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Evaluation of supplementation of hydroponic fodder on productive and reproductive performance of rabbit

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ABSTRACT

Aim : The study was to investigate the dietary effect of hydroponic fodder on productive and reproductive performance of rabbits and economic sustainability of using hydroponic fodder for rabbit production.

Method and Materials : There were two experiments under the study were carried out in Rabbit Research Unit of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. In *Expt. I*, total 48 post-weaned young rabbits of 8 weeks old were selected to evaluate growth performance by feeding hydroponic maize sprouted fodder up to 16 weeks of age. The rabbits were randomly divided into four dietary treatment groups (T_1, T_2, T_3 and T_4) and each groups having 6 replications with 2 rabbits in each replication. T_1 considered as control group fed only commercial concentrate feed (CCF) where the rabbits of T_2, T_3 and T_4 groups fed diets supplemented with 25, 50, 75% hydroponic sprouted fodder by replacement of required CCF, respectively. In *Expt. II*, total 24 rabbit does of 10 months old were selected to investigate the dietary effect of hydroponic maize sprouted fodder on reproductive performance. The rabbits does were randomly divided into four dietary treatment groups (T_1, T_2, T_3 and T_4) and each groups having 6 replications having 2 rabbits in each. Where, $T_1$was considered as control group fed only commercial concentrate feed and the rabbit does of T_2, T_3 and T_4 fed diets supplemented with 25, 50, 75% hydroponic sprouted fodder by replacement of required CCF, respectively.

Results : The results revealed that the diet supplementation with 50% hydroponic maize sprouted fodder by replacement of the required CCF showed better live weight gain, improved feed efficiency in young rabbits and rabbit does as well as showed greater litter weight and individual kit weight. The results of cost-effective analysis also were observed of greater profit when the rabbits offered diet with 50% hydroponic maize sprouted fodder.

Conclusion : It was concluded that hydroponic sprouted fodder might be supplemented upto 50% of the required CCF for economically sustainable rabbit production without any adverse effects on productive and reproductive performances.

Keywords: Economic sustainability, hydroponic fodder, productive and reproductive performance, sprouted fodder.

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Introduction

Bangladesh is suffering from severe shortage of livestock products like meat, milk and egg due to higher density of population. At present meat produced by cattle, buffalo, goat, sheep and poultry is quite insufficient to meet up the growing demand of animal protein in developing countries. So, now it is important to explore some alternative sources of animal protein to minimize the deficiency of protein. Domestic rabbit is raised mainly for meat (Payne and Wilson, 1999) in recent years, the domestic rabbits have been recommended as a good alternative source of protein due to the increasing of human population in developing countries (Lukefahr and Cheeke, 1991). Agro-climatic condition, religious points of view, social practices and technological aspects support the prospects and potentials of raising rabbit in Bangladesh (MIDAS, 1992), as a result, rabbit is now recognized potentially as an important industry in the developing world (Karikari and Asare, 2009). Many people in Bangladesh prefer rabbit meat as a conventional food item (Salma et al, 2004).

It reaches sexual maturity at the age of 4-5 months, litter size is about 2-7 and gestation period is about 1 month. A female rabbit reproduce 5-7 times in a year (Cheeke, 1986). Feed cost is negligible because it can directly convert forages into animal protein. Rabbit can effectively utilize cellulose rich feed with ration containing less than 20% grain. Growing rabbits can be maintained satisfactorily on diets consisting of 100 to 200 g green roughage and 40 to 60 g concentrate mixtures for maximum production (Ranjhan, 1980).

Rabbits fed with a balanced food developed a higher weight than rabbits fed with hydroponic fodder (Bautista, 2002). Efficient use of water by the production of hydroponic fodder of barley and wheat for goats in semi-desert conditions (Bustos et al, 2002). Hydroponic fodder produces plenty of fiber (Harris et al, 1981), which is necessary for a better digestion and nutrition of rabbits.

In order to maximize the food production in Bangladesh, all possible options including rabbit production may be addressed. Limited works have been done for overall improvement of rabbit. Therefore, the present study was designed to investigate productive and reproductive performance of rabbit by supplementation of hydroponic sprouted fodder and to study economic sustainability of using hydroponic fodder for rabbit production under the agro-ecological conditions of Bangladesh.

Materials and Methods

The study was designed to evaluate the dietary effect of hydroponic sprouted fodder on productive and reproductive performance of New Zealand White Rabbit.

Experimental site and animals

The present study was conducted with two experiments at the Advanced Animal Research Farm of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. In *Expt: I,* a total of 48 post-weaned young rabbits of 8 weeks old were selected to study the dietary effect of hydroponic sprouted fodder on growth performance up to 12 weeks of age. In *Expt: II*, a total 24 does of 10 months of age were selected to investigate the dietary effect of hydroponic sprouted fodder on reproductive performances.

Production of hydroponic sprouted fodder

Hydroponic sprouted fodder was produced under intensive care at the Advanced Animal Research Farm of the Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur. The result of the germination test was >80%.

