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Feed Intake, Growth Performance and Digestibility of Nutrients of Goats Fed with Outdoor-Grown Hydroponic Maize Sprouts

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ABSTRACT

The study aimed to determine the effects of feeding outdoor-grown hydroponics maize sprouts (HMS) on the growth performance and digestibility of nutrients in goats. Three treatment groups (n = 5), group T1 (control), were fed 500 g concentrate, and Napier grass; T2, 500 g concentrate, and HMS, while T3 had sole feeding of HMS using a completely randomized design. The results showed that HMS had a better feed nutritive composition with the lower concentration of indigestible fibre (P<0.05) and higher concentration of crude protein (12.28%) compared to Napier grass (7.22%) (P<0.05). Goats in T1 and T2 fed with concentrate had a higher average daily gain (ADG) of 79 g/day and 48 g/day rivalling goats fed with HMS (44 g/day) (P<0.05). Feed conversion ratio (FCR) was significantly better (P<0.05) in goats in T1 and T2 compared to T3. Goats in groups T1 and T2 showed significantly higher dry matter digestibility (69.27% and 63.95%, respectively) and crude protein digestibility (71.89% and 72.28%, respectively) compared to group T3. Sole feeding of HMS exerted a minor impact on growth performance in the animals. However, the HMS could potentially replace the conventionally planted sprouts in conjunction with commercial concentrate to improve the growth performance of the small ruminants.

Keywords: Average daily gain, feed intake, hydroponic maize sprouts, Napier grass, nutrient digestibility

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INTRODUCTION

In Malaysia, fodder is currently being utilized as a significant component in the ruminant diet. Consistency in the quality and production of high-quality fodder is fundamental for a successful animal production system. The Napier grass (*Pennisetum purpureum* Schumach.), a perennial tropical grass in the Poaceae family, is currently the most used fodder in dairy and feedlot production in livestock management (Halim et al., 2013). It is the most prevalent forage species due to its high nutritive value and is quickly established through stem propagation (Wijitphan et al., 2009). However, this feeding method is labour-intensive, which requires sowing, earthing up, fertilizing, weeding, and harvesting. Furthermore, the yield and quality of Napier grass can be affected by cultivar selection (Halim et al., 2013), type and rate of fertilizer (Fauzi & Soetanto, 2020), plant density (Mukhtar et al., 2003), and lastly, the cutting management, such as cutting frequency (Mukhtar et al., 2003), cutting intervals (Jusoh et al., 2014), and cutting height (Wijitphan et al., 2009).

The hydroponics production reduced the expenses of farmers since minimal space is required with a vertical production system. The optimum harvesting period of hydroponic maize fodder is 7–10 days (Naik et al., 2013). The crude protein (CP) content of maize seed is significantly increased after seven days of sprouting (ranging from 8.60%–13.57%) (Naik et al., 2012). A numeric increase in CP, neutral detergent fibre (NDF), water-soluble carbohydrate (WSC), and ether extract (EE) concentration of 1.8%, 16.1%, 17.1%, and 1.8%, respectively, was observed in the 7-day sprouted barley compared with the barley grains (Hafla et al., 2014). Various commercial hydroponic fodder producers report yields of 6–10 times with dry matter (DM) content ranging from 6.4% to 20%, although trial yields range from 5–8 folds (Sneath & Mclntosh, 2003). Hydroponic maize fodder yields of 5–6 times on a fresh basis (1 kg seed produces 5–6 kg hydroponic maize fodder) and DM content of 11%–14% are common (Naik et al., 2013). Besides, hydroponic maize fodder contains higher CP, EE, and nitrogen-free extract (NFE) contents; lower crude fibre (CF), total ash (TA), and acid insoluble ash (AIA) contents than the conventional maize fodder (Naik et al., 2012). For the 7-day growth sprout samples, maize have reported nutrient profiles of DM ranging from 12.4% to 25.0%, CP from 13.3% to 13.8%, CF from 6.4% to 14.8%, EE from 3.3% to 3.6%, NFE from 60.7% to 75.3%, TA from 1.8% to 3.8%, and AIA from 0.3% to 0.6% when reported on a DM basis.

