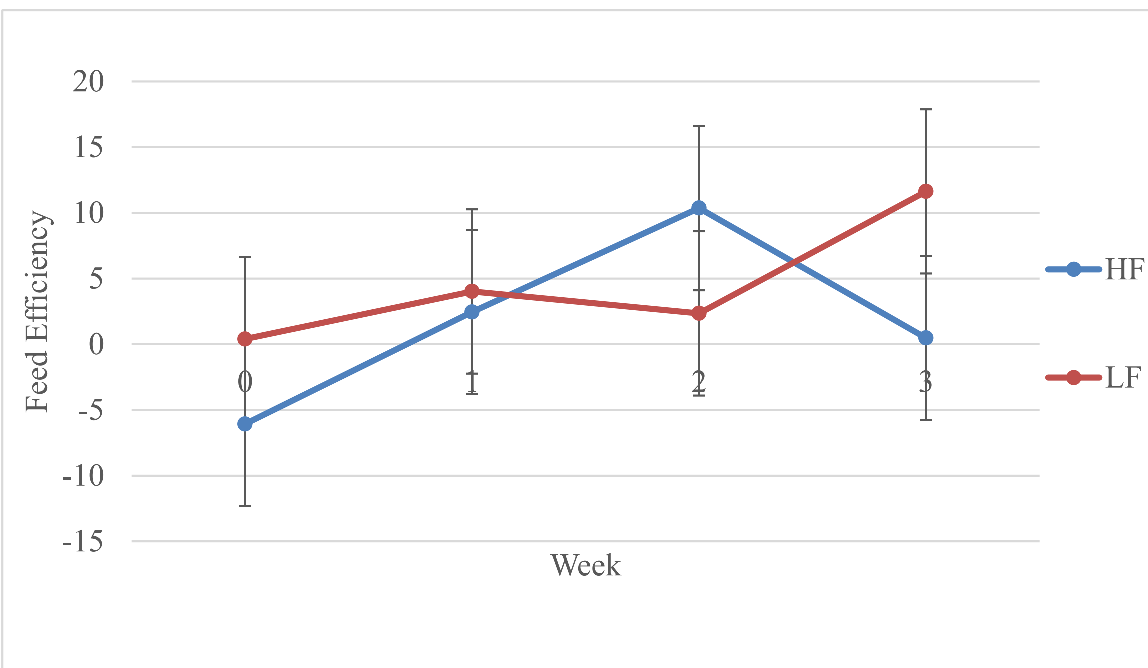

Figure 5 Average Feed Efficiency of Holstein heifers fed diets with either peanut hay or corn silage

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