Experimental design and dietary treatments

Experiment I

The study was conducted with 48 young (8 weeks old) New Zealand White rabbits that were randomly assigned into four dietary treatment groups under a completely randomized block design (CRBD) asT_1, T_2, T_3 and T_4 having 12 rabbits in each group with six replications so that there were two rabbits in each replication. T_1 considered as control group and fed 100% commercial concentrate feed (CCF) only, where T_2, T_3 and T_4 groups were fed 75, 50, and 25% CCF along with 25, 50, 75% hydroponic sprouted fodder, respectively. Initial live weight of each rabbit was recorded just prior to grouping and kept into separate steel-iron made cage (2×2 feet; two/cage). Live weight at 7 days interval and daily feed intake were recorded up to 16 weeks of experimental period.

Experiment II

A total of 24 adult rabbit does were randomly assigned into four dietary treatment groups under a completely randomized block design (CRBD), having 6 replications with 2 rabbits in each replication. T_1 considered as control group and fed only commercial concentrate feed, where T_2, T_3 and T_4 groups fed 75, 50, 25% CCF and 25, 50, 75% hydroponic maize sprouted fodder, respectively.

General management

Each rabbit was kept in separate steel-iron made cage (2×2 feet). Before mating, all does were injected intramuscularly with 0.25 ml Ovuprost® (each ml containing 250 µg Cloprostenol), a synthetic analogue of prostaglandin F2α (PGF2α; Bayer, New Zealand) at first day of experiment (Abdel-Azeem, 2010 and Mobarak et al, 2015). At 72 h post-injection of prostaglandin, 0.20 ml of Ovurelin® (each ml containing 100 µg of GnRH; Bayer, New Zealand) was applied intramuscularly. Just after treatment, natural mating was performed by fertile bucks. Pregnancy diagnosis was performed at the 14^{th} day of gestation and does live weight were recorded. The live weights of the does were recorded weekly. Finally, live weight of does at 28 day after breeding was recorded to calculate the doe live weight gain during pregnancy. After birth of kits, litter size and litter weight was recorded in each week early in the morning.

Measurements and methods of interpreting results

Live weight gain (LWG)

Rabbits were individually weighed to the nearest gram in the early morning before providing any food and water at initially and weekly during the

experimental period.
It was calculated by using the following formula:

$$LWG_X = LW_{Dx} - LW_{DI}$$

Where:

LW_{DI}= Initial live weight of the rabbit at the time of start of experiment.

LW_{Dx}= Final live weight of the rabbit at the x time period.

(x = Specific weeks when live weight is calculated)

Growth rate of the rabbit

It was calculated by following formula:

$$\text{Growth rate} = \frac{\text{Total weight gain in a certain time period}}{\text{Total feeding period}}$$

Feed conversion ratio (FCR)

It was calculated using the following formula:

$$\text{FCR} = \frac{\text{Total weight gain (g) per doe during a certain period}}{\text{Feed consumption (g) per doe during the same period}} \times 100$$

Performance parameters of does

Live weight gain of doe (LWGD)

It was calculated at 28 days after mating by using the following formula:

$$LWGD_{28} = LW_{D28} - LW_{D0}$$

Where:

LW_{D0}= Initial weight of does at the time of start of experiment

LW_{D28} = Final weight of does at 28 days after breeding

Gestation period

The duration of pregnancy is also called the gestation period. The gestation period was recorded for each doe during the experimental period.

Conception rate

The conception rate was calculated for each group by the following equation:

$$\text{Conception rate (\%)} = \frac{\text{Number of pregnant does}}{\text{Number of mated does}} \times 100$$

Performance of offspring

Litter size, Litter weight and individual kit weight at birth

Litter size was recorded at birth and at each week up to weaning. The litter weight and individual kit weight was recorded with the help of digital balance at birth and 7th days of age.

Kit mortality

Kit mortality was recorded up to weaning. Following formula was used to identify the mortality rate of offspring:

Mortality

$$= \frac{\text{Total litter size at birth} - \text{alive kits number at weaning}}{\text{Total litter size at birth}} \times 100$$

Performance of post-weaned kits

Post-weaned litter performance was obtained by recording the following parameters:

Live weight gain (LWG)

Kits were individually weighed to the nearest gram in the early morning before providing any food and water at the start of the experiment and then at each week up to 5 weeks.

It was calculated by using the following formula:

$$LWG_{D35} = LW_{D35} - LW_{D0}$$

Where:

LW_{D0}= Initial weight of kits at the time of start of experiment

LW_{D35}= Final weight of kits at 35 days after start of experiment

Growth rate of the kits

It was calculated by following formula:

$$\text{Growth rate} = \frac{\text{Total weight gain in a certain time period}}{\text{Total feeding period}} \times 100$$

Litter size

The litter size (total, alive and dead) was recorded at the start of the experiment and then at each week up to 5 weeks after starting of the experiment.

Evaluation of productive performance

Feed and fodder were supplied by weighing using digital balance daily. Leftover feed was weighed daily. All animals were weighed to obtain the initial weight and subsequently weighed weekly to obtain the live weight and live weight gains. Other parameters were measured during the period include feed intake, feed conversion efficiency (FCE) and mortality rates. Growth and feed efficiency were measured using following equations:

$$\textit{Equation 1.}\ \text{Growth rate} = \frac{\text{Total weight gain in certain time}}{\text{Total days of the experiment}}$$

$$\textit{Equation 2.}\ \text{FCE} = \frac{\text{Feed Intake}}{\text{Live weight gain}}$$

Evaluation of economic performance

Calculation of economic performance was carried out using market prices of feed ingredients and other necessary items to compare the costs on different treatment groups. Price of rabbit, feed, grain, electricity, labor, medication etc. were taken into account to know the accurate cost. Pricing of rabbit was determined on the basis of market price during the experimental period in Bangladesh. The financial values of the experiment were calculated on the basis of the national money unit of Bangladesh. Average exchange rate of Bangladesh Bank over the research period was 1 USD = 80 BDT.