Most smallholder goat farms practice improper feeding regimes due to poor knowledge and information, resulting in lower growth and reproductive performance of the goats, feed consumption, and production (Ghani et al., 2017). Moreover, the consumption of mutton in Malaysia substantially increased. Nevertheless, the reports on the effect of hydroponic fodder on the growth performance and growth hormone profile of goats, particularly in Malaysia, are scarce. Reviews have shown that hydroponic fodder is alternative to green fodder for animals. However, developing low-cost devices for hydroponic fodder production using locally accessible materials on different livestock categories requires more focus. This study aims to develop a low-cost device for hydroponic fodder, which plays the role of a new goat feeding system in achieving successful and profitable goat farming.

METHODS

This study was conducted at Wawasan Manis Sdn. Bhd., a breeding farm located at Lendu, Melaka, from November 2018 to February 2019. Chemical composition was analysed at Nutritional Laboratory, Department of Animal Science, Faculty of Agriculture, UPM.

Animal Welfare

This study was carried out according to the guiding principle stated in the Code of Practice for The Care and Use of Animals for Scientific Purposes, Universiti Putra Malaysia (The Institutional Animal Care and Use Committee [IACUC]).

Open-Air Hydroponic System

A used cattle pen-sized 35 ft width and 27 ft length were sheltered with polyethene sunshade netting to protect green fodders from heat before installing the open-air hydroponic fodder growing system (Figure 1). The cattle pen was also fenced with galvanized welded iron wire mesh (bottom) and zinc sheet (top) as a protective measurement from rodents. Two water tanks were used as the water storage system: Tank 1 was fed by clean tap water, and Tank 2 was fed by water from an outlet at the bottom of Tank 1 (Figure 2). Two centrifugal pumps (Model CPM-158, AC 200–240 V ~50 Hz, Victa™, Malaysia) connected to Tank 2 pumped water to a filter and then to the water channels (Figure 3). Polyethene pipes sized 25 mm were used as water-conducting networks from tanks, centrifugal pumps, filters, and water channels. The water channels drained water into eleven water ducts of polyethene pipes sized 16 mm. The water flow of five ducts was drained from pump 1 and another six ducts from pump 2. The water ducts were spaced 2 ft apart, and plastic misting spray nozzles were placed at 2-ft intervals along these water ducts.

Figure 1. A used cattle pen was transformed into the open-air hydroponic green fodder growing system

Figure 2. A two-tanks system was applied to ensure a continuous supply of water

Figure 3. The water-conducting network from Tank 2, two centrifugal pumps and filters

Preparation of Feeding Treatment

Napier grass was used as a control group as it is commonly fed to goats. Napier grass was already planted at this farm and fertilized with goat manure. The grass was harvested daily from the pasture (8–10 weeks old) at about 1.0–1.5 m height (Zailan et al., 2016). A fuel-driven chopper machine was used to chop the Napier grass to about 3–5 cm. However, the maize sprouts will be hydroponically grown, as reported by Morgan et al. (as cited in Naik et al., 2015, p. 3). The maize grains were grown through an outdoor hydroponic sprouts production unit (Figure 4). Polyethene trays sized 52.0 cm length × 32.0 cm width × 2.5 cm height were used as the hydroponic trays. Each tray was manually drilled to make holes at the base to drain excess water from irrigation. Maize grains were cleaned with several piles of washing (at least three times) to remove the darkened or damaged seed and floating particles. Next, maize grains were treated with 0.1% hypochlorite solution (or bleach) for 20 minutes. Then, maize grains were washed again with water to remove excess bleach. The washed grains were covered with wet cotton cloths for 12–24 hours. Each hydroponic tray was spread with 1 kg sprouted grain with 1–1.5 cm layer thickness. All maize grains were irrigated using overhead mist ten times a day. Each irrigation session lasted for 1 minute, set by a digital timer. The sprouts of maize were harvested on Day 7 (Naik et al., 2015). There was no supplemental light used for this hydroponics system due to the high availability of sunlight at this hydroponic site. It is because photosynthesis is not dominant for the metabolism of the seedlings until the end of the fifth day when the chloroplasts are activated (Sneath & Mclntosh, 2003).

