STUDY ON HYDROPONIC CULTIVATION OF MAIZE AND SESBANIA SPROUTED FODDER AND THEIR EFFECTS ON GROWTH PERFORMANCE OF TURKEY

A THESIS

By

Kanis Yasmin

Registration No. 1605165

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MASTER OF SCIENCE (MS)

IN

ANIMAL NUTRITION

DEPARTMENT OF GENERAL ANIMAL SCIENCE AND NUTRITION

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Dedicated to
my beloved parents
for their celestial affection
and endless sacrifices in
each and every stage of my
life

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The Author

ABSTRACT

The present study was designed to determine nutritional composition and investigate the effect and economic value of hydroponic maize and sesbania sprouted fodder replaced by commercial concentrate feed (CCF) on growth performances of turkey. The study was conducted at the Advance Animal Research Farm of Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh. A total of 48 (8- wks-old) turkeys were randomly assigned into four dietary treatment (T_1, T_2, T_3, T_4) groups where each group consisting of 3 replications having 4 birds in each. T_1 considered as control group fed only CCF where T_2, T_3 and T_4 denoted groups of turkeys fed the diet comprising of 90, 70 and 60% CCF and 10, 30, 40% hydroponic sprouted fodders, respectively. The ratio of hydroponic maize and sesbania sprouted fodders were 80 and 20, 70 and 30, 60 and 40%, respectively. The percentage of moisture, dry matter (DM), ash, organic matter (OM), crude protein (CP), crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE) on dry matter basis contents of hydroponic maize and sesbania sprouted fodder was 85.21 & 90.54, 14.79 & 9.46, 2.50 & 3.41, 97.5 & 96.6, 10.92 & 37.26, 5.30 & 7.21, 2.94 & 3.71, 78.34 & 48.41, respectively. The ash, CP and CF (%) were significantly higher (P< 0.01) in hydroponic sesbania than maize sprouted fodder but the NFE (%) was significantly higher (P< 0.01) in hydroponic maize than sesbania sprouted fodder. The results revealed that dietary supplementation of hydroponic maize and sesbania sprouted fodder replaced by commercial concentrate feed increased live weight in T_2 (2.83) than T_1, T_3 and T_4 (2.64, 2.39 & 2.09), respectively, live weight gain T_2 (20.61) than T_1, T_3 and T_4 (18.39, 15.55 & 12.07), respectively and highest FCE observed in T_1 (5.26) and lowest as well as best FCE observed in T_2 (4.03) group of turkey. On the other hand, the cost effective analysis showed higher benefit in T_2 than other T_1, T_3 and T_4 groups. Therefore, dietary supplementation of CCF replaced by hydroponic maize and sesbania sprouted fodder at 10% level may improve live weight, feed efficiency of turkey as well as reduce total cost of feed.

Key words: Turkey, hydroponic sprouted fodder, concentrate feed, growth performance, nutritional composition.

Abbreviation and Acronyms

ADF	Acid Detergent Fibre
AIA	Acid Insoluble Ash
ANOVA	Analysis of Variance
AOAC	Association of Analytical Communities
BGF	Barley Green Fodder
CCF	Commercial concentrate Feed
CF	Crude Fibre
CP	Crude Protein
CTO	Capital Turnover
DM	Dry Matter
EE	Ether Extract

FAO	Food and Agricultural Organization
FCE	Feed Conversion Efficiency
FCM	Fat Corrected Milk
FCR	Feed Conversion Ratio
FI	Feed Intake
FMS	Finger Millet Straw
GF	Green Fodder
GLM	General Linear Model
GR	Gross revenue
HB	Hydroponic Barley
HBF	Hydroponic Barley Fodder
HF	Hydroponic Fodder
HGF	Hydroponic Green Fodder
HMF	Hydroponic Maize Fodder
ME	Metabolizable Energy
NDF	Neutral Detergent Fiber
NFI	Net Farm Income
NS	Not Significant
OM	Organic Matter
PF	Prairie Forage
PI	Profitability index
RRI	Rate of Return on Investment
SEM	Standard Error of Mean
SPSS	Statistical Package for the Social Sciences

TA	Total Ash
TC	Total Cost
TCF	Treatment Conventional green Fodder
TDN	Total Digestible Nutrients
TFC	Total Fixed Cost
TMR	Total Mixed Ration
TR	Total Revenue
TVC	Total Variable Cost

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CHAPTER I

INTRODUCTION

Livestock is an important part of the expanding and diverse agricultural sector of Bangladesh. More than 70% of the population in Bangladesh is dependent on the agriculture and rearing livestock and poultry. Its plays an important role for the nutritional security, particularly of the small and marginal farmers. The poultry sector also is an integral part of farming systems and has created both direct and indirect employment opportunity, improved food security and enhanced supply of quality protein to people's meals, contributing country's economic growth and reducing poverty level in rural and urban areas of Bangladesh. The present meat and egg production can meet only 68 and 64% of the national demand where, poultry meat alone contributes 37% of the total meat production in Bangladesh (Begum *et al.,* 2011). The demands for meat, egg and their food products have been expanding dramatically with income growth, population growth, urbanization and dietary changes. The poultry sector consists of chickens (63%), ducks (11%), geese (9%), turkeys (5%), pigeons (3%) and guinea fowls (3%). From the last decade, demand for poultry products has been increased rapidly in Bangladesh, and propelled by rising levels of income, population and urbanization (Besbes, 2009). Experience shows that the climatic condition of Bangladesh is convenient to rear different poultry species.

In fact, poultry keeping is an integral part of the rural household and provides family income for the small, marginal and landless poor. The farmers cannot afford to rear cattle and goat but can easily rear poultry. However, the poultry industry (specially, commercial broiler and layer) is in the line to be destroyed due to severity of avian influenza (bird flu). Thus, it is crying need to find out the alternative protein source to meet up the increasing demand. In developing countries, variable options need to be explored and evaluated in order to maximize food production and meet protein requirements (Owen *et al.,* 2008).

Turkey meats one of the best options for alternative protein source in Bangladesh. Turkey production is an important and highly profitable agricultural industry which have a rising global demand for its products (Yakubu *et al.,* 2013), and they are adaptable to wide range of climatic conditions (Ogundipe and Dafwang, 1980). Karki, (2005) stated that the consumption of turkeys and broilers as white meat was increasing day by day worldwide and a similar trend also existed in developing countries. In the whole world, total production of turkey meat was 5.6 million ton in 2012, which was higher than 5.1 million ton in 2003, a decade earlier (FAOSTAT, 2012). Turkey is an excellent insect forager and most crops that are troubled by insect population including vegetables are candidates for insect control by turkeys (Grimes *et al.,* 2007). Turkey thrives better under arid conditions, tolerates heat better, ranges farther and has higher quality meat (Yakubu *et al.,* 2013). But turkey production has not been fully exploited in Bangladesh including other developing countries despite its huge potential over other poultry species. In poultry production, the most of the cost is due to the purchasing commercial concentrate feed. Feed price have been rising due to rapid increase in demand for feed grains and a price support policy that raised grain price each year (Gale, 2013). The cost may be reduced by the replacement of commercial concentrate feed with hydroponic fodder.

The word hydroponic has been derived from two Greek words hydro means ‘water’ and ponic means ‘working’. Thus, fodder produced by growing plants in water or nutrient rich solution but without using any soil is known as hydroponic fodder or sprouted grains or sprouted fodder (Dung *et al.,* 2010a). Hydroponic is produced in green houses under controlled environment within a short period (Sneath and Intosh, 2003). Hydroponic cultivation is an eco-friendly method of growing fodder and hydroponically grown cereals grow up to 50% faster and produce higher yields of better quality fodder. Hydroponic growing is a privilege and free of soil, chemical fertilizer, free of herbicides and pesticides where, producing 10 times the amount of conventional fodder as a traditional farming. Hydroponically grown green fodder is highly water efficient and reduces water waste and essential natural and manmade resources required to grow fodder while controlling the effects of climate and growing conditions (Anonymous, 2015). Fodder produced hydroponically has a short growth period 7-10 days and does not require high quality arable land, but only a small piece of land for production to take place (Shtaya, 2004). It has high feed quality, rich with proteins, fiber, vitamins and minerals (Chung *et al.,* 1989). However, the major constraints in production of green fodder by farmers are unavailability of land for fodder cultivation due to small land holding size, scarcity of water or saline water, labour required for cultivation (sowing, earthing up, weeding, harvesting etc.) requirement of manure and fertilizer, more growth time (approx. 45–60 days), fencing to prevent fodder crops from wild animal and natural calamities etc. (Naik *et al.,* 2014).

Due to the above constraints in the conventional method of fodder cultivation, hydroponic technology is coming up as an alternative to grow fodder for farm animals (Sneath and Intosh 2003, Naik *et al.,* 2011a, Naik *et al.* 2012b, Naik *et al.,* 2013b). The biological and economical performances of hydroponic green fodder and their effects when fed as part of turkey diet is not known under local conditions and need to be evaluated. Limited research has been conducted on the feeding value of hydroponic fodder and the results are not consistent. Many researchers showed improved results in animal production (Tudor *et al.,* 2003) while some researchers noticed no additional advantage in including hydroponic fodder in animal diets (Fazaeli *et al.,* 2012). There is no systemic study has been conducted on the feeding value of hydroponic sprouted fodder and its effect on growth performance of turkey in Bangladesh. Therefore, the present study was designed under Bangladesh condition with the following objectives:

i) To know the nutritional composition of hydroponic maize and sesbania sprouted fodder.

ii) To investigate the effects of dietary hydroponic maize and sesbania sprouted fodder on growth performance, feed intake, feed conversion efficiency in turkey.
iii) To evaluate the cost effectiveness of turkey production using hydroponic maize and sesbania sprouted fodder.