Net farm income (NFI)

Net farm income means difference between total returns for the farm and total expenses for production. Total revenue is the total money value of all output produced whether sold, consumed or in stock. Total variable cost is the cost of variable inputs such as feeds, labor and drugs used for production, and it changes directly with the level of production. Total fixed cost was costs of permanent items which do not vary when output changes, therefore no influence on production decisions in short run. In this study, NFI was calculated using the following equation (3):

Equation 3. NFI=TR – (TVC + TFC)

Where; NFI = Net farm income (NFI), TR = Total revenue, TVC = Total variable cost and TFC = Total fixed cost.

Profitability index (PI)

Profitability index (PI) means the net farm income (NFI) per unit of gross revenue (GR) and it was calculated using the following equation (4).

$Equation\ 4.\ \mathrm{PI} = \frac{\mathrm{NFI}}{\mathrm{GR}}$

Where; PI = Profitability index, NFI = Net farm income and GR = Gross revenue

Rate of return on investment (RRI)

Rate of return on investment is the performance measure that is used to evaluate the efficiency of an investment or to compare the efficiency of different investments. It is net farm income divided by total cost of investment and is usually expressed as amount or ratio. It was calculated using the following equation (5):

$Equition\ 5.\ \mathrm{RRI} = \frac{\mathrm{NFI}}{\mathrm{TC}}$

Where; RRI = Rate of return on investment, NFI = Net farm income and TC = Total cost.

Capital turnover (CTO)

Capital turnover is the ratio of total revenue to total cost. It measures the efficiency of a business and provides information about the business capability to deliver a return per taka of its capital investment. It was measured using the following equation (6):

$Equition\ 6.\ \mathrm{CTO} = \frac{\mathrm{TR}}{\mathrm{TC}}$

Where,

CTO = Capital turnover, TR = Total revenue and TC = Total cost

Results and Discussion

The present study was undertaken to evaluate the effects of replacement of concentrate feed with hydroponic sprouted fodder on rabbit production by two separate experiments *Expt. I* and *Expt. II.* The Rabbit of different dietary treatment groups (T_1, T_2, T_3, and T_4) fed 25, 50 and 75% hydroponic fodder, respectively.

Effect of hydroponic sprouted fodder on live weight gain in growing rabbits

Effects of dietary supplementation of hydroponic sprouted fodder on live weight gain in young rabbits during the growing period under the *Expt. I* was shown (Fig 1). The study showed that there was no significant effect of feeding hydroponic sprouted fodder on live weight of rabbits among the different dietary treatment groups (T_1, T_2 and T_3) except T_4 group. The final live weight was decreased in the rabbit fed 75% hydroponic sprouted fodder. The live weight gain of rabbits among the dietary treatment groups T_1 (375.5 g/d), T_2 (403.5 g/d) and T_3 (417.0 g/d) was almost similar, though it was decreased in the rabbits of T_4 group (304.8 g/d).

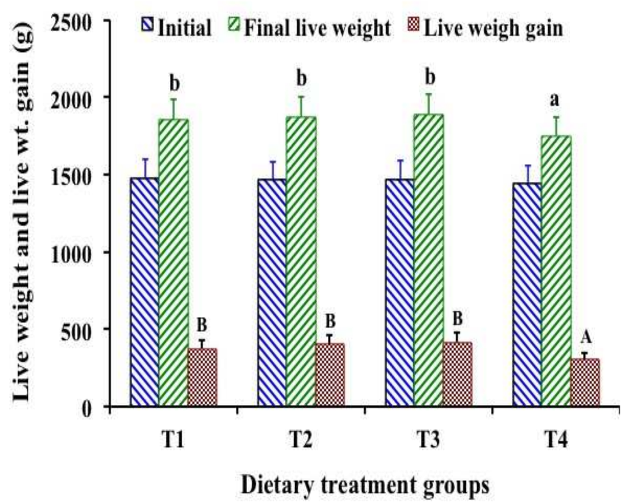

Fig 1. Effect of hydroponic sprouted fodder on live weight gain in growing rabbits (T_1 = 100% commercial concentrate feed (CCF), T_2 = 75% CCF + 25% hydroponic fodder, T_3 = 50% CCF + 50% hydroponic fodder and T_4 = 25% CCF + 75% hydroponic fodder. Each bar with error bar represents Mean ± SEM value. Differences were significant at 5% level of significance (P<0.05)

Table 1: Cost and returns for per-rabbit production (calculation was made in BDT and on the basis of market price during the experimental period, in FY 2019-20)