A commercial concentrate was purchased from Nutri Vet Trading (livestock feed supplier located in Negeri Sembilan) and used as the daily diet for the Control group (T1) and T2 in the morning. The chemical composition of the commercial concentrate is summarized in Table 1 (Association of Official Analytical Chemists [AOAC], 1990).

In a completely randomized design, a total of fifteen male Boer crossbred goats with a mean age of 178.4 days old with an average initial body weight of 18.8 kg were allotted to different single pent sized 3.5 ft width × 4.3 ft length on a raised slatted floor, which is equipped with water nipple. The goats were randomly grouped into three treatments, which consist of Treatment 1 (T1) fed with 100% fresh Napier grass and concentrate as Control group, Treatment 2 (T2) with 100% HMS and concentrate, and Treatment 3 (T3) with 100% HMS only, respectively. The concentrate (Table 1) was fed at the 500 g/goat rate in the morning (0830 h) daily.

Figure 4. The hydroponic maize sprouts, which were grown for seven days

Table 1
Chemical composition of commercial concentrate for T1 and T2

Parameters	Dry matter basis (%)
Dry matter (DM)	80.80±0.74
Crude protein (CP)	16.24±0.10
Organic matter (OM)	88.78±0.52
Neutral detergent fibre (NDF)	46.91±0.61
Acid detergent fibre (ADF)	22.53±0.13
Acid detergent fibre (ADL)	5.78±0.22
Hemicellulose	24.38±0.68
Cellulose	16.75±0.23
Ash	11.22±0.52

Feed Intake and Growth Performance

During the 13 weeks of the feeding trial, all fresh fodder was offered *ad libitum* in the evening (1630 h) at approximately 10% (fresh basis) of the live weight of the goats, which was approximately 20% above the observed intakes during the adaptation period. The pens and troughs are cleaned every day before offering a feed. All animals had free access to water. The goats were fed with treatments for two weeks of adaptation before data collection. Feed intake was determined on a subsequent day by weighing the remnants and subtracting them from the feed offered. A representative sample from the feed was obtained for chemical composition analysis. During the feeding trial, the live weight (LW) was measured weekly before the morning feed was served. The average of LW gain daily was determined by dividing the differences of the initial and final LW with the duration of the feeding trial (91 days). Feed conversion ratio (FCR) was calculated as follows:

$$FCR = \frac{\text{Feed intake}}{\text{Weight gain}}$$

Total Collection Digestibility Trials

During the last week of the feeding trial, a 5-day digestion trial was conducted on all experimental animals. The representative feed samples (200 g each) were taken from each treatment group to determine the nutrient composition. In addition, approximately 100 g of faecal sample was collected directly from the anus of each animal and kept in a sealed bag. The faecal samples were then taken to Plant Biochemistry and Animal Physiology Laboratory, Department of Biology, Faculty of Science, UPM for oven drying at 60 °C for 48 hours. The dried samples were ground, sieved through a 1-mm screen, and packed in an air-tight container to be used for chemical analysis. The apparent nutrient was determined as follow:

$$\text{Nutrient digestibility (\%)} = \frac{\text{Nutrient voided in the faeces}}{\text{Nutrient intake}} \times 100$$

Analytical Procedure

Feed and faecal samples were oven-dried at 60 °C for 48 hours, ground to pass a 1-mm mesh screen sieve and stored for chemical analysis. The nutritive values were analysed by Near-infrared Spectroscopy (NIRS) (NIRS™ DS2500, FOSS, Denmark) with additional calibration from the fodder samples analysed using standard laboratory procedure. The amount of CP was determined (N × 6.25) (AOAC, 1990). The NDF and ADF were analysed using FiberCap 2023 System (FOSS, Denmark) (International Organization for Standardization [ISO], 2008). Feed intake was measured on a subsequent day by weighing the remnants and subtracting them from the feed offered. A representative sample from the remnants was obtained for chemical composition analysis.