CHAPTER II
REVIEW OF LITERATURE

The main limiting factor in improving livestock production and reproduction efficiencies is scarcity of feed and fodder (Birthal and Jha, 2005). It has become very difficult to get year round supply of quality green fodder due to more land requirement, scarcity of water or saline water, more labor requirement for cultivation (sowing, earthing up, weeding, harvesting etc.), more growth time (approx. 60 days), non-availability of same quality green fodder round the year, requirement of manure and fertilizer and affected by natural environment (Naik *et al.,* 2012a). Now-a-days, alternative methods of feeding are gaining importance. Hydroponic fodder production which provides year round supply of fresh green fodder while using minimal labor, land, water and space is one of the most important alternative method (Sneath and McIntosh, 2003; Naik *et al.*, 2011; Naik *et al.,* 2013b). Hydroponics is a method of growing plants without soil. Hydroponic fodder is palatable and germinated grain embedded in the root system is also consumed along with the shoots of the plants without any nutrition wasting (Pandey and Pathak, 1991). In regions with limited forage production, this technology may be very important (Fazaeli *et al.,* 2012). Depending on the grain selected, hydroponics looks like a mat of 11-30 cm height at the period of 7-8 days germination with germinated grain embedded in their white roots and green shoots (Mukhopad, 1994; Snow *et al.,* 2008; Dung *et al.,* 2010b; Naik *et al.,* 2011; Naik *et al.,* 2014). So the steps and problems in production of hydroponic fodder, nutritional composition of hydroponic fodder grown from several grain and several works done on livestock by supplementing hydroponic fodder in their diets is reviewed here.

2.1 History of hydroponic plant culture

Dr. W. F. Gericke is the person who used the term "Hydroponics" and first developed procedures to grow plants in a nutrient solution on large scale in the late 1920s and early 1930s (Butler & Oebker, 1962). While in the middle of the 19th Century, Jean Boussingault was a French chemist who verified the nutritional requirements of plants grown without soil, the techniques of "nutria-culture" were being perfected by Sachs and Knop working independently in England by 1960s (Hoagland & Arnon, 1938). Myers (1974) reviewed the publication of a War Department technical manual (Withrow, 1946) which first removed the science from the laboratory to the field for the production of vegetables for troops in remote and desolate areas using this hydroponic technology. Ivan Z. Martin, an American inventor developed a complete system in 1960 by which "optimum temperature, humidity, aeration, light and periodic rainfall of a nutrient solution could be automatically maintained" (Anonymous, 1969; cited by Myers, 1974).

2.2 Hydroponic fodder production

2.2.1 Choice of grain

There are many types of grains grown hydroponically. Grains such as oats, barley, wheat, sorghum and corn have all been tried. The main characteristics of choosing grain that come into play are their nutritional value, speed of grain growth and protein levels. The grain that has all these qualities is - Malt Barley as it is highly nutritious with a very high protein level and under the right conditions can grow to a height of 30 cm. Calder stated that 'when all of the necessary items are put into the equation such as – size of the grain, germination, price, availability, protein increase, nutritional value etc, then malt barely comes out on top'. (Naik *et al.,* 2015) suggested that maize is the grain of choice for production of hydroponic fodder because of its easy availability, lower cost, good biomass production and quick growing habit.

2.2.2 Soaking time

Morgan *et al.* (1992) studied that germination rates were assessed for three days for cultivar Triumph barley grain that were soaked between 1 to 24 hours at 21ºC and then placed on moist filter paper in Petridishes at 24ºC. Soaking periods of 1-4 hours resulted in germination rates in excess of 80% with a 4-hour soak giving 88% germination. If the soaking period is prolonged, the germination rates will be below 60%. Thus he achieved better results at 4-hour soaking treatment. Naik *et al.* (2013) suggested that 4 hours of soaking is beneficial for maize grain.

2.2.3 Pre-soaking water temperatures

The effect of water temperature used for soaking on germination amount was studied by Morgan *et al.* (1992). He also observed that water temperatures of 12ºC, 23ºC and 30ºC during 4 hours of soaking made little difference on germination amount after 72 hours, but grain soaked at 23ºC appeared to germinate more rapidly.

2.2.4 Aeration during soaking

Morgan *et al.* (1992) found that aeration did not affect the amount of germination after 4 or 24 hours of soaking period. But it was observed that the reduced germination amount resulting from 24 hour soaking period was prevented due to aeration.

2.2.5 Chemical treatments of grain

It was observed that initial chemical treatments to reduce mould also reduced germination and growth. Morgan *et al.* (1992) found that 1-hour treatment in 1% 'domestos' (equivalent to 0.1% hypochlorite) was effective in reducing contamination without adversely affecting germination amount. It was reported by Sneath and McIntosh (2003) that one hour treatment of grain with 0.1% hypochlorite is effective in reducing the contami0nation without adversely affecting the germination rate. Al-Karaki and Al-Hashimi (2012) reported that all crops grain can be cleaned from debris and other foreign materials and then treated with 20% sodium hypochlorite solution (household bleach) to control the formation of mould. The grain should then be washed well from residues of bleach and resoaked in tap water overnight (about 12 hours) before planting.

2.2.6 Growing temperature

Morgan *et al.* (1992) measured dry matter (DM) losses over 8 days at 21ºC and 27ºC growing temperatures. The sprouts received balanced nutrient feed and light for 16 hours daily from day three. They observed that the dry matter loss was gradually decreased to day 4; it began to drop rapidly after day four. DM appeared to increase after six days.

Sprouts grown at 21ºC lost 18% DM by day 8 and at 27ºC the loss was 23.6%. In Indian conditions, the opinion of Subodh Kumar (2012) was that optimum temperatures required by hydroponic crops was around 22ºC and the maximum that a crop can tolerate is 30-32ºC.

2.2.7 Lighting schedule

Light is not important to sprout cereal grains. But some light in the second half of the sprouting period encourages photosynthesis and greening of the sprouts. If the seedlings are grown without light or too low a light intensity, photosynthesis is non-existent or minimal (Hillier and Perry, 1969 and Bidwell, 1974) and seedlings must depend on their starch and fat reserves to meet their energy demand. Where sprouts are stacked inside a shed many sprouts may be heavily shaded. O'Sullivan (1982) as cited in Morgan *et al.* (1992) reported that no light causes increased losses of DM. He found that the rate of decrease of DM content slowed down after the fourth day in lighted experiments, when leaves began photosynthesizing. Lighting prior to day 3 was of little significance (Morgan *et al.* 1992). El-Deeba *et al.* (2009) indicated that root length dose not influence with lighting operating hours, however its value was about 6 cm under all treatments of lighting (8, 12, 16, and 24 hours/day). The vegetative length of barley had been significantly affected by lighting operating hours. However, the increasing of the vegetative length was about 5.88, and 16.67 % with application of 8-12, 12-16 and 16-24 lighting time (hours/day). The above mentioned results are in agreement with those observed by Morgan *et al.* (1992). The increasing rate of yield with about 109.73 g was obtained when the lighting operating hours increased from 8 up to 12 hours/day, after then, decreased with a little value of about 6.96% with increasing the lighting hours from 12 up to 16 hours/day, and the yield reduction amount was about 35.13% when increasing the lighting hours from 16 h up to 24 h/day. This means that the most suitable lighting hours ranged from 12 up to 16 h/day for barley fodder production under closed hydroponics system. This may be due to that after the 16 h lighting; the highest light level caused a decrease in rate of grass height, due to diminishing efficiency of light use. Data are in agreement with O'Sullivan (1982).

2.2.8 Seeding density

The effect of grain rate on hydroponic fodder production was studied by Morgan *et al.* (1992). Here trays were sown at the rate of 2.5, 5 and 7.5 kg/m² of grain and were provided with nutrients at 500µS and irrigated and illuminated as observed in previous studies. Dry matter (DM) was assessed after 7 days. The root mat became so thick at the highest rate of 7.5 kg/m² grain. When anaerobic conditions occurred within it towards the end of the growing cycle and the mat began to heat. He stated that most commercial units recommend seeding rates of 6-8 kg/m², while Massantini *et al.* (1980) reported that total dry weight increasing with seeding rates up to 5 kg/m² and the seeding rate of 4 kg/m² is the most efficient for grainling growth. Naik *et al.* (2013) also suggested that a seeding rate of 6.4–7.6 kg/m² for higher output in hydroponic maize fodder production.

2.2.9 Nutrient solution

Trubey *et al.* (1969) as cited in Morgan (1992) reckoned that the small improvement in the nutrient content of the sprouts did not justify the added expense of using nutrient solution rather than water. Massantini *et al.* (1980) reported a positive response to added nutrient solution, which was attributed to temperature. The studies published by Sneath and McIntosh (2003) and Dung *et al.* (2010a) indicated that there was non-significant improvement in nutrient content of sprouts which does not justify the added expense of using nutrient solution rather than fresh water.

2.2.10 Light level

Morgan *et al.* (1992) reported that the effect of level of light intensity on growth and dry matter retention of hydroponic fodder. In this study at illumination levels using at warm white fluorescent tubes ranging from 1000 to 9000 lux for 16 hours daily from the third day, soaked grain was grown at 24ºC. At the end of day eight, DM content was measured. Illuminance level appeared to have little effect on DM content, suggesting that increasing light intensity in production units is not likely to give a significant or cost effective improvement in the DM of output grass.

2.3 Nutrient changes with sprouting grain

When seeds are soaked, solutes leak out of them. Leakage is fastest at the start of imbibition (water uptake) and comes to a halt after about one day (Simon, 1984 as cited in Chung et al., 1989). Solutes that leak include proteins, amino acids, sugars, organic acids, and inorganic ions. The desirable nutritional changes that occur during sprouting are mainly due to the breakdown of complex compounds into a more simple form, transformation into essential constituents, and breakdown of nutritionally undesirable constituents (Chavan and Kadam, 1989). The sprouting of grain caused increased enzyme activity, a loss of total DM, increases in sugars, change in amino acid composition, increase in total protein, decrease in starch, slight increase in crude fat and crude fibre and slightly higher amounts of certain vitamins and minerals. Most of the nutrients increases are not true increase; they simply reflect the loss of DM, mainly in the form of carbohydrates, due to respiration during sprouting. As total carbohydrates decreases, the amount of other nutrients increases (Lorenz, 1980). The cause of loss of dry matter is the energy reserve in the endosperm fuelling the growth process. Protein is not used for growth, increases in amount terms but in absolute terms remains fairly static; this also generally applies to the other nutrients. Fibre is a major constituent of cell walls, which increases both in amount and real terms with the synthesis of structural carbohydrates, such as cellulose and hemicelluloses (Cuddeford, 1989). Chung *et al.* (1989) found that the fibre content in unspotted barley grain increased from 3.75% to 6% in 5-day sprouts. Morgan *et al.* (1992) found that ash and protein contents change rapidly from day 4 corresponding with the extension of the radicle (root), which allows mineral uptake. The level of crude protein (CP) increases by the absorption of nitrates which facilitates the metabolism of nitrogenous compounds from carbohydrate reserves. Naik *et al.* (2012b) conducted a study to evaluate the nutrient changes during growth of hydroponics fodder maize. The crude protein contents of hydroponic maize fodder remained highest on 7th day of growth (13.57%), which was higher than the conventional green fodder maize (10.67%). The ether extract content of hydroponics fodder maize (3.49%) was highest on 7th day. The crude fiber content of hydroponic fodder maize was 14.07% on 7th day which was higher than the maize grain (2.50%) but was lower than the fodder maize grown under conventional practices (25.92%). The nitrogen free extract content of the hydroponic fodder maize decreased to its maximum level (66.72%) at 7th day and was higher to maize fodder grown under conventional practices (51.78%). The total ash (TA) and acid insoluble ash (AIA) contents of the hydroponics fodder maize were lower than the TA (9.36%) and AIA (1.40%) contents of the conventional fodder maize. It was concluded that hydroponics fodder maize was more nutritious than the conventional fodder.