Parameters	Dietary treatment groups				Level of significance
	T_1	T_2	T_3	T_4	
A. Variable Costs					
Labor	100	100	100	100	NS
Feeds	227.56±1.57^{d}	191.48±1.44^{b}	201.20±1.35^{c}	108.07±1.56^{a}	*
Hydroponic fodder	-	68.79±0.55^{a}	128.94±0.51^{c}	188.25±1.55^{b}	*
Medication	10.67	10.67	10.67	10.67	NS
Miscellaneous	36.00	36.00	36.00	36.00	NS
Total Variable Cost (TVC)	374.23±3.55^{a}	406.94±4.41^{b}	476.81±3.27^{d}	442.99±2.57^{c}	*
B. Fixed Costs					
Cost of rabbit	200	200	200	200	NS
Total Fixed Cost (TFC)	200	200	200	200	NS
Total cost	574.23±7.47^{a}	606.94±6.51^{b}	678.81±6.48^{d}	642.99±6.51^{c}	*
C. Revenue					
Sales of per rabbit	464±9.45^{b}	464±8.44^{a}	488±7.51^{d}	478±8.27^{c}	*
Sales of per kit	200	230	300	250	*
Sales of waste feed	22.00	22.00	22.00	22.00	NS
Total revenue (TR)	686±6.58^{a}	716±6.57^{b}	810±7.53^{d}	750±8.47^{c}	*
Net farm income (NFI)	109.77±4.17^{c}	109.06±3.67^{b}	133.19±3.37^{d}	107.01±4.33^{a}	*
Profitability index (PI)	0.160±0.03^{c}	0.152±0.01^{b}	0.164±0.01^{d}	0.142±0.02^{a}	*
Rate of return on investment (RRI)	19.11±1.33^{c}	17.96±1.11^{b}	19.62±1.23^{d}	16.64±1.53^{a}	*
Capital turnover (CTO)	1.19±0.07^{C}	1.179±0.05^{b}	1.19±0.01^{d}	1.16±0.07^{a}	*

Values are Means±SEM, ^{a,b,c,d}Means within a row without common superscripts differ significantly; NS-not significant; statistically significant difference is expressed as *(P<0.05). Here, T_1=100% commercial concentrate feed (CCF), T_2= 75% CCF + 25% hydroponic fodder, T_3=50% CCF +50% hydroponic fodder and T_4=25% CCF + 75% hydroponic fodder.

Effect of hydroponic sprouted fodder on feed intake and feed efficiency in growing rabbits

Effects of dietary supplementation of hydroponic sprouted fodder on feed intake and feed efficiency in growing rabbits under the *Expt. I.* are presented (Fig 1). Total feed intake (DM) among the rabbits of different treatment groups (T_1, T_2, T_3 and T_4) was 2.88, 3.06, 3.51 and 4.05 kg, respectively. The results show that the total feed intake of the rabbit among the dietary treatment groups (T_1, T_2 and T_3) was not significantly (P> 0.05) affected by feeding hydroponic sprouted fodder but in T_4 group it was slightly increased (P<0.05) than that of the rabbits in T_1 and T_2 groups. Feed efficiency of the rabbits in different dietary treatment groups (T_1, T_2, T_3 and T_4) were 7.67, 7.39, 8.41 and 13.3, respectively (Fig 2). The feed efficiency was almost similar in the rabbits T_1, T_2 and T_3 groups where, it was poorest in the rabbits of T_4 group than other dietary treatment groups.

Cost-benefit analysis on rabbit production (in 2019-20)

The cost effective analysis for rabbit production based on hydroponic sprouted fodder replaced by commercial concentrate feed at different levels are shown (Table 1). Total cost per rabbit was higher in T_3 (P<0.05) group than other dietary treatment groups. Total cost per rabbit was T_1 (574.23), T_2 (606.94), T_3 (678.81) and T_4 (642.99). Total revenue per rabbit was also higher in T_3 (810) while 686, 716 and 750 were for T_1, T_2 and T_4, respectively. The highest net farm income was found in T_3 group (133.19) while it was (109.77), (109.06) and (107.01) in T_1, T_2 and T_4, respectively. Capital turnover (CTO) per rabbit was higher in T_1 and T3 (1.19) group followed by T_2 (1.17), and T_4 (1.16) group, respectively.

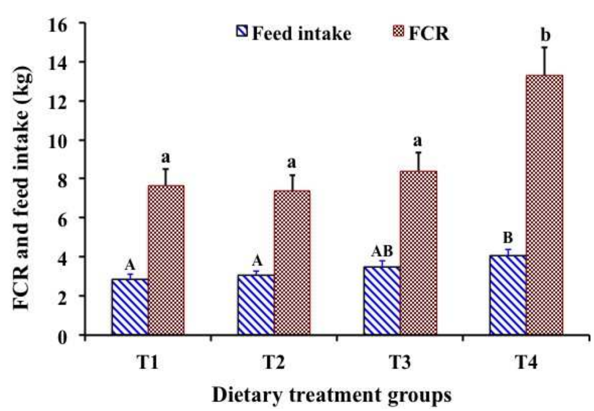

Fig 2. Effect of hydroponic sprouted fodder on feed intake and feed efficiency in growing rabbits (T_1 = 100% commercial concentrate feed (CCF), T_2 = 75% CCF + 25% hydroponic fodder, T_3 = 50% CCF + 50% hydroponic fodder and T_4 = 25% CCF + 75% hydroponic fodder. Each bar with error bar represents Mean ± SEM value. Differences were significant at 5% level of significance (P<0.05)