Statistical Analysis

All data were examined using IBM SPSS version 22.0 for Windows and presented as the mean ± S.E.M. Statistical significance was established at $P<0.05$. The chemical compositions between two green fodders were compared using the independent sample t-test. While the collected data of growth performance, feed intake and apparent digestibility were analysed using the analysis of variance (ANOVA) test. The least significant difference (LSD) test determined the significance of mean differences among the treatments.

RESULTS AND DISCUSSION

Chemical Composition Between Conventional Fodder and Hydroponic Maize Sprouts

The total chemical composition in green fodders is summarized in Table 2. Napier grass presently denoted a higher DM but a lower CP composition than HMS ($P<0.05$). On the other hand, Napier grass showed significantly higher OM content, 90.99%, compared to 88.85% in HMS. Besides, higher NDF, ADF, and ADL compositions were significantly higher in Napier grass ($P<0.05$).

DM indicates the available amount of nutrients to the animal in a diet. Livestock voluntarily consume a certain amount of DM per day (measured in kg/day) to maintain health, growth, and production (Naik et al., 2014). The values of DM reported by Lounglawan et al. (2014) as 18.93% in Napier grass harvested at 10 cm height on day 60^{th}, Ghani et al. (2017) as 13.04% in which Napier grass was harvested manually at the age of 8 weeks (Rahman et al., 2014) as 20.79% were lower than the present study, 26.01%. In the present investigation, the DM content in HMS was 24.75%, lower than Napier grass because of high moisture content. However, this value was higher than the results reported by Gebremedhin (2015) and Naik et al. (2014) in HMS as 18.30% and 18.48%, respectively. Higher DM content in HMS was reported if harvested at an older age and cultivated in a nutrient solution. A study conducted by Thadchanamoorthy and Pramalal (2012) reported higher DM content as 26.07% in 10 days old HMS, while Adebiyi et al. (2018) noted 25.00% DM content in 7-days old HMS, which was cultivated with nutrient solution.

The CP content presently denoted in HMS was 12.28% higher than the Napier grass ($P<0.05$). CP in feeding stuff includes the true protein containing amino acids and non-protein nitrogenous compounds, such as amides. HMS was preferred as a source of quality forage for livestock because it has a high protein (Ndaru et al., 2020). It is encouraging to compare the findings of this study with the results by Vennila (2018), who recorded 10.55% CP content of HMS with an 8-days growth period but lower than the CP content reported by several studies as ranged from 13.30%–16.54% (Adebiyi et al., 2018; Kide et al., 2015; Naik et al., 2012, 2013, 2014; Thadchanamoorthy & Pramalal, 2012). The minor differences in minor results are probably due to the variety and quality of seed used, light intensity, quality of the irrigation water, and germination time (Kaouche-Adjlanea et al., 2016). A study showed that hydroponic maize fodder would have higher CP content (24.07 g/100g) when harvested on the eighth day (Islam et al., 2016). However, the current study produced outdoor HMS exposed to high humidity, unlike those grown in a greenhouse. High humidity is one of the promoting factors of mould growth at the mat of roots when the length of the growth period increases. Generally, a concentration of 6–8% CP in the basal forage is a threshold for a response by ruminant livestock to nitrogen (N) supplements (Mathis et al., 2000). The CP content of Napier grass investigated in the present study was 7.22%. The value was higher than the findings obtained by Zailan et al. (2016) in common Napier grass harvested at an interval of 8 weeks as 6.44% and Ghani et al. (2017) as 3.88%. The higher value of CP was reported by Rambau et al. (2016) in Napier grass leaves harvested at intermediate stage (8 weeks) as 140.4 g/kg and Halim et al. (2013) in common Napier grass as 9.79%, Lounglawan et al. (2014) as 8.87%, Bayble et al. (2007) as 14.13% in Napier grass. The increment in enzymatic activities of nutrients can improve the CP content in hydroponic maize fodder (Naik et al., 2013).