2.4 Nutritional composition of different hydroponic fodders

The nutritional composition of hydroponic fodder grown from various grains was reported by different research personnel working in various conditions.

Thadchanamoorthy *et al.* (2012) studied the nutritional composition of hydroponic maize fodder. Dry matter, ash, crude protein (CP), crude fibre (CF), ether extract (EE), neutral detergent fibre (NDF) and acid detergent fibre (ADF) of maize fodder (at 10th day after planting) and maize grain were analyzed. The moisture, ash, CP, EE, CF, NDF and ADF % content in sprouted maize were higher (73.93, 3.09, 16.54, 6.42, 8.21, 29.27 and 10.16 % respectively) than the levels found in maize grain (10.26, 1.48, 8.21, 4.69, 2.11, 19.22 and 5.5 % respectively). Dung *et al.* (2010b) examined the nutrient profile of hydroponic barley grain for duration of 7 days. It was found that 21.9 % loss in DM from the original grain after sprouting for a period of 7 days. The CP, ash and all other minerals except potassium were lower in concentration on a DM basis in the barley grain than in the sprouts. Further, Dung *et al.* (2010a) used a hydroponic nutrient solution to raise barley sprouts which was compared with sprouts raised using tap water irrigation (two treatments). In both treatments, the sprouts were raised in continuous light in a temperature-controlled room for a period of 7 days. There was no difference in DM loss after 7 days of sprouting. The DM losses were 16.4 vs. 13.3 % for tap water irrigation and hydroponic nutrient solution, respectively after 7 days of sprouting. Sprouts which were grown with nutrient solution had a higher protein concentration than those grown with tap water irrigation (17.3 vs. 15.9%), respectively. Finney (1982) studied the effects of germination on the physical, physiological, biochemical, nutritional, and food functional properties of cereals and legumes. Studies suggest that ant scorbutic properties are related to those grains sprouted in sunlight. Water soluble B vitamin may increase in sprouts; thiamin increased after day 3 of sprouting in a number of studies. Riboflavin levels also increased in sprouts vs. original grains. Hande Işıl Akbağ *et al.* (2014) investigated the effects of different harvesting times on the nutritional value of barley fodder producing in hydroponic system. Barley fodders were harvested on the 4th, 7th, 10th and 13th days following sowing date. Analysis performed for determining the nutritional composition and organic matter digestibility (OMD) and ME content with in vitro gas production technique. It was determined that the DM content was decreased, the CP content was not changed significantly, cell wall contents (NDF, ADF, ADL) and ash content were increased by the maturation of the sprouts. DM, ADF and ash contents were changed significantly. It was obtained that 96 hours cumulative gas production, OMD and ME contents were decreased by the increasing number of harvesting time but the variations were not significant.

Naik *et al.* (2012b) evaluated the nutrient changes during growth of hydroponics fodder maize. The samples were analyzed for the nutrients content *viz.* crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE), total ash (TA) and acid insoluble ash (AIA) and were subjected for test of significance (Snedecor and Cochran, 1994) along with the data of nutrients contents of fodder maize (*Zea maize L.*) grown under conventional practices (Naik *et al.,* 2011). The crude protein content remained highest on 7th day of growth (13.57%), which was higher than the conventional green fodder maize (10.67%). The crude fiber content of the maize grain was 2.50% and increased up to14.07% in hydroponic fodder maize on 7th day but was lower than the fodder maize grown under conventional practices (25.92%). The nitrogen free extract content of the maize grain growth in hydroponics system decreased to its maximum level (66.72%) at 7th day and was higher to maize fodder grown under conventional practices (51.78%). The ether extract content of hydroponics fodder maize on 7th day (3.49%) was highest. The total ash (TA) and acid insoluble ash (AIA) contents of the hydroponics fodder maize were lower than the TA (9.36%) and AIA (1.40%) contents of the conventional fodder maize. Fazaeli *et al.* (2012) chemically analyzed sprouted barley grain grown in hydroponic growing chamber for 6, 7 and 8 day periods and found that CP, Ash, EE, NDF, ADF and water soluble carbohydrate (WSC) were increased but organic matter (OM) and non-fiber carbohydrate (NFC) decreased in the green fodder when compared with the original grain. The CP, Ash, EE, NDF and ADF were increased but NFC and WSC reduced when the growing period extended from day 6 to day 8. Sharif *et al.* (2013) reported that sprouting of grain has increased protein quantity and quality. Sprouting also increased the concentration of certain nutrients including sugars, minerals and vitamin contents. Naik *et al.* (2014) studied hydroponics maize fodder of 7 days growth and observed that such hydroponics maize fodder (HMF) had higher CP (13.30 vs. 11.14, %), EE (3.27 vs. 2.20, %), NFE (75.32 vs. 53.54, %) and lower CF (6.37 vs. 22.25, %), TA (1.75 vs. 9.84, %) and AIA (0.57 vs. 1.03, %) than napier bajra hybrid.