Effect of hydroponic sprouted fodder on live weight and live weight gain in rabbit does

The effect of hydroponic sprouted fodder on final weight and live weight gain of rabbit does under the *Expt. II* is shown (Fig 3). The average final live weight of the rabbit in T_1 group was significantly (P<0.01) lowest than others dietary treatment groups (T_2, T_3 and T_4), where, T_2 and T_4 was almost similar (2620 and 2952 respectively), though the live weight was increased in the rabbits of T_3 group. The live weight gain of the rabbit does of different treatment groups (T_1, T_2, T_3 and T_4) were -37, 763, 1100.2 and 878.9 g, respectively after 8 weeks of feeding period. The live weight gain of the rabbits was comparatively better (P<0.05) among the dietary treatment groups (T_1, T_2, T_3 and T_4) respectively than the rabbits of T_1 (-37) group.

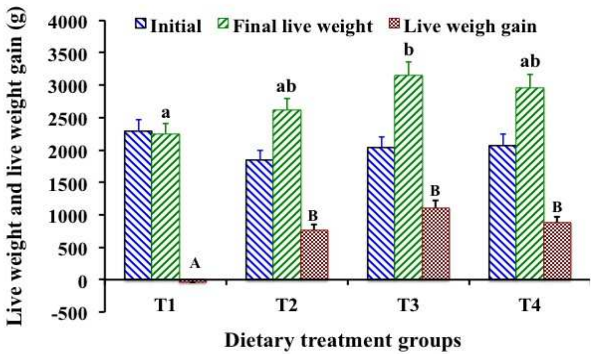

Fig 3. Effect of hydroponic sprouted fodder on final live weight and live weight in rabbit does (T_1 = 100% commercial concentrate feed (CCF), T_2 = 75% CCF + 25% hydroponic fodder, T_3 = 50% CCF + 50% hydroponic fodder and T_4 = 25% CCF + 75% hydroponic fodder. Each bar with error bar represents Mean ± SEM value. Differences were significant at 5% level of significance (P<0.05)

Effect of hydroponic sprouted fodder on feed intake and feed efficiency in Rabbit does

The average feed intake and feed conversion ratio of rabbit does during the experiment period are shown (Fig 4). Total feed intake (DM) among the rabbits of different treatment groups (T_1, T_2, T_3 and T_4) was 2.88, 3.06, 3.51 and 4.05 kg, respectively. The results express that the total feed intake of the rabbit among the dietary treatment groups (T_1, T_2 and T_3) was not significantly (P> 0.05) affected by feeding hydroponic sprouted fodder but in T_4 group was increased (P>0.05) than that of the rabbits of other groups. Feed efficiency was also almost similar in T_1 (7.67), T_2 (7.49) T_3 (8.41), and except T_4 (13.28) group. The feed efficiency was significantly (P<0.05) lower in T_4 group than that of the other groups.

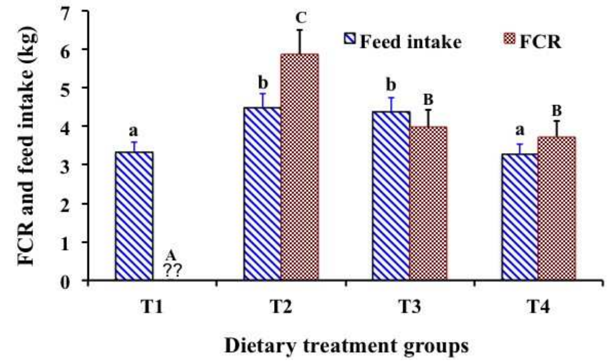

Fig 4. Effect of hydroponic sprouted fodder on feed intake and feed inefficiency in rabbit does (T_1 = 100% commercial concentrate feed (CCF), T_2 = 75% CCF + 25% hydroponic fodder, T_3 = 50% CCF + 50% hydroponic fodder and T_4 = 25% CCF + 75% hydroponic fodder. Each bar with error bar represents Mean ± SEM value. Differences were significant at 5% level of significance (P<0.05)

Effect of hydroponic sprouted fodder on litter size, litter weight and individual kit weight at birth

Under the *Expt. II,* effects of hydroponic sprouted fodder on litter size, litter weight and individual kit weight were shown (Fig 5).

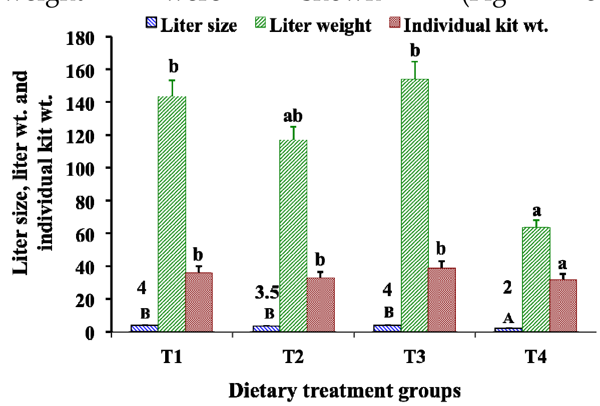

Fig 5. Effect of hydroponic sprouted fodder on litter size, litter weight and individual kit weight in rabbit does (T_1 = 100% commercial concentrate feed (CCF), T_2 = 75% CCF + 25% hydroponic fodder, T_3 = 50% CCF + 50% hydroponic fodder and T_4 = 25% CCF + 75% hydroponic fodder. Each bar with error bar represents Mean ± SEM value. Differences were significant at 5% level of significance (P<0.05)