Napier grass showed significantly higher OM (90.99%) content due to the application of fertilizer after each cutting ($P<0.05$). The value of total ash (11.22%) observed in the HMS of the present study is higher than the results reported by Naik et al. (2013) as a range of 1.75–3.80%. The total ash content rises on account of the mineral absorption by roots throughout the sprouting phase. HMS had higher palatability due to the younger harvesting age that showed a decrease in the number and size of cell walls for the synthesis of structural carbohydrates (Bayble et al., 2007). The comparable crude fibre content was reported by a few studies in HMS as a range of 9.33–14.10% (Gebremedhin, 2015; Kide et al., 2015; Naik et al., 2013). The higher value of crude fibre was reported by Adebiyi et al. (2018) as 14.77%, and lower values were also reported by Thadchanamoorthy and Pramalal (2012) as 8.21% and Naik et al. (2014) as 6.37%.

Although Napier grass showed a higher DM composition, the lower value of the CP justifies the need for HMS as alternative green fodders. In small ruminants, the amount of protein is more important than the quality of protein (Valente, 2016). In addition, the significantly lower NDF, ADF, and ADL in HMS represent lower indigestible fibres, which predict HMS as more acceptable green fodder to animals.

Table 2

Chemical composition of green fodder

Parameters (% of DM)	Conventional Napier green fodder	Hydroponic maize sprouts
	n = 32	n = 32
DM	26.01 ± 0.38^{b}	24.75 ± 0.20^{a}
CP	7.22 ± 0.09^{a}	12.28 ± 0.25^{b}
OM	90.99 ± 0.10^{b}	88.85 ± 0.35^{a}
NDF	75.66 ± 0.24^{b}	64.02 ± 0.45^{a}
ADF	48.92 ± 0.38^{b}	17.90 ± 0.51^{a}
ADL	43.55 ± 0.32^{b}	3.49 ± 0.40^{a}
Hemicellulose	26.80 ± 0.60^{a}	46.09 ± 0.92^{b}
Cellulose	5.38 ± 0.66^{a}	14.41 ± 0.70^{b}
Ash	8.93 ± 0.15^{a}	11.22 ± 0.38^{b}

Note. DM = Dry matter; CP = Crude protein; OM = Organic matter; NDF = Neutral detergent fibre; ADF = Acid detergent fibre; ADL = Acid detergent lignin; n = Number of samples
All analyses are mean ± standard error of means (S.E.M.)
Means with different superscript letters in a row are significantly different (P<0.05)

Feed Intake and Growth Performance

Table 3 shows the effect of experimental diets on the feed intake of goats. The performance in average weight gain (ADG) was highly significant in the control group, T1 (79 g/day), compared to T2 and T3. The higher performance in ADG by animals fed with Napier grass and 500g concentrate could be due to the higher DM content to supply necessary nutrients for growth. The

ADG was similar (*P*>0.05) among the T2 and T3, with a mean value of 48 g/day and 44 g/day, respectively. This result can be considered good performance, considering the long feeding period since it was higher than the one as 37.74 g/day of growing goats (Gebremedhin, 2015). It was in line with the concept of Naik et al. (2014) pointed out that hydroponic fodder is a good source of nutrients and have a grass juice component that helps livestock perform better. Similar results were also reported by Eshtayeh (2004) in lactating Awassi ewes fed the hydroponic barley and hydroponic with olive cake at a rate of 15, and 25% exhibited significant body weight gain. In addition, male calves fed green hydroponic fodder observed 200 g/day body weight gain (Fazaeli et al., 2011). However, Farlin et al. (1971) found no difference between cattle given sprouted grain and cattle fed non-sprouted grain.