2.5 Effect of hydroponic fodder supplementation on livestock performance

Mysaa Ata, (2016) conducted a study to investigate the effect of feeding hydroponic barley (HB) on the performance of Awassi ram lambs. A total of 50 weaned lambs were used in a feeding trial by dividing it into two groups. The first was fed a total mixed ration diet (control) while lambs in the second group were fed similar ration except that barley grain was totally replaced by HB for 90 days feeding trial. Results of the experiment showed that HB had a positive effect on feed intake, final live weight, total gain, average daily gain, and FCR on lambs fed the HB diet when compared to lambs fed the control diet. In conclusion, HB can be used as feed for lambs in the fattening period to enhance their growth performance. Weldegerima Kide *et al.* (2015) conducted an experiment to investigate the effect of feeding hydroponically maize and barley sprouted fodder for Konkan Kanyal goats. Eighteen growing male kids of 3-7 months old with initial live weight of 11.01±0.26 kg were divided into six treatments (3 animals each) randomly to receive one of the treatment diets *viz*. T0-Finger millet straw (FMS) 100%; T_1-FMS + hydroponic maize fodder (HMF) 80%: 20%; T_2-FMS + hydroponic barley fodder(HBF) 80%: 20%; T_3-FMS + HMF 60%: 40%; T_4-FMS + HBF 60%: 40%; T_5-FMS + HMF + HBF 60%: 20%: 20% for 97 days. Results denoted a significant improvement in DM intake in T_5 (504.51 g/day) and T_3 (415.36 g/day) than control (317.54 g/day) and DM digestibility coefficient was highest in T_5 (68.44%) and T_3 (67.28%) while feed conversion efficiency in T_3 (12.15%) and T_5 (10.56%) was higher than T_0 (-0.47%) and average body weight gain in T_3 (61.93g/day) and T_5 (56.70g/day) was significantly higher than T_0 (-1.17g/day). Therefore, it can be concluded that feeding of hydroponically sprouted maize and barley fodder to growing goats increased the digestibility of nutrients, live weight gain and feed conversion efficiency. Williams (1956) supplemented 20 lb of 6-day-old hydroponic oats grass two sets of lactating identical twin cows (Holsteins and Guernseys) for 30 days. He observed that there was no change in milk production or fat amount. In another study, Tinley and Bryant (1938) at Wye (England) found in their experiment that there was no significant difference in milk yield between the sprout-fed and control groups. Bartlett *et al.* (1938) concluded that feeding sprouted maize showed no advantage in either milk yield or quality. Badran *et al.* (2017) investigated the effect of feeding different levels of hydroponic barley (HB) on general performance and milk yield and quality of lactating Awassi ewes. A total of 48 lactating ewes were used in a feeding trial in three groups. The first was fed a regular lactation total mixed ration (TMR) while ewes in the second and third treatments were fed similar ration except that regular wheat hay was replaced by HB at levels of 50 (HB_1) and 100% (HB_2), for 120 days feeding trial. Results of the experiment showed that HB yield in 8 days germination cycle was 8.0 kg per 1 kg barley grains. HB at two levels had no effects on feed intake (FI), live weight changes, milk yield, and milk composition; however, HB had positive effects on ewe's health conditions, mortalities, conception rates and abortion. Reddy *et al.* (1988) used eight cross-bred (Ongole × Holstein) milch cows into two groups of 4 animals each fed in individual stalls with artificial green fodder (group-1) and natural barley fodder (NB-21, group-2) fodder at the rate of 10kg/animal/day with concentrate mixture at the rate of 1 kg for every 2.5 kg milk produced and maize silage *ad libitum* as bulk of ration. It was observed that an increase of 7.8% in milk production, 9.3% in fat corrected milk (FCM) and 10.5% in fat yield in animals of group 1 fed artificial green fodder. They suggested that artificially grown fodder was supplying more nutrients than NB-21. Pandey and Pathak (1991) fed artificially grown barley fodder to five cross bred (*Bostaurus × Bosindicus*) cows (3-4 years old and 350 – 410 kg live weight) *ad lib* during the 3rd to 5th month of their second lactation in a feeding experiment. The fresh sprouts intake was 50.38 kg/day or 7.13 kg DM. The intake of mean dry matter was 1.93% of live weight and milk yield was 9.13 kg/day. Gebremedhin (2015) identified the nutritional benefit and economic values of feeding hydroponically grown maize and barley fodder for Konkan Kanyal goats. Eighteen growing male kids of 3-7 months old with initial body weight of 11.01±0.26 kg were grouped randomly into six treatments (3 animals each) and receive treatment diets viz. T_0-Finger millet straw (FMS)100%; T_1- FMS + hydroponic maize fodder (HMF) 80:20; T_2-FMS + hydroponic barley fodder (HBF) 80:20; T_3-FMS + HMF 60:40; T_4-FMS + HBF 60:40; T_5-FMS + HMF + HBF 60:20:20% for 90 days feeding trial and 7 days metabolic trial period. After completion of 97 days, a significant improvement in DM intake was observed in T_5 and T_3 than control and feed conversion efficiency was highest in T_3 and T_5 than T_0 and highest live weight gain in T_3 and T_5 than T_0 as well as economically profitable in T_3 than T_0. Therefore, it can be concluded that feeding of hydroponically grown maize and barley fodder for growing goats increased the total DM intake, feed conversion efficiency, live weight gain and it was economically valid. Reddy *et al.* (1991) conducted an experiment with 8 crossbred cows to observe the effect of supplementation of machine grown barley fodder on paddy straw based rations of lactating cross bred cows and reported that average milk yield, 4 % fat corrected milk (FCM), fat and SNF percent were similar in all groups. Tudor *et al.* (2003) conducted a study on drought master steers of (15 – 18) months old and average 330 kg live weight fed with low quality hay and barley sprouts fodder over 70 days. During first 48 days cattle were ate 1.9 kg DM/head/day of sprouts (15.4 kg wet weight) and 3.1 kg DM/head/day of poor quality hay and gained1.01 kg/head/day. Muela *et al.* (2005) analyzed the effect of hydroponics green fodder (HGF) on the productive and reproductive behavior of lactating Salers cows with calf. There were 35 cows used with 42 days and randomly assigned into two treatment groups, range land forage plus HGF as supplement plus green fodder (GF) and range land forage plus irrigated prairie forage (PF). The consumption of forage was 1.07 and 1.32 kg/DM/d of GF and 2.66 and 0.88 kg/DM/d of PF in May and June, respectively. Both groups were bred with fertility tested registered Salers bulls. The cows on PF lost weight from day 28 to day 56 of the experiment; the GF cows maintained the live weight on the same period. The cows showed daily live weight lost on PF and daily weight gain on GF. The calves showed differences between treatments in live weight at day 56. The daily average weight gain of calves from day 0 to 56 was 0.535 vs. 0.759 kg/d on PF and GF, respectively. Miscera *et al.* (2009) made three homogeneous groups of 45 lactating Comisana sheep (4th- 5th parity), 15 in each, to evaluate the effects of two different levels of partial substitution of a complete feed with hydroponically germinating grain on the plasma cortisol and milk production responses. They concluded that integration with hydroponically germinating at in partial substitution of the complete feed does not modify biochemical and hematological parameters and seems to produce an improvement in animal welfare and production of milk. Hillier and Perry (1969) conducted a study by feeding of cattle with four levels of supplemental oat sprouts (0, 0.63, 0.95, 1.26 kg DM) on both low and high-energy diets. They found no effect on digestibility of DM, protein, fibre, ether extract, nitrogen free extract or energy. Hillier and Perry (1969) also found the effect of hydroponic fodder on growth responses for poultry and also increased gains for cattle when sprouted corn was added to the ration (Patterson, 1937 and Mc Candlish, 1939). Marsico *et al.* (2009) studied plasma levels of cortisol and milk production of 30 Jonica breed goats, divided into three homogeneous groups in lactation (4th - 5th parity) to evaluate the effects of two different levels of partial dietary substitution with hydroponically germinating oat. They found that there was no relevant change in the milk yield among the groups. Deveder and Kumari, (2016) evaluated the yield and feeding value of hydroponics barley fodder (HBF) in growing lambs. The results indicated that, replacement of concentrate mixture with hydroponics barley fodder at 50 per cent level in the ration of growing lambs improved the nutrient utilization, N balance, plane of nutrition and growth performance and also reduced the production cost. However, though replacement of concentrate mixture with HBF up to 75 per cent has no beneficial affect but it could be comparable with control in nutrient utilization and plane of nutrition. Fazaeli *et al.* (2011) conducted an experiment to study the effect of hydroponic barley green fodder on the performance of feedlot calves where 24 cross bred (Holstein × Local) male calves were assigned randomly into two treatment groups that were either control (grain barley) or hydroponic barley green fodder (BGF) that was included to provide 22.8 percent of the total diet on dry matter basis. They found that live weight gain was not significantly different between the treatments, but the animals that had received the control diet had higher dry matter intake than those fed BGF diet. Sharif *et al.* (2013) observed increased digestibility by using sprouted grain in the diet of broilers and large animals. This was achieved possibly by changes in rate and extent of digestion and absorption. Addition of sprouted grain has improved milk yield up to 8.7% in ruminant animals. Grigor'ev *et al.* (1986) conducted an experiment to investigate the effect of hydroponic barley on two groups of 8 cows, at the same stage of lactation, for 101 days on mixed feeds based on maize silage. Replacement of 50% of the maize silage with 18 kg of hydroponic barley grass increased milk yield by 8.7% although milk fat was depressed.

2.6 Effect of hydroponic fodder usage in livestock feeding on cost economics:

Naik *et al.* (2014) studied the cost benefit effect of hydroponics maize fodder of 7 days growth fed to 6 dairy cows divided into two equal groups (BW 442 kg; avg. milk yield 6.0 kg). They observed that there was higher net profit of Rs.12.67/- per cow/d on feeding hydroponic maize fodder (HMF). The cost of the feed/d and feed cost per kg milk production was higher in the T-HF (hydroponic fodder) group (Rs. 144.88 and Rs. 34.98) than the T-CF (conventional green fodder) group (Rs. 137.51 and Rs. 33.69). The higher cost of the hydroponics maize fodder (Rs.4/kg) than the conventional green fodder (Rs. 1.50/kg) might be the reason for higher cost of the feed in the T-HF group than T-CF group. It was concluded that feeding of HMF to lactating cows increased the digestibility of nutrients and milk production leading to increase in net profit. Rahim (2015) investigated the biological and economical values of hydroponic barley (HB) on lactating Awassi ewes. A total of 48 lactating ewes were used in a feeding trial in two groups. The first was fed a regular lactation total mixed ration (TMR) while ewes in the second treatment were fed similar ration except that regular wheat hay was totally replaced by HB for 120 days feeding trial. Results of the experiment showed that the green fodder yield in 8 days germination cycle was 7.5 kg per 1 kg barley grains of green fodder. HB had no effects on feed intake (FI), live weight changes, milk yield, and milk composition; however, HB had positive effects on ewe's health conditions, mortalities, conception rates and abortion. In conclusion, HB can be used as feed for lactating sheep as cost of feed can be reduced by 42%. Fazaeli *et al.* (2012) conducted an experiment to evaluate the effect of barley green fodder produced by hydroponics system on the performance of feedlot calves. These findings suggest that green fodder had no advantage over barley grain in feedlot calves, while it increased the cost of feed.

CHAPTER III
METERIALS AND METHODS

3.1 Experimental site

The study was conducted at the Advance Animal Research Farm of the Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh. The study lasted for 6 months from April– September, 2017. Two sheds were needed for conducting the study, one was for production of hydroponic sprouted fodder and another was for feeding trial.

3.2 Preparation of hydroponic sprouted fodder shed

The hydroponic sprouted fodder shed was made by polythene, bamboo and wood. Polythene Shed of 20×12 square feet was set-up with a number of stacks to keep trays. The trays of 2.5×2 square feet were made by aluminum sheet for sprouting fodder. The structure of the shed was made in such a way that a temperature range of between 17-25ºC could be maintained. If the temperature of the shed was below 17ºC there might be slow growth and above 25ºC there might be threat of fermenting.

3.3 Preparation of turkey shed

One week prior to arrival of poults, the house was cleaned thoroughly with water and disinfectant. All necessary equipment was set properly and performed complete fumigation. A foot bath was made in front of the door of the house and it was dipped with potassium permanganate to maintain bio-security.


FULL

Photo 1. Experimental site and turkeys used in the experiment

3.4 Production of hydroponic sprouted fodder

3.4.1 The hydroponic system

Hydroponic sprouted fodder was produced under intensive care at the Advance Animal Research Farm of the Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, as described by Rahim, Saidi and Omar (2015).

3.4.2 Plant materials

Maize and sesbania seeds were obtained from the local market of Dinajpur and subjected to germination test to check for their viability before using; the result of the germination test was 80%.

3.4.3 Treatment of seeds

Seeds were cleaned from debris and other foreign materials. The dead and broken seeds were removed. Planting trays were also cleaned and disinfected. The seeds were then washed well from residues of bleach and resoaked in tap water overnight (about 12 hours). Seeds were kept under anaerobic condition in a dark environment for better germination before planting.

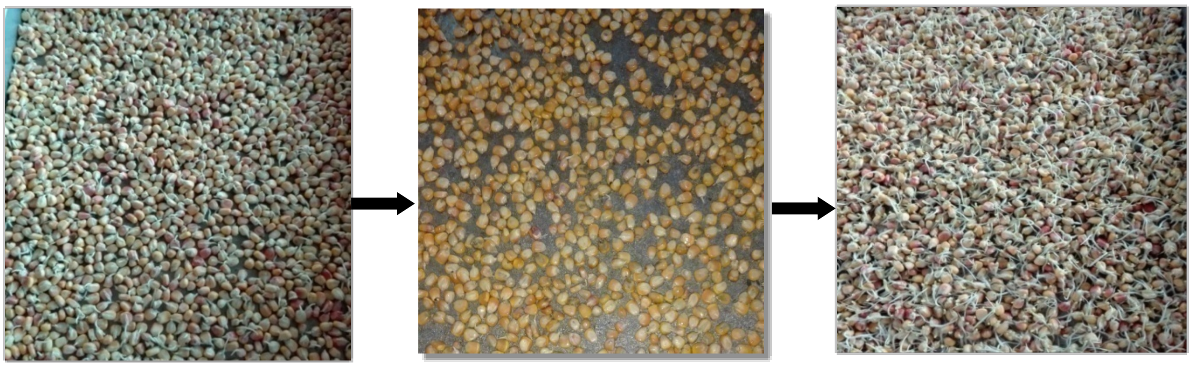
3.4.4 Seed sowing and irrigation

The germinated seeds of hydroponic fodder seeds were spread uniformly in the planting trays which have holes at the bottom to allow drainage of excess water from irrigation. The seeding rates used in this experiment were about 350 g of maize and 175 g of sesbania grain per tray. Total number of tray per day was 4 in which 2 trays for maize and 2 trays for sesbania. Trays were irrigated manually with water sprayer four times in a day.