The result shows that litter size had no significantly (P<0.05) differed among the rabbit does groups (T_1, T_2, T_3 and T_4) by feeding of sprouted fodder. However, the litter size was lowest in the rabbit does of T_4 (2) group. The result also demonstrated that litter weight at birth was significantly (P<0.05) differed among the dietary treatments groups (T_1, T_2, T_3 and T_4). On the other, litter weight at birth was the poorest in the rabbits of T_4 group. The individual kit weights at birth were 35.87, 32.85, 38.7 and 31.75 g in T_1, T_2, T_3 and T_4, respectively. However the individual kit weight was almost similar in the dietary treatment groups of the rabbit does.

Experiments (*Expt. I* and *Expt. II)* were performed to investigate productive and reproductive performance of rabbit by supplementation of hydroponic sprouted fodder with the economic sustainability of using hydroponic fodder for rabbit production in Bangladesh. T_1, T_2, T_3, and T_4dietary treatment groups fed 25, 50, 75% hydroponic fodder, respectively.

This study shows that there was no significant effect of feeding hydroponic sprouted fodder on live weight of rabbits (375.5, 403.5, 417.0 and 304.8 g) among the different dietary treatment groups (T_1, T_2 and T_3) except T_4 group. The final live weight was decreased in the rabbit fed 75% hydroponic sprouted fodder. So this is comparable with the study determined that rabbits fed with a balanced food developed a higher weight than rabbits fed with hydroponic fodder (Bautista, 2002). However, there was a correlation between the rabbit's weight and the hydroponic given as a diet. The final live weight decreased in T_4 group because this group fed 75% of hydroponic fodder and only 25% of concentrate commercial feed so it is not balanced food as Bautista determined his studies. The best combination of feed was 50% hydroponic sprouted fodder and 50% concentrate commercial feed that showed better growth rate. Shanti et al, (2017) also reported similar findings which stated on feeding trial to investigate its effects on performance, visceral organs and blood biochemistry of growing local Baladi rabbits. Four mixed diets based on a pelleted commercial rabbit feed (18% crude protein) were made by substituting HB (containing 18% dry matter, 2% crude protein and 15% crude fiber) for the commercial feed (0, 20, 40 and 60%). They concluded that replacing pelleted commercial feed by wet HB had negative effects on rabbits' performance.

Morales et al (2009) conducted experiment of replacing a commercial feed with hydroponic green barley forage (HGBF) was studied on productive performance and carcass yield of growing New Zealand rabbits. They concluded that replacing pelleted commercial feed by wet HGBF impaired growth performances.

There were no significant differences in the live weight gain of Baladi rabbits by feeding sprouted barley grain (Shanti et al, 2017). Morales et al (2009) reported that feeding hydroponic green barley forage (HGBF) at the levels of 0, 10, 20 and 30% in diets of growing New Zealand rabbits decreases linearly with HGBF increase. However, feeding sprouted fenugreek seeds (SF) and/or hydroponically sprouted barley grains (SB) has the highest body weight gain compared with control (El-Rahman et al, 2011). Fayed (2011) also found a significant effect of feeding sprouted barely on Tamarix (BTm) or rice straw (BRs) on the live weight gain of lambs. Feeding 15% hydrponic barley increased the body weight and body weight gain of ewes (Intissar and Eshtayeh, 2004). They investigated the performance of 20 lactating Awassi ewes (2 years age) fed with Hydroponic Barley (HB). They reported that ewes fed the two levels of HB and 15% of HBOC had higher ($P<0.05$) weight gain and daily gain compared to ewes in other groups.

The results showed that the total feed intake of the rabbit (2.88, 3.06, 3.51 and 4.05 kg) among the dietary treatment groups (T_1, T_2 and T_3) was not significantly ($P> 0.05$) affected by feeding hydroponic sprouted fodder but in T_4 group it was slightly increased ($P<0.05$) than that of the rabbits in T_1 and T_2 groups .

Feed efficiency of the rabbits in different dietary treatment groups (T_1, T_2, T_3 and T_4) were 7.67, 7.39, 8.41 and 13.3, respectively. The feed efficiency was almost similar in the rabbits of T_1, T_2 and T_3 groups where, it was poorest in the rabbits of T_4 group than other dietary treatment groups. The present study is in agreement with the results reported by Sneath and McIntosh (2003). Voluntary intake of 50.38 kg fresh hydroponics fodder per day, which supplied 7.13 kg DM and concluded that DM intake, is a limiting factor on sole feeding of hydroponic green fodder (Pandey and Pathak, 1991).

