

Competitive Research Grant

Sub-Project Completion Report

on

**Dietary effect of hydroponic sprouted fodder on
turkey production in Bangladesh**

Project Duration

July 2017 to September 2018

**Dept. of Animal Science and Nutrition
Hajee Mohammad Danesh Science and Technology University
Dinajpur-5200**



**Submitted to
Project Implementation Unit-BARC, NATP 2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215**



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Citation

Dietary effect of hydroponic sprouted fodder on turkey production in Bangladesh
Project Implementation Unit
National Agricultural Technology Program-Phase II Project (NATP-2)
Bangladesh Agricultural Research Council (BARC)
New Airport Road, Farmgate, Dhaka – 1215
Bangladesh

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National Agricultural Technology Program-Phase II Project (NATP-2)
Bangladesh Agricultural Research Council (BARC)
New Airport Road, Farmgate, Dhaka – 1215
Bangladesh

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Acronyms

AI	:	Artificial insemination
ANOVA	:	Analysis of variance
Ca	:	Calcium
CCF	:	Commercial concentrate feed
CF	:	Crude fiber
cm	:	Centimeter
CP	:	Crude protein
d	:	Day
DCP	:	Dicalcium phosphate
DM	:	Dry matter
EE	:	Ether extract
FCF	:	Formulated concentrate feed
FE	:	Feed efficiency
g	:	Gram
h	:	Hour
HSF	:	Hydroponic sprouted fodder
M	:	Maize sprouted fodder
ME	:	Metabolizable energy
NFE	:	Nitrogen free extract
NM	:	Natural mating
OM	:	Organic matter
P	:	Phosphorus
SEM	:	Standard error of the mean
S	:	Sesbania sprouted fodder
W	:	Wheat sprouted fodder
Wm	:	Mineral treated wheat sprouted fodder

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Executive Summary

The study was undertaken with the objectives to know the nutrient composition of the different hydroponic sprouted fodders (maize, wheat and sesbania) and to investigate the effect of dietary supplementation of hydroponic sprouted wheat fodder on productive and reproductive performances with the economic sustainability of turkey production in Bangladesh. On station research approaches were followed as *modus operandii* for implementing the study. A total of four experiments on the dietary effects of hydroponic sprouted fodders were conducted for this study. The experiments included: Effects of legume and non-legume sprouted fodder on growth performances (Experiment I), Effects of wheat sprouts on growth performances of young turkey (Experiment II), Effects of mineral treated wheat sprouts on growth performances of grower turkey, and the Effects of mineral treated wheat sprouts on reproductive performances of turkey (Experiment IV). Each experiment included five treatments with different levels of sprouted fodders [T₁= control with 100% commercial concentrate feed (CCF), T₂= 95% CCF with 5% hydroponic sprouted fodder (HSF), T₃= 90% CCF with 10% HSF, T₄= 85% CCF with 15% HSF and T₅= 80% CCF with 20% HSF]. In case of the experiment IV however, instead of the CCF formulated concentrate feed (FCF) was used for all the treatment groups. The results revealed that the supplementation of hydroponic sprouted fodder up to 15% (under T₄ group) with the required amount of concentrate feed met with better performances in terms of live weight gain (12 gm/day at 25-33 weeks of age) and the age at 1st laying (29 weeks) in turkey without hampering the reproductive performances such as fertility and hatchability. A total of seven concentrate rations were formulated for different age groups of turkey (0-4, 4-8, 8-12, 12-16, 16-20, 20-24 weeks old and breeding hen) that could be used for the heritage type of turkeys available in Bangladesh. The cost benefit analysis for productive and reproductive performances of turkey fed on different levels of supplementary hydroponic sprouted wheat fodder revealed that the net farm income, profitability index, rate of return on investment and capital turnover were significantly higher in case of T₄ group of turkey (fed with 15% hydroponic sprouted wheat fodder supplemented ration) than the other treatment groups. It was therefore finally recommend that up to 15% hydroponic sprouted wheat fodder may be used for economic turkey production in Bangladesh.

CRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. Title of the CRG sub-project:

Dietary effect of hydroponic sprouted fodder on turkey production in Bangladesh

2. Implementing organization:

Hajee Mohammad Danesh Science and Technology University

3. Name and full address with phone, cell and E-mail of PI/Co-PI (s):

Dr. Ummay Salma

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4. Sub-project budget (Tk):

4.1. Total: 18,00,000/- (Eighteen lakh only)

4.2. Revised (if any): 1868855/- (RPA =1692182/-; GOB = 176673/-)

5. Duration of the sub-project:

5.1. Start date (based on LoA signed): 13 July 2017

5.2. End date: 30 September 2018

6. Justification of undertaking the sub-project:

Turkey is an important poultry species named *Meleagrisgallopavo* of the Family Meleagrididae. Turkey was domesticated probably first in Mexico and then disseminated in Europe and America. There are different breeds of turkey and the most traditional breeds are Norfolk Black, Mammoth Bronze, Broad Breasted Bronze and Modern White Turkeys. Weight and size of turkeys vary on the basis of breed and variety. However, medium size stags weigh 7-8 kg and hens 4-5 kg, whereas large size stags weigh 20-22 kg and hens 15-18 kg. In some countries eating turkey meat is a tradition, for example in UK during Christmas and in USA in Thanks giving Day. Turkey is reared mainly to meet up the requirement of meat. Turkey attains sexual maturity at 30 weeks of age. Hens have 25 weeks laying cycle and could lay 95-100 eggs in a laying cycle. Turkeys are adaptable to a wide variety of climatic conditions and can be raised successfully almost anywhere in the world if their nutritional requirements are met and protection is provided against diseases, predatory animals, and adverse weather conditions. Turkey is a newly introduced poultry species in Bangladesh. A large number of farmers are rearing turkey with a limited extent without having prior experience. They are importing day-old turkey chicks (Poult) from different countries, especially from India. Its popularity is increasing gradually because of gamey flavor of meat with lower fat content. Turkey meat contains 3.9% while chicken meat and beef contain more than 8.0% and 15.5% fat respectively, (USDA, 1975).