Photo 2. a) Weighing, b) Soaking and c) Germination of maize and sesbania seeds

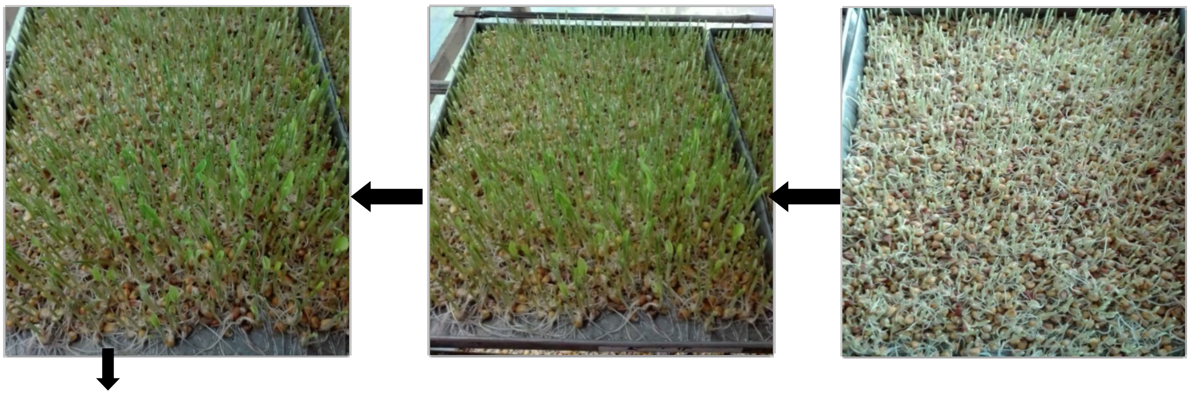
b

Photo 3: a) Sowing and b) Irrigation of maize and sesbania seeds



Day 0 Day 1

Day 2



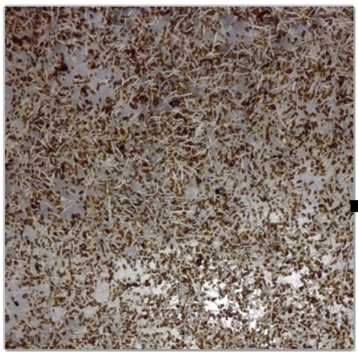
Day 5 Day 4

Day 3

Day 6 Day 7

Day 8

Photo 4: Growth phase of hydroponic maize sprouted fodder

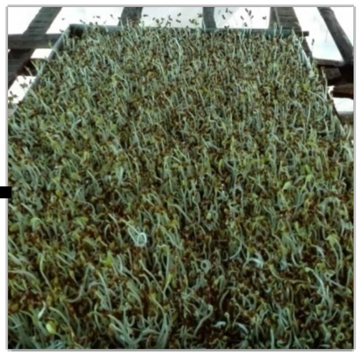


Day 0

Day 1

Day 2

Day 4



Day 3

Photo 5: Growth phase of hydroponic sesbania sprouted fodder

Photo 6: Sprouted mat

Photo 7: Weighing of hydroponic maize and sesbania sprouted fodder

3.4.5 Fodder yield

After 8 days (maize) and 4 days (sesbania) from seeding, the total fresh and dry fodder yields were recorded and ratio of produced green fodder: initial planted seeds weight was calculated. Fodder samples were collected from day-8 and day-4 of germination for chemical analysis.

3.4.6 Proximate analysis of hydroponic fodder

Dry matter (DM), organic matter (OM), ash, crude protein (CP), crude fiber (CF) and ether extract (EE) of both maize and sesbania were determined by proximate analysis using following methods of AOAC (2007) at Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka. The methods were described as follows:

3.4.6.1 Collection of sample

At day-8 and day-4 of germination 100–150 g sample of maize and sesbania fresh hydroponic fodders were collected in zipper bag as fresh condition and carried to the laboratory of feed analysis.

3.4.6.2 Protocol of proximate analysis

3.4.6.2.1 Determination of dry matter (DM):

Apparatus:

- Drying oven
- Crucible
- Drying tray
- Fresh hydroponic sample

Procedure:

- At first 5-10 g of fresh hydroponic sprouted fodder samples were taken in a pre-weighted crucibles and crucibles taken in drying tray.
- Then the trays were kept in oven.
- Samples were dried in oven at 105ºC for 12 hours.
- After 12 hours, dried samples were weight again (taking care not to exposed sample atmosphere)

Calculation:

$$\text{Dry matter (DM)\%} = \frac{\text{Sample weight with crucible - Crucible weight}}{\text{Fresh sample weight}} \times 100$$

3.4.6.2.2 Determination of crude protein (CP):

Apparatus and materials:

- Kjeldahl digestion
- Kjeldahl distillation
- Kjeldahl flask (500 ml)
- Erlenmeyer flask (250 ml)
- Glass bead

Reagents:

- Potassium sulphate

- Mercuric oxide
- Sulphuric acid
- 4% Sodium sulphate
- 40% Sodium hydroxide
- Boric acid indicator solution
- Standard solution of 0.1N hydrochloric acid (HCl)

Procedure:

- 0.5 g dry sample was weighed out in Kjeldahl flask.
- 10 g Potassium sulphate, 0.7 g Mercuric oxide and 20 ml Sulphuric acid were added with sample.
- The flask was placed in the digester, heated at boiling point till solution was clear, and continued to heat 30 minutes more.
- The solution was cooled gradually at 90 ml deionized distilled water. When cold, 25 ml 4% Sodium sulphate was added and stirred.
- 1 glass bead and 80 ml 40% Sodium hydroxide were added. The flask was kept tilted and two layers were formed.
- The flask was quickly connect to the distillation unit and heated. 50 ml distillate was collected.
- At the end of the distillation, the receptor flask was removed and rinsed the end of the condenser. The solution was Tritrated with the Standard solution of 0.1N hydrochloric acid (HCl).

Calculation:

Crude protein % = Nitrogen in sample × 6.25

$$\text{Nitrogen in sample \%} = \frac{A \times B \times 0.014}{C} \times 100$$

Where,

A= Hydrochloric acid in titration (ml)

B= Normality of standard acid (0.1N)

C= Sample weight

3.4.6.2.3 Determination of ether extract (EE):

Apparatus and reagents:

- Petroleum ether, boiling point 40-60ºC
- Soxhlet extraction apparatus
- Laboratory kiln at 105ºC
- Dryer
- Extraction thimbles

Procedure:

- At first, the extraction flask was removed from the kiln without touching them with the fingers, cooled in dryer and weighed.
- Then 4 to 5 g of dry sample was weighed in extraction thimble, handled with metal tongs and placed in the extraction unit. The flask was connected containing petroleum either at 2/3 of total volume of extractor.
- The flask was brought to boiled and heat to obtain about 10 refluxes per hour. The length of extraction will depend on quality of lipid in the sample; very fatty materials will take 6 hours.
- The boiling was finished, after finishing of boil the ether with was evaporated distillation and roto evaporator. The flask was cooled and weighed them.
- Defatted sample was used in CF determination.

Calculation:

$$\text{Ether extract (EE)\%} = \frac{B - A}{C} \times 100$$

Here,

A= Weight of clean dry flask (g)

B= Weight of flask with fat (g)

C= Weight of sample (g)

3.4.6.2.4 Determination of crude fiber (CF):

Apparatus:

- 600 ml flat bottomed balloon flask with roughen neck
- Condensation unit for flask
- 11 Kitazato flask
- Buchner funnel
- Filtration crucible
- Rubber cones
- What man Nº 541 filter paper
- 500 ml retort
- Dryer
- Laboratory kiln
- Crucible furnance

Reagents:

- 0.25 N Sulphuric acid solution
- 0.31 N Sodium hydroxide solution
- Antifoam (Octyl alcohol)
- 95% Ethyl alcohol
- Petroleum ether
- 1% Hydrochloric acid solution

Procedure:

- At first defatted dry sample of maize (0.5 g) and sesbania (1 g) were added with 200 ml sulphuric acid boiling solution taken in 600 ml flat bottomed balloon flask with roughen neck and set the flask at fibre set.
- Then boiled gently 30 minutes and stirred occasionally.
- The solution was filtered in a vacuum and after filtering filter paper was washed with boiling water.

- 200 ml sodium hydroxide solution was added with residue and boiled for 30 minutes.
- The solution was filtered in a vacuum and washed residue with boiling water.
- This residue was washed with hydrochloric acid solution and another washed was done with boiling water.
- The residue was washed with petroleum ether for 3 times.
- After washing the residue, kept in dry crucible in kiln set at 105ºC for 12 hours.
- After 12 hours, the crucible was removed from kiln and Cooled in dryer.
- Crucible was weighed with residue.
- Residue was furnanced at 550ºC for 3 hours in muffle furnance.
- Then residue was cooled in dryer and weighed them again.

Calculation:

$$\text{Crude fiber (CF) \%} = \frac{A - B}{C} \times 100$$

Here,

A= Weight of crucible with dry residue (g)

B= Weight of crucible with ash (g)

C= Weight of sample (g)

Fresh sample Drying Oven

Dry sample Grinding of sample

Photo 8: Preparation of hydroponic sprouted fodder sample for proximate analysis

Sample in crucibles Muffle furnance

Metal tong Desiccator

Photo 9: Apparatus used for ash determination

Photo 10: Soxhlet apparatus for ether extraction

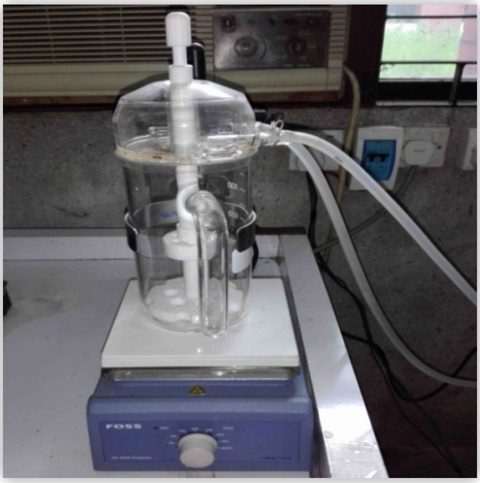
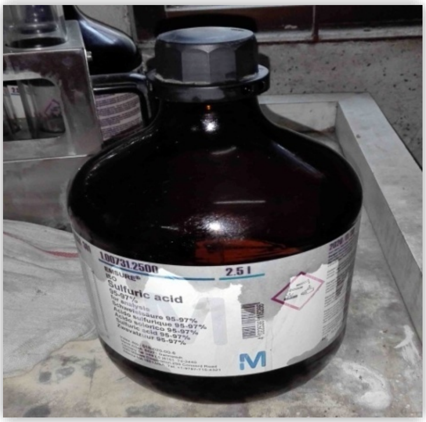


Photo 11: Apparatus used in crude fiber determination



Kjeldahl digestion tube Concentrate sulphuric acid

Kjeldahl digestion machine Kjeldahl digestion machine

Kjeldahl distillation set

Photo 12: Apparatus used in crude protein determination

3.4.6.2.5 Determination of Ash:

Apparatus:

- Porcelain crucible

- Muffle furnance
- Dryer

Procedure:

- Five to ten gram of dry sample was taken in a pre-weighted crucible.
- The crucible was placed in a muffle furnance and heated at 550ºC for 12 hour and cooled and transfer to a dryer.
- The crucible was weighed again with ash carefully.