Reddy et al (1988) used artificially grown barley fodder vs NB-21 (10 kg/d) as a constituent of the ration of the milch cows and observed similar DM intake (2.74 vs 2.84, kg/100 kg BW) and roughage: concentrate ratio (65: 35 vs 63: 37) in both the groups. DM content (on fresh basis) of the hydroponics fodder was slightly higher than the conventional CO-3 green fodder and the hydroponics barley fodder. However, Dung et al (2010) observed 3.7 times increase in the fresh weight of the 7-d hydroponics barley fodder with DM% of 19.7%. Feed (dry matter) intake and growth rate decreased linearly by 1.16±0.080 g/d

(P<0.001) and 0.998±0.062 g/d (P<0.001) per unit of HB increase (Shanti et al, 2017). Intissar and Eshtayeh (2004) investigated the performance of 20 lactating Awassi ewes (2 years age) fed with HB. The experimental diets had an effect on feed intake. Feed intake was higher (P<0.05) in ewes fed the two levels of HB and 15 per cent hydroponic barley with olive cake (HBOC).

Reddy et al (1988) observed that sometimes, the animals took the leafy parts of the hydroponics green fodder and the roots portions are left which can be avoided by mixing the hydroponics green fodder with the other roughage components (chopped straw or conventional green fodder) of the ration. Ruminants prefer diets that are leafy and non-stemmy and with leaves have a low to intermediate tensile strength (Dung et al, 2010).

Fayed (2011) reported that sprouted barley grains increased roughage intake by 31.79%, on rice straw and by 34.3% on *Tamarix* which may be attributed to increase in palatability of sprouted barley grains on rice straw (BRs) or sprouted barley grains on dried *Tamarix* (BTm).

Naik and Singh (2014) concluded that sprouted corn seeds on potatoes peel waste (PPW) or date palm leaves (DPL) revealed a significant (P≤0.05) improvement in digestibility coefficients of DM, EE and CHO. There was increase (P>0.05) in the digestibility of CP and CF of the cows due to feeding of hydroponics fodder; however, the increase (P>0.05) in the digestibility of DM, OM, EE, and NFE was non-significant.

Feeding of hydroponic barley fodder to Hariana male calves increased DM intake and digestibility of nutrients (Verma et al, 2015). Where, feeding different levels of sprouted fodder affects the total feed efficiency of growing rabbits (El-Rahman et al, 2011).

However, feeding sprouted to the adult rabbit has shown significantly higher live weight and weight gain than the rabbits supplied with 0% sprouted fodder (100% concentrate). Best live weight and live weight gain was observed in the rabbit group supplied with 50% sprouted maize.

Under the *Expt. II,* effects of hydroponic sprouted fodder on litter size, litter weight and individual kit weight was shown. The result showed that litter size had no significantly (P<0.05) differed among the rabbit does groups (T_1, T_2, T_3 and T_4) by feeding of sprouted fodder. However, the litter size was lowest in the rabbit does of T_4 (2) group. The result also demonstrated that litter weight at birth was significantly (P<0.05) differed among the dietary treatments groups (T_1, T_2, T_3 and T_4). On the other, litter weight at birth was the poorest in the rabbits of T_4 group. The individual kit weights at birth were 35.87, 32.85, 38.7 and 31.75 among dietary treatment groups T_1, T_2, T_3 and T_4, respectively. However, the individual kit weight was almost similar in the dietary treatment groups of the rabbit does.

Guerrero-Cervantes et al (2016) investigated twenty six Katahdin ewes (i.e., female lambs from breeding to 2 month of their 1st lactation)were used in a completely randomized design (13/treatment) to evaluate effects of replacement of dietary dry-rolled corn grain (DRC) and cottonseed meal (CSM) with hydroponically grown whole plant green wheat (HGW; *Triticum aestivum* L.) on productive parameters and blood metabolites during mating, gestation and lactation, and on body weight (BW) gain of their lambs in their 1st 60 days of age. They concluded that hydroponically grown green wheat is a suitable substitute for a portion of the DRC and CSM in ewe's diets during gestation and lactation without negative effects. However, The findings were not in agreement to the findings of some authors (Morales et al, 2009, El-Rahman et al, 2011 and Fayed, 2011), which stated that significant effect of using hydroponic fodder on the fed intake and feed conversion ratio of rabbit and lambs. Although slightly lower litter size was observed in the adult rabbit does supplied with 75% sprouted fodder, litter size was not significantly differed among the different rabbit does supplied with different level of sprouted fodder.

Litter weight at birth was significantly differed among the different dietary treatments groups and it was lowest in the adult rabbit does supplied with 75% sprouted fodder.

However the individual kit weight was almost similar in the dietary treatment groups of the rabbit does. Researchers used other type of animals for investigating the effect of HB on their performance. On the other hand, pigs fed 4-day-old sprouts gained significantly less weight than those fed barley grain (Morgan et al, 1992).

Conclusions

In conclusion, the feeding of hydroponic sprouted fodder at 50% level in replacement with commercial concentrate feed improved live weight gain and feed efficiency of growing rabbits and reproductive performance of rabbit does as well as reduced total production cost, means ultimately increased net farm income. Therefore, hydroponic sprouted fodder may be supplemented and replaced upto 50% of the required commercial concentrate feed for economically sustainable rabbit production with improved growth and reproductive performance.

Reference

Abd El-Rahman KM, Taie HT, AbouSekken MS and Shereen AR (2011). Utilization of some hydroponic plants in rabbit feeding. Minufiya J. Agric. Res., 36(1): 31-41.