The daily dry matter intake, DMI (g/day), for different treatment groups, T1, T2, and T3, was compiled and presented in Table 3. In the present investigation, the average daily DMI was observed to be 315.64 g/day in treatment group T1, 179.19 g/day in treatment group T2, and 513.81 g/day in treatment group T3, respectively. As the statistical result conveyed, the daily DMI (g/day) was found significantly higher in treatment group T3 in comparison with the other treatment groups. The higher daily DMI (g/day) observed in treatment group T3 was due to the higher amount of HMS offered since no concentrate was given for this treatment group. Raeisi et al. (2018) reported that DMI increased with diet containing 7%, 14%, and 21%, respectively of hydroponic barley fodder fed to male sheep. The DMI of control group T1 showed 136.45 g/day more than the one in T2 may be due to the high-water content hydroponic fodders may have made them bulky, limiting the DMI of animals (Fazaeli et al., 2011). The present finding was comparable with the reports of Fazaeli et al. (2011) as they observed 6.6 kg DMI/day in male calves fed as control (roughage + concentrate) and 7.2 kg DMI/day in male calves supplemented 22.8% barley hydroponic fodder in their daily ration. Naik et al. (2014) denoted 8.85 kg/day in milking cows fed hydroponic maize fodder. According to a recent study that used hydroponic fodder as the sole feed, the DMI (% of body weight) of hydroponic maize fodder was 1.11%, lower than the recommended 2.6% to 2.8% for adult sheep maintenance (Ansari et al., 2019). In addition, some studies indicate a decrease in the DM intake of the animals when hydroponics fodder is fed (Farghaly et al., 2019). However, some reports recommended that 30% CP of kid starters be replaced with hydroponic maize fodder without affecting growth and DMI (Shyama et al., 2016).

The average total weight gain (TWG) of animals for the experiment is presented in Table 3. The TWG achieved 7.20, 4.40, and 4.00 kg in T1, T2, and T3, respectively. At the same time, the average total feed intake of each treatment group was recorded as 110.50, 65.8, and 188.7 kg in T1, T2, and T3, respectively. Statistically, the total body weight gain of animals in T2 and T3 were at par, but T3 had significantly lower TWG than the control group (T1). In addition, the value of total feed intake in T3 was significantly higher than T1 and T2. Thus, the FCR value of T3 was 49.42 (P>0.001) compared to 14.93 in T1 and 16.62 in T2. T3 was the practice of solely feeding HMS to the animals, which did not fulfil the required production attributes unless combined with dry fodder to promote utilization (Prasad et al., 1998). A previous study showed a higher daily gain of goats fed with sprouted barley on agriculture by-products (48.13–49.43 g/day) (Helal, 2015). Although the difference of FCR values between T1 and T2 is insignificantly different, this implied that the amount of green fodder required for 1.0 kg weight gain (kg) in the goats fed Napier grass was insignificantly minimum, followed by T2. However, the diet in T2 able to attain a similar average weight gain (g/day) as comparable to T1 with lower daily feed intake. The hydroponic sprout mat is entirely edible and highly nutritious; the animals ingested the entire mat, including roots and green shoots, as it is a living food and no waste. It was supported by the concept of Eshtayeh (2004), who reported that the high DMI observed among the Awassi ewes could be due to the high palatability of hydroponic barley. In addition, the age of the animal, sexual state, the composition of body weight gain, feed digestibility, and energy density can all affect feed efficiency (Lage, 2012; Mazon et al., 2017).

Table 3

The animal feed intake of goats fed with the experimental diets

Parameters	Types of diet			P
	T1	T2	T3	
	n = 5	n = 5	n = 5	
Total feed intake (kg)	110.5±29.57^{a}	65.8±5.48^{a}	188.7±27.28^{b}	0.009
Daily feed intake (kg/day)	1.21±0.32^{a}	0.72±0.06^{a}	2.07±0.30^{b}	0.009
Dry matter intake (DMI) (g/day)	315.64±84.64^{ab}	179.19±14.97^{a}	513.81±74.07^{bc}	0.012
Total weight gain (kg)	7.20±1.12^{b}	4.40±0.71^{a}	4.00±0.71^{a}	0.046
Average daily gain (g/day)	79±0.12^{b}	48±0.01^{a}	44±0.01^{a}	0.046
Feed conversion ratio (FCR)	14.93±2.18^{a}	16.62±2.92^{a}	49.42±4.78^{b}	0.000

Note. T1 = Fresh Napier grass and 500g concentrate; T2 = HMS and 500g concentrate; T3 = HMS only;
n = Number of samples
All analyses are mean ± standard error of means (S.E.M.)
Means with different superscript letters in a row are significantly different (P<0.05)