Calculation:

$$\text{Ash \%} = \frac{A - B}{C} \times 100$$

Here,

A= Weight of crucible with sample (g)

B= Weight of crucible with ash (g)

C= Weight of sample (g)

3.5 Experimental birds

A total of 48, 6-weeks old poults were purchased from a local turkey breeding farm. The birds were reared in cage for 2 weeks then in deep litter pens and divided according to the dietary treatment groups, where proper lighting, ventilation and heating arrangement were insured. A total of 48 (eight weeks old) turkeys were randomly divided into four dietary treatment (T_1, T_2, T_3, T_4) groups where each group consisting of 3 replications having 4 birds in each. Each of the cages contains a feeder and waterer for each of the 4 birds. Birds were housed in proper atmospheric and hygienic condition. All the birds involved in the experiment were treated equally in all respects, except supplying amount of concentrate feed and hydroponic fodders. Turkeys of all dietary treatment groups were fed with isocaloric and isonitrogenous diet. Broiler grower feed manufactured by Aftab Bahumukhi Farms Limited, Bangladesh, was fed to the turkeys of all dietary treatment groups. The experimental feed was prepared using: maize, rice polish, soybean meal, full fat soybean, animal protein, vitamin-mineral premix, amino acid, salt, toxin binder and antioxidant. The nutrient composition is shown in Table 1.

3.6 Experimental layout

Total 48 of eight weeks old turkeys were randomly assigned into four dietary treatment groups (T_1, T_2, T_3, T_4) and having three replications in each. T_1 considered as control group and fed only commercial concentrate feed, where T_2, T_3 and T_4 groups fed 90, 70 and 60% commercial concentrate feed (CCF) and 10, 30, 40% hydroponic fodders respectively. The ratio of maize and sesbania were 80 and 20, 70 and 30, 60 and 40%, respectively. Initial live weight of each bird was recorded just prior to grouping and kept them into separate bamboo-made chambers; the birds were reared on slatted floor with deep litter. Live weight at 7 days interval and daily feed intake were recorded upto 21 weeks of experimental period.

3. 7 Experimental diets

T_1 = 100% commercial concentrate feed (CCF)

T_2 = 90% CCF + 10% hydroponic fodder (80% maize and 20% sesbania)

T_3 = 70% CCF +30% hydroponic fodder (70% maize and 30% sesbania)

T_4= 60% CCF + 40% hydroponic fodder (60% maize and 40% sesbania)

The Nutritional composition of commercial concentrate feed is presented in Table 1.

Table 1. Nutritional composition of commercial concentrate feed

Nutrients	Amount (%)

Moisture	12
Crude protein (CP)	19.3
Crude fat (CF)	5
Calcium	0.9
Av. Phosphorus	0.42
Metabolizable Energy (ME, Kcal/kg)	3000

Source: Aftab Bahumukhi Farms Limited, Bangladesh

3.8 General management practices

Feed and water were supplied in plastic feeders and waterers. *Ad libitum* fresh, clean drinking water was made available all day through experimental period by using hanging drinkers. Before starting the experiment, the birds were kept as adjustment period to be comfortable with their respective experimental diets. To avoid wastage and reduce the quantities of leftover supply of feed was adjusted every week on the basis of consumption pattern of birds. The amount of hydroponic fodder was determined on the basis of DM requirement supplied to the control group. Feed and fodder were supplied two times in a day; in the morning between at 8:30 to 9:00 AM and in the afternoon between at 3:30 to 4:00 PM. To ensure freshness, fodder was supplied directly from the fodder growing shed both in the morning and afternoon. Rice husk was used as litter. Each turkey was marked with colored plastic beads for proper identification. The environmental conditions of the experimental unit such as ventilation and illumination were supplied both naturally and mechanically. The experimental temperature was between 28-35°C and lighting schedule was 16 h light and 8 h dark. Following measures were taken during the experimental period to prevent diseases. Entrance of personnel was restricted except researcher, supervisor, co-supervisor and labour who visited the farm following special care. Hands and feet were washed with soap and $KMnO_4$ was sprayed thoroughly just prior to entrance the shed. Hygienic measures were taken for weighing of birds, feeds, feed storage and during administration.

3.9 Data collection

3.9.1 Calculation of productive performance

Feed and fodder were supplied by weighing using digital balance daily. Leftover feed was weighed daily. All birds 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:

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

$$\text{FCE} = \frac{\text{Feed Intake}}{\text{Live weight gain}} \quad \text{(Equation 2)}$$

3.9.2 Calculation 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 turkey, feed, grain, electricity, labor, medication etc. were taken into account to know the accurate cost. Pricing of turkey 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.

3.9.3 Net farm income (NFI)

Net farm income (NFI) 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 is the cost of permanent items which do not vary when output changes and therefore have no influence on production decisions in short run. In this study, NFI was calculated using the following equation (3):

$$NFI = TR - (TVC + TFC) \quad \text{(Equation 3)}$$

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

3.9.4 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).

$$PI = \frac{NFI}{GR} \text{(Equation 4)}$$

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

3.9.5 Rate of return on investment (RRI)

Rate of return on investment is the performance measure which 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 a amount or ratio. It was calculated using the following equation (5):

$$RRI = \frac{NFI}{TC} \quad \text{(Equation 5)}$$

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

3.9.6 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):

$$CTO = \frac{TR}{TC} \quad \text{(Equation 6)}$$

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

3.9.7 Depreciation cost

To calculate the worth of each of the fixed cost items, the straight line method of depreciation was used. Depreciation cost was measured using the following equation (7):

$$\text{Depreciation cost} = \frac{\text{Purchase Price}}{\text{Number of useful years of the asset}} \quad \text{(Equation 7)}$$

3.10 Statistical analysis

Effect of treatment on live weight gain, feed intake and feed efficiency were analyzed using the One-way ANOVA following the GLM procedure of SPSS computer software 22.00. Significance of differences among the means of treatments was compared by using Duncan's Multiple Range test of the same package. All data were expressed as Mean±Standard Error of Mean (SEM). Differences were considered significant at level of $P<0.01$ and $P<0.05$. The following linear model summarizes the statistics employed to analyze the data:

$$Y_i = \mu + TR_i + E_i,$$

Where,

Y_i = is the dependent variable,

μ = is the overall mean,

TR_i = is the treatment effect, and

E_i = is the error.

CHAPTER V

RESULTS

4.1 Nutritional composition of hydroponic fodder

Nutritional composition of hydroponic maize and sesbania sprouted fodder fed to turkey is presented in Table 2. The amount of dry matter (DM) was significantly higher ($P<0.01$) in maize than sesbania sprouted fodder and the amount moisture was significantly higher ($P < 0.05$) in sesbania than maize sprouted fodder. But the amount of organic matter (OM) was not significantly differed between maize and sesbania sprouted fodder. The amount of ash, crude protein (CP) and crude fibre (CF) was significantly higher ($P < 0.01$) in sesbania than maize sprouted fodder and the amount of ether extract (EE) was significantly higher ($P < 0.05$) in sesbania than maize sprouted fodder but the amount of nitrogen free extract (NFE) was significantly higher ($P < 0.01$) in maize than sesbania sprouted fodder.

4.2 Effect of hydroponic fodder on live weight gain in turkey

Effects of dietary supplementation of hydroponic fodder on live weight gain in turkey are presented in Figure 1. The present study revealed that hydroponic maize and sesbania sprouted fodder had significant ($P<0.05$) effect on daily live weight gain. The highest live weight gain (g/d) was found in T_2 group (20.61) than those of the other three groups i.e. T_1 (18.39), T_3 (15.55) and T_4 (12.07). The final live weight (kg) was significantly higher ($P <0.05$) at T_2 (2.83) group than the final live weights were (2.64), (2.39) and (2.09) in T_1, T_3 and T_4 groups, respectively.

Table 2. Nutritional composition of hydroponic fodder

Nutrients (%) / Hydroponic fodder	Moisture	DM	Ash	OM	CP	CF	EE	NFE
					% DM basis			
Maize	85.21±8.22	14.79±1.52	2.50±0.02	97.5±11.02	10.92±1.12	5.30±0.02	2.94±0.04	78.34±7.02
Sesbania	90.54±9.95	9.46±1.01	3.41±0.03	96.6±10.03	37.26± 4.2	7.21±0.01	3.71±0.05	48.41±4.43
Level of Significance	*	**	**	NS	**	**	*	**

Values are Means±SEM; NS-not significant; statistically significant difference is expressed as *($P < 0.05$) or ** ($P < 0.01$).