Turkey is well known as good forager. However, presently turkey farmers specially in the cities and towns, have to completely depend on commercial concentrated feed that incurs high feeding cost. So, it was thought that an alternative way of partial replacing the expensive concentrate feed with sprouted

fodder may lower the feeding cost that in turn may help to expand the turkey farming in the cities and towns in Bangladesh. Hydroponically-sprouted fodders are rich in carbohydrate, protein, vitamins (E, A, C and B complex) and minerals (Se, Zn, Cr, etc.) that are essential for reproductive health of animals (Dung *et al*, 2010; Fazaeli *et al*, 2012). It is now emerging as an alternative technology to grow fodder for farm animals. Hydroponic fodder cultivation follows the vertical production system, which may reduce the pressure on croplands. One kg of un-sprouted seed yields 8-10 kg of green forage in 7-8 days (Sneath and McIntosh, 2003; Naik *et al*, 2013; Reddy, 2014; Anonymous, 2015; FAO, 2015; Kamanga, 2016). The hydroponic maize fodder yield on fresh base is 5-6 times higher than that obtained in a traditional farm production, and is more nutritious (Naik *et al.*, 2014).

Therefore, the sub-project was proposed with the objectives mentioned below. The study hypothesized that a feeding model of hydroponic sprouted fodder for turkey production might be developed and that would be practiced by the turkey farmers specially from the cities and towns, in Bangladesh.

7. Sub-project goal:

- i) To introduce turkey as a promising poultry species, and its meat as an alternative protein source in Bangladesh
- ii) To encourage small-scale turkey farming through hydroponic sprouted fodder cultivation specially in cities and towns

8. Sub-project objective (s):

- i) To determine the nutrient composition and biomass yield of hydroponic sprouted fodders
- ii) To investigate the dietary effect of hydroponic sprouted fodder on productive and reproductive performances of turkey
- iii) To study the economic sustainability of hydroponic sprouted fodder on turkey production

9. Implementing location (s):

Turkey Research Unit, Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200

10. Methodology in brief:

The study was conducted at the Turkey Research Unit of the Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh. The study lasted for 12 months from August 2017 to September 2018 as describe below.

10.1 Determination of nutrient composition and biomass yield of hydroponic sprouted fodders

Maize and sesbania seeds were obtained from the local market of Dinajpur and wheat from Wheat Research Institute, Dinajpur. The seeds were subjected to germination test to check for their viability before using; the result of the germination test was >80%. Seeds were cleaned from debris and other foreign materials. The dead and broken seeds were removed and treated with anti-fungal substance (Provax, Arysta Life Science, USA; supplier Hossain Enterprise C C Ltd.). Planting trays were also cleaned and disinfected. The seeds were washed well from residues of fungicide and presoaked in tap water overnight (about 12 hours). Seeds were kept under anaerobic condition in a dark environment for better germination before planting. The germinated seeds of hydroponic sprouted fodder were spread uniformly in the planting trays (2'x2' for maize and 1'8"x1'2" for wheat); two trays each for the maize, sesbania and wheat were used. The seeding rates used in this experiment were about 350 g of maize,

175 g of sesbania and 250 g of wheat per tray. Trays were irrigated four times in a day with mineral solutions A & B as shown in Table 1 using water sprayer.

Table 1. Composition of mineral Solution-A and Solution-B used for production of hydroponic sprouted fodder

Mineral Solution-A		Mineral Solution-B	
Ingredients	Amount (g)	Ingredients	Amount (g)
Calcium nitrate (Ca(NO ₃) ₂ .H ₂ O)	100.00	Potassium hydrogen phosphate (KH ₂ PO ₄)	27.00
Ammonium nitrate (NH ₄ NO ₃)	1.44	Magnesium sulfate (MgSO ₄ .7H ₂ O)	51.20
Potassium nitrate (KNO ₃)	16.73	Manganese sulfate (MnSO ₄ .4H ₂ O)	0.60
Iron EDTA (3.8 g Iron EDTA Sprint)	8.00 (10% EDTA)	Copper sulfate (CuSO ₄ .5H ₂ O)	0.035
		Zink sulfate (MnSO ₄ .4H ₂ O)	0.044
		Sodium molybdate (Na ₂ MoO ₄ .2H ₂ O)	0.0023
		Boric acid (H ₃ BO ₃)	0.18
Water (ml)	1000	Water (ml)	1000

Source: Bangladesh Council of Scientific and Industrial Research, Dhaka-1205, Bangladesh

After 7 days from seeding for maize and wheat and 4 days for sesbania (as after 4-5 days their stems were laid down, data not shown) the total fresh and dry sprouted fodder yields were recorded. The ratio of produced sprouted fodder as against the initial planted seed weight was then calculated and sent for chemical analysis. Dry matter (DM), organic matter (OM), ash, crude protein (CP), crude fiber (CF) and ether extract (EE) of maize, wheat and sesbania were determined by proximate analysis following the methods of AOAC (2007) at Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka.

10.2 Investigation on the dietary effects of hydroponic sprouted fodder on the productive and reproductive performances of turkey

Investigation on the dietary effects of hydroponic sprouted fodder on the productive and reproductive performances of turkey was conducted involving 4 experiments. Each experiment included 5 treatment groups (T₁, T₂, T₃, T₄, and T₅ for the 5 experimental diets) as detailed up below