Apparent Digestibility

Figure 5 shows the effect of dietary treatments on nutrient digestibility in goats after feeding with different treatments. The CP digestibility of T1 (71.89%) and T2 (72.28%) were at par with each other and significantly higher than the results of T3 (52.34%). The increasing CP digestibility (*P*>0.05) observed in the T2 treatment groups could be attributed to the higher CP intake compared to the T1 treatment group due to highly soluble protein and amino acids following the enzymatic transformations throughout the early stages of plant growth. The hydroponic maize sprouts with lower harvesting age were rich in grass juice that could be a good source of nutrients for bacterial rumen activity, leading to increased nutrient digestibility (Finney, 1983). Similar results were reported by Naik et al. (2014), who found that digestibility of CP was 72.46% in milking cows fed hydroponic maize fodder. The average DM digestibility values in experimental goats kept on treatment T1 was 69.27%, 63.95% in treatment T2 and 35.09% in treatment T3. The average digestibility of DM in treatment T1 and T2 were significantly higher than treatment T3. Naik et al. (2014) pointed out the digestibility of DM as 65.39% in milking cows fed hydroponic maize fodder. In the present investigation, goats fed with HMS (T3) only showed the lowest digestibility (%) of CP and DM, comparable with T1 and T2 that had a concentrate-based diet. However, the apparent digestibility of DM and CP is higher in hydroponic barley fodder as 87.14% and 95.87%, respectively (Tawfeeq et al., 2018). The difference in the digestibility of the nutrients might be due to the difference in the quantity of hydroponics maize fodder fed to the experimental animals (Gebremedhin, 2015).

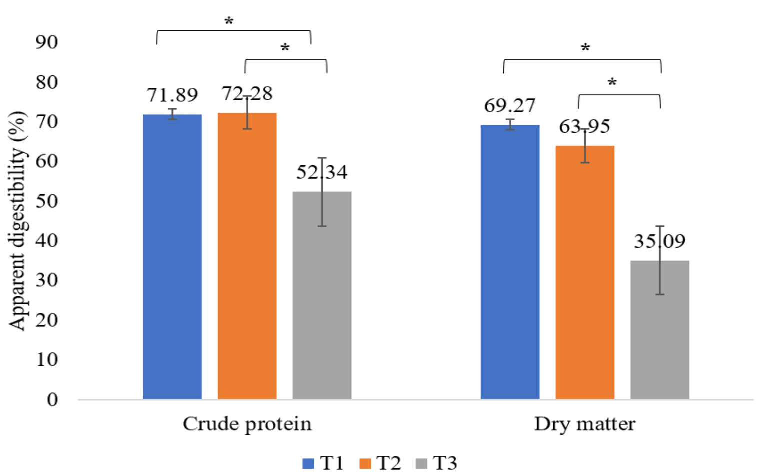

Figure 5. Apparent digestibility (%) of crude protein and dry matter for the different treatment groups
Note. T1 = Fresh Napier grass and 500g concentrate; T2 = HMS and 500g concentrate; T3 = HMS only
All analyses are mean ± standard error of means (S.E.M.)
* Indicates that the results have significant difference (*P*<0.05)

CONCLUSION

Sole feeding of hydroponic maize sprouts exerted a minor impact on growth performance in the animals. However, the HMS could potentially replace the conventionally planted sprouts in conjunction based on the insignificant difference in feed intake and average daily gain between the treatment groups that were offered with commercial concentrate in this study.

The open-air hydroponic system could become a solution among the smallholder farmers for its simple design and inexpensive cost compared to the customised or high-tech hydroponic system. The outdoor-grown HMS is highly palatable due to its tenderness, and younger harvesting age possesses lower indigestible fibres (including NDF and ADF) compared to conventional fodder. The highly nutritious HMS is fed as alternative green fodder because of the improved CP content. Although the dry matter of HMS was significantly lower than Napier grass, this shortcoming could be overcome by adding dry fodder or concentrate to the livestock diet.

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