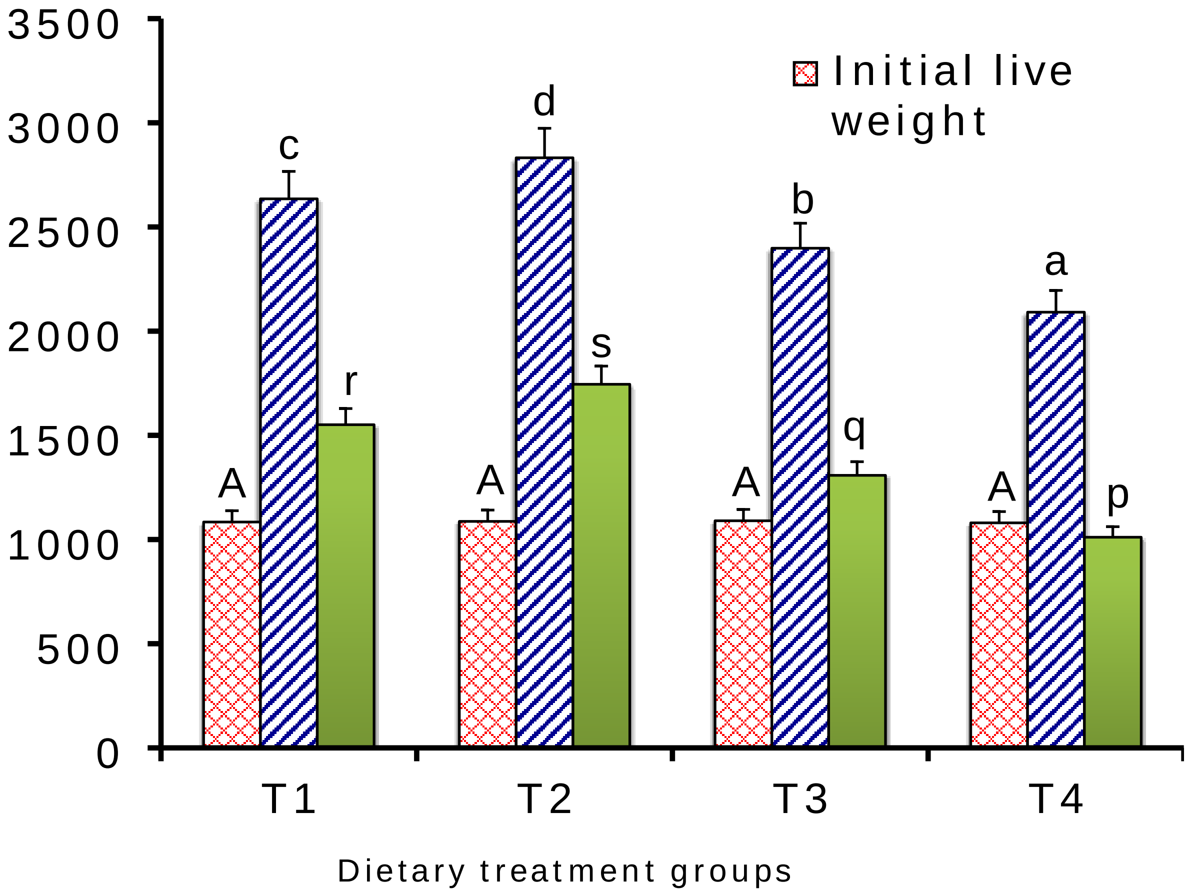


Figure 1: Effect of hydroponic sprouted maize and sesbania fodder on initial live weight (g), final live weight (g) and live weight gain (g) in turkey. Here, T_1=100% commercial concentrate feed (CCF), T_2= 90% CCF + 10% hydroponic fodder (80% maize and 20% sesbania), T_3=70% CCF +30% hydroponic fodder (70% maize and 30% sesbania) and T_4=60% CCF + 40% hydroponic fodder (60% maize and 40% sesbania). Each bar with error bar represents Mean ± SEM value. Differences were significant at 5% level of significance ($P<0.05$).

4.3 Effect of hydroponic fodder on feed intake and feed conversion efficiency (FCE) in turkey

Daily feed intake (g), hydroponic fodder intake (g) and feed conversion efficiency of turkey are shown in Table 3. It was observed that average daily commercial concentrate feed intake (g) ($P< 0.05$) and average hydroponic fodder intake (g) had significant ($P<0.01$) difference among the dietary treatment groups. The highest average commercial concentrate feed intake (g/d) was observed at T_1 group (96.85) whereas it was 83.16, 67.30 and 56.53 in T_2, T_3 and T_4 group, respectively. The average hydroponic fodder intake (g) was observed lower in T_2 (35.61) group than T_3 (95.16) and T_4 (119.77) group (on DM basis). The result revealed that FCE was significantly differed among the turkey of control group T_1 (5.26) and turkey of T_2 (4.03), T_3 (4.34) and T_4 (4.65) group fed hydroponic sprouted fodder with commercial concentrate feed.

4.4 Cost-benefit analysis of production

The cost effective analysis for turkey production based on hydroponic sprouted maize and sesbania fodder replaced by commercial concentrate feed at different levels are shown in Table 4. Total cost per bird was higher ($P<0.05$) in control group than other dietary treatment groups. Total cost per bird was T_1 (1839), T_2 (1821), T_3 (1816) and T_4 (1797) group. Total revenue per bird was higher in T_2 (2828) while 2645, 2410 and 2102 were for T_1, T_3 and $T_{4,}$ respectively. The highest net farm income was found in T_2 group (1007) while it was (806), (595) and (306) in T_1, T_3 and $T_{4,}$ respectively. Capital turnover (CTO) per bird was higher in T_2 (1.55) group followed by T_1 (1.44), T_3 (1.33) and T_4 (1.17) group, respectively.

Table 3: Effects of hydroponic fodder on feed intake and feed conversion efficiency (FCE) in turkey

Variables	Dietary Treatment Groups				Level of significance
	T_1	T_2	T_3	T_4	
Av. daily feed intake (g)	96.85±0.01[d]	83.16±0.06[c]	67.30±0.20[b]	56.53±0.28[a]	*
Av. hydroponic fodder intake (g)	-	35.61±.05[a]	95.16±0.03[b]	119.77±.05[c]	**
FCE	5.26±0.05[d]	4.03±0.05[a]	4.34±0.05[b]	4.65±0.05[c]	*
Survivability (%)	100±0.00	100±0.00	100±0.00	100±0.00	NS

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 *($P < 0.05$) or ** ($P < 0.01$). Here, T_1=100% commercial concentrate feed (CCF), T_2= 90% CCF + 10% hydroponic fodder (80% maize and 20% sesbania), T_3=70% CCF +30% hydroponic fodder (70% maize and 30% sesbania) and T4=60% CCF + 40% hydroponic fodder (60% maize and 40% sesbania).

Table 4: Cost and returns per turkey production (calculation was made in BDT and on the basis of market price during the experimental period, in FY 2016-17)

Parameters	Dietary treatment groups				Level of significance
	T_1	T_2	T_3	T_4	
A. Variable Costs					
Labour	200	200	200	200	NS
Feeds	342±1.57[d]	293±1.44[c]	238±1.35[b]	198±1.56[a]	*
Hydroponic fodder	-	29.92±0.55[a]	79.91±0.51[b]	100.61±1.55[c]	*
Medication	13.67	13.67	13.67	13.67	NS
Miscellaneous	146.00	146.00	146.00	146.00	NS
Total Variable Cost (TVC)	702±3.55[d]	684±4.41[c]	678±3.27[b]	659±2.57[a]	*
B. Fixed Costs					
Cost of poult	1100	1100	1100	1100	NS
Depreciation on housing @5%	35.22	35.22	35.22	35.22	NS
Depreciation on equipment@10%	2.22	2.22	2.22	2.22	NS
Total Fixed Cost (TFC)	1137	1137	1137	1137	NS

Total cost	1839±7.47^{c}	1821±6.51^{b}	1816±6.48^{b}	1797±6.51^{a}	*
C. Revenue					
Sales of per turkey	2634±9.45^{c}	2817±8.44^{d}	2399±7.51^{b}	2091±8.27^{a}	*
Sales of litter	11.00	11.00	11.00	11.00	NS
Total revenue (TR)	2645±6.58^{c}	2828±6.57^{d}	2410±7.53^{b}	2102±8.47^{a}	*
Net farm income (NFI)	806±4.17^{c}	1007±3.67^{d}	595±3.37^{b}	306±4.33^{a}	*
Profitability index (PI)	0.30±0.03^{c}	0.36±0.01^{d}	0.25±0.01^{b}	0.15±0.02^{a}	*
Rate of return on investment (RRI)	43.80±1.33^{c}	55.31±1.11^{d}	32.75±1.23^{b}	17.01±1.53^{a}	*
Capital turnover (CTO)	1.44±0.07^{c}	1.55±0.05^{d}	1.33±0.01^{b}	1.17±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= 90% CCF + 10% hydroponic fodder (80% maize and 20% sesbania), T_3=70% CCF +30% hydroponic fodder (70% maize and 30% sesbania) and T_4=60% CCF + 40% hydroponic fodder (60% maize and 40% sesbania).

CHAPTER V

DISCUSSION

The effect of feeding hydroponic maize and sesbania sprouted fodder replaced with commercial concentrate feed on growth performance of turkey is discussed in conjunction with the available literature.

The CP (10.92%) content in hydroponic maize sprouted fodder reported in the present study is comparable to the value (16.54%) of Thadchanamoorthy *et al.* (2012) and (13.57%) of Naik *et al.* (2012b) in hydroponic maize sprouted fodder. The CF (5.30%) content observed in the present study was comparable with the value (6.37%) of Naik *et al.*

(2014) and (8.21%) of Thadchanamoorthy *et al.* (2012), respectively. The ash (2.50%), NFE (78.34%) and EE (2.94%) content observed in the present study was comparable with the value 1.75%, 75.32% and 3.27% reported by Naik *et al*. (2014). Thadchanamoorthy *et al.* (2012) observed that the amount of moisture, ash, EE, NDF and ADF % content in sprouted maize were 73.93, 3.09, 6.42, 29.27 and 10.16 %, respectively. The CP (37.26), moisture (90.54) and ash (3.41) % content in hydroponic sesbania sprouted fodder is higher than the value 16.54, 73.93 and 3.09 % of hydroponic maize sprouted fodder but EE (3.71%) content in hydroponic sesbania sprouted fodder is lower than the value (6.42%) of hydroponic maize sprouted fodder reported by Thadchanamoorthy *et al.* (2012). The NFE (48.41 %) content in hydroponic sesbania sprouted fodder is lower than the value (75.32 %) of hydroponic maize sprouted fodder reported by Naik *et al.* (2014). No literature is available for the discussion of nutritional composition of sesbania. The differences observed in the nutritional composition of hydroponic maize and sesbania sprouted fodder observed in the present study could be attributed to the difference in moisture levels in the fodder and methods adopted in production of hydroponic maize sprouted fodder.