Abdel-Azeem S (2010). Improving Reproductive Efficiency of Rabbit Does Using Hormonal, Nutritional or Acetic Intra- Vaginal Washing Treatments., Ph.D. Thesis, Fayoum University, Egypt.

Bautista SH (2002). Producción de forrajeverdehidropónico de trigoTriticum aestivum L. paraelman tenimiento de conejoscriollos Oryctolagus cuniculus. Thesis. Universidad Autónoma de Guerrero (UAG) Chilpancingo, Guerrero, México.

Bustos CDE, Gonzalez EL, Aguilera BA and Espiniza GJA (2002). Forrajehidropónico, unaalternativapara la suplementacióncaprina en el semidesierto Queretano. XXXVIII Reunión Nacional de Investigación Pecuaria. Puebla, México. pp 383.

Cheeke PR (1986). Potentials of rabbit production in tropical and subtropical agricultural systems. J. Anim. Sci., 63: 1581-1586

Dung DD, Godwin IR and Nolan JV (2010). Nutrient content and in sacco digestibility of barley grain and sprouted barley. J. Anim. and Vet. Advances, 9(1–9): 2485–2492.

Fayed M (2011). Comparative study and feed evaluation of sprouted barley grains on rice straw versus Tamarix Mannifera on performance of growing Barki lambs in Sinai.J.of American Sci.,7(1):954-961.

Guerrero-Cervantes M, Cerrillo-Soto MA, Plascencia A, Salem AZM, Estrada-Angulo A, Rios-Rincón FG, Luginbuhl JM, Bernal-Barragán H, Abdalla AL (2016). Productive and reproductive performance and metabolicprofiles of ewes supplemented with hydroponically growngreen wheat (Triticumaestivum L.). Anim. Feed Sci. Tech. 221: 206–214.

Harris D, Cheeke PR, Patton NM and Brewbaker JL (1981). A note on the digestibility of leucaena leaf meal in rabbits. Journal of Applied Rabbit Research 4:99

Intissar FA and Eshtayeh (2004). A new source of fresh green feed (Hydropnic barley) for Awassi sheep. Thesis (unpub) Master in Environmental Sciences, Faculty of Graduate Studies, at Najah National University, Nablus, Palestine.

Karikari PK and Asare K (2009). An Economic Analysis of a Smallholder Meat Rabbit Production System. Journal of Applied Sciences Research, 5(8): 969-973.

Lukefahr SD and Cheeke PR (1991). Rabbit project development strategies in subsistence farming systems. 1. Practical considerations. Wld. Anim. Rev., 68: 60-70

MIDAS (1992). Prospects of commercial rabbit raising in Bangladesh a survey report. Micro Industries Development.

Mobarak H, Miah AG, Chowdhury A, Begumu S, Haydar R and Salma U (2015). Improvement of reproductive performance of rabbit does by hormonal and acetic acid treatment in hot-humid climatic condition of Bangladesh. Int. J. Agri. Sci. Vet. Med. 3(3):67-74.

Morales MA, Fuente B, Juárez M and Ávila E (2009). Effect of substituting hydroponic green barley forage for a commercial feed on performance of growing rabbits. World Rabbit Sci.; 17(1): 35-38.

Morgan J, Hunter RR and O'Haire R (1992). Limiting factors in hydroponic barley grass production. In: Proc. 8th International Congress on Soilless Culture. Hunter's Rest, South Africa, pp: 241-261.

Naik PK and Singh NP (2014). Production and feeding of Anim. Feed Sci. Technol. 13: 183190.

Pandey HN and Pathak NN (1991). Nutritional evaluation of artificially grown barley fodder in lactating crossbred cows. Ind. J. Anim. Nutri. 8(1): 77-78.

Payne A and Wilson T (1999). Micro livestock in 'An introduction to Animal Husbandry in the tropics' Blackwell Publishing Company, Osney Mead, United Kingdom. 687-692

Ranjhan SK (1980). Animal Nutrition in the Tropics. 3rd edn., Vikas Publishing House Pvt. Ltd., Sahibabab, Ghaziabad, New Delhi. P: 335.

Reddy GVN, Reddy MR and Reddy KK (1988).

Nutrient utilization by milch cattle fed on rations containing artificially grown fodder. Ind. J. Anim. Nutri. 5 (1): 19– 22.

Salma U, Miah AG, Khandaker ZH and Reza A (2004). Effect of different levels of protein on reproductive performance of rabbit does under tropical condition. Int. J. Agri. Biol.6: 794-796.

Shanti H, Omar J, Alwaheidi IN, Abdallah J, Dbadran E (2017). Effect of substituting hydroponic barley for a commercial feed on performance and blood metabolites of growing Baladi rabbits. J. N. Sci.; 39(5): 2131-2135.

Sneath R and McIntosh F (2003). Review of hydroponic fodder production for beef cattle. Queensland Government, Department of primary Industries, Dalby, Quensland 84.McKeehen, pp: 54.

Verma S, Singh A, Kalra A and Saxena MJ (2015). Effect of Feeding Hydroponic Barley (Hordeumvulgare) Fodder on Nutrient Utilization, Growth, Blood Metabolites and Cost Effectiveness in Hariana Male Calves. Ind. J. Anim. Nutri.32 (1): 10-14.

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