In the present study, the highest live weight gain (20.61) and final live weight (2.832) was observed in T_2 group supplemented with 90% CPF + 10% hydroponic sprouted fodder (80% maize and 20% sesbania) than T_1, T_3 and T_4. This variation in live weight gain may be due to the differences in the levels of hydroponic sprouted fodder supplementation to the turkey. Most of the studies performed by feeding hydroponic sprouted fodder to animals showed similar results with our study. Gebremedhin (2015) also reported that highest live weight gain was found in Konkan Kanyal goats fed with Finger millet straw 60% and 40% hydroponic maize fodder. Deveder and Kumari, (2016) observed that 50% replacement of concentrate mixture with hydroponic barley fodder had significantly improved the average daily weight gain and live weight gain of ram lambs. Mysaa Ata, (2016) revealed that hydroponic sprouted barley fodder had a positive effect on feed intake, final live weight, total gain, average daily gain, and FCR on lambs fed hydroponic sprouted barley diet when compared to lambs fed the control diet and also revealed that hydroponic sprouted barley fodder can be used as feed for lambs in the fattening period to enhance their growth performance. Moreover, a study performed by Fayed, (2011) on the effect of feeding barley grains that sprouted rice straw on performance of growing Barki lambs showed enhancement of those lambs growth performance. The higher performance in the live weight gain of lambs supplemented with hydroponic fodder in this experiment could be due to the ability of the hydroponic barley to supply necessary nutrients. Naik *et al.,* (2014) reported that hydroponic sprouts is rich sources of bioactive enzymes and may contain ingredients that improve the performance of livestock. Tudor *et al.* (2003) found that the increase in live weight gain of lambs offered barley sprouts may reflects the effect of microbial activity in the rumen. Similar researchers also noticed that maize hydroponic fodder has been reported to improve the performance of birds and animals up to 8%. Moreover, feeding hydroponic barley mixed with poor quality hay to drought master steers gained more by 1.01 kg/head/day when compared to steers fed concentrate diets (Muhammad *et al.,* 2013; Tudoe *et al.,* 2003). Feed intake was not affected by feeding ewes at different levels of hydroponic sprouted barley reported by Shtaya (2004). Cuddeford (1989) described some possible advantages of hydroponic sprouts fed to horses. On the other hand, Morgan *et al.,* (1992) found that pigs fed 4-day-old sprouts gained significantly less weight than those fed barley grain. In our study, a positive effect of feeding hydroponic maize and sesbania sprouted fodder at 10% level to turkey was shown, which reflects that this type of feed might be a great benefit to farmers for increasing profit from the turkey meat industry.

The present study also revealed that hydroponic fodder had effect on feed intake of turkey. Highest average feed intake (DM basis) was found in dietary treatment groups $T_{4,}$ T_3 and T_2, respectively than control group (T_1). The present results related with the result of Gebremedhin, (2015) who reported that feeding hydroponically grown barley fodder for growing goats increased total DM intake, FCR, and live weight gain when compared to goats fed concentrate diets. Feed conversion efficiency (FCE) in turkey was differed between the turkey of control group T_1 (5.26), T_2, T_3 and T_4 (4.03, 4.34 and 4.65). Highest FCE was observed in the control group (5.26) and lowest as well as best FCE was observed in the turkey group fed hydroponic sprouted fodder at 10% level replaced with commercial concentrated feed (4.03). This result was found most probably due to the increased live weight gain by feeding hydroponic sprouted fodder at 10% level replaced with commercial concentrated feed in turkey groups. Other dietary treatment groups T_3 and T_4 (4.34 and 4.65) had also better FCE than control group T_1 (5.26). The present result supports the result of Weldegerima Kide *et al.* (2015) who concluded that feeding of hydroponically sprouted maize and barley fodder up to 40 % substitution (DMI) increased the digestibility of nutrients, better FCE and live weight gain of growing goats. Intissar and Eshtayeh, (2004) also reported that using sprouted barley grains with olive cakes that was fed to ewes gave highest FCE results when compared to ewes fed the control diets and that might be due to the higher crude protein and energy contents of the hydroponic barley diet which provided absorbable nutrients and also enhancing the treated straw nutrients utilization. Naik *et al.* (2014) reported that FCR in terms of DM, CP and TDN were better in lactating cows fed hydroponic maize fodder as compared to the control. The slightly improved efficiency observed in lactating graded Murrah buffaloes fed rations supplemented with hydroponic maize fodder might be attributed to the higher digestibility of hydroponic maize fodder which may be due to the tenderness of fodder (Naik *et al.,* 2014) or high enzyme activity in 7- day- old hydroponic sprouted maize fodder (Chavan and Kadam, 1989). Further, it is reported that the hydroponic sprouts are rich source of nutrients and contain a grass juice factor that improves the performance of livestock (Finney, 1982). But, Reddy *et al.* (1988) also revealed that the DM required per kg milk production decreased by 11.6% in milch cattle when fed rations containing artificially grown fodder.

Under this study, the lower cost of feed observed in dietary treatment groups $T_{2,}$ T_3 and T_4 than (T_1) control group. But the total revenue per bird was higher in T_2 than $T_{1,}$ T_3 and T_4. Feeding hydroponic maize and sesbania sprouted fodder at 10% level replaced commercial concentrate feed reduce the production cost of farm. It study conducted by Rahim, (2015) when hydroponic barley can be used as feed for lactating sheep as cost of feed can be reduced by 42%. Chinnam Harish Khannab (2015) revealed that the average cost of feed/kg 6% fat corrected milk (FCM) of lactating buffaloes in the control and treatment groups were 15.28 and 15.15, respectively. The lower cost of feed/kg 6% FCM observed in the treatment group was due to increased average 6% FCM per day although higher cost was involved in the production of hydroponic maize fodder (16.80/- per 7 kg) as compared to farm made concentrate mixture (15.24/- per kg). However, higher feed cost per kg milk production with hydroponic fodder was also reported earlier due to higher costs involved in hydroponic fodder production (Naik *et al.*, 2014; Reddy *et al.*, 1988). However, Naik *et al.* (2014) observed that there was higher net profit of Rs. 12.67/- per cow/d on feeding hydroponic maize fodder (HMF). The cost of the feed /d and feed cost per kg milk production was higher in the hydroponic sprouted fodder treatment (T-HF) group (Rs. 144.88 and Rs. 34.98) than the conventional fodder treatment (T-CF) group (Rs. 137.51 and Rs. 33.69). The hydroponics maize fodder cost is higher (Rs. 4/kg) than the conventional green fodder (Rs. 1.50/kg) might be the reason for higher cost of the feed in the T-HF group than T-CF group. It was concluded that feeding of HMF to lactating cows increased the digestibility of nutrients and milk production leading to increase in net profit.

In conclusion, growing of maize and sesbania fodder hydroponically in a semi-intensive hydroponic unit saved water, labour and shown a sizeable increment in nutrients such as fresh fodder weight, CP, EE, NFE. Therefore, growing of hydroponic maize sprouted fodder proved improved nutrient content with less water, less space used and cost effective. Hydroponic sprouted fodder at 10% level can replace commercial concentrate feed in turkey ration as a part of total mixed rations had no negative effects on growth performance of turkey. However, significant reduction in feed cost can be achieved when feeding rations incorporated with hydroponic sprouted maize and sesbania fodder. In the area especially in city and town where land is not available for fodder production, turkey production can be profitable by producing fodder hydroponically in the roof of building.

CHAPTER VI

SUMMARY AND CONCLUSION

It is crying need to find out the alternative animal protein source to meet up the increasing protein demand of the large-scale population of Bangladesh. The farmers cannot afford to rear cattle and goat but can easily rear poultry. But the poultry industry (specially, commercial broiler and layer) is in the line to be destroyed due to severity of avian influenza (bird flu). In this case, turkey production is important and highly profitable agricultural industries which have a rising global demand for its products and they are adaptable to wide range of climatic conditions. Turkey flourishes better under arid conditions, tolerates heat better ranges further, more disease resistance than broiler and layer, and has higher quality meat. Turkey is an unfamiliar poultry species to be reared for commercial purpose in Bangladesh; it has some limitations, including unavailability of their commercial concentrates supplement, high price of the substitute feed like pellet and low performance of the turkey in the poor diet. To overcome these limitations, the present study was conducted with the aims to investigate and establish a suitable turkey ration by using hydroponic sprouted maize and sesbania fodder in replacement with commercial concentrate feed to improve the growth performance of turkey. Therefore, the experiment was carried out in Advance Animal Research Farm of the Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh. A total of 48 of eight weeks old turkeys were divided randomly into four dietary treatment (T_1, T_2, T_3, T_4) groups and each groups having 3 replications, each replication contains 4 birds. T_1 considered as control and fed with only commercially concentrate feed and T_2, T_3 and T_4 denoted the turkey groups fed the diet comprising of 90, 70 and 60% commercially concentrate feed (CCF) and 10, 30, 40% hydroponic sprouted fodders, respectively. Where, the ratio of maize and sesbania sprouted fodder were 80 and 20, 70 and 30, 60 and 40%, respectively. Also this experiment was aimed to identify the nutritional composition and economic value of hydroponic maize and sesbania sprouted fodder. The moisture, DM, ash, OM, CP, CF, EE and NFE (%) content of hydroponic sprouted maize fodder was 85.21, 14.79, 2.50, 97.5, 10.92, 5.30, 2.94 and 78.34%, respectively. The moisture, DM, Ash, OM, CP, CF, EE and NFE (%) content of hydroponic sesbania sprouted fodder was 90.54, 9.46, 3.41, 96.6, 37.26, 7.21, 3.71 and 48.41%, respectively. The ash, CP and CF (%) were significantly higher ($P < 0.01$) in hydroponic sesbania than maize sprouted fodder but the NFE (%) was significantly higher ($P < 0.01$) in hydroponic maize than sesbania sprouted fodder. The results revealed that dietary supplementation of hydroponic maize and sesbania sprouted fodder replaced by commercial concentrate feed increased live weight in T_2 (2.83) than T_1, T_3 and T_4 (2.64, 2.39 & 2.09), respectively, live weight gain T_2 (20.61) than T_1, T_3 and T_4 (18.39, 15.55 & 12.07), respectively and highest FCE observed in T_1 (5.26) and lowest as well as best FCE observed in T_2 (4.03) group of turkey. On the other hand, the results of cost effective analysis was significantly higher in T_2 than other T_1, T_3 and T_4 dietary treatment groups. In conclusion, the feeding of hydroponic maize and sesbania sprouted fodder at 10% level in replacement with commercial concentrate feed of turkey acts as an improving tool on growth performance of turkey and also reduce cost of feed and reduce total cost of production ultimately increase net farm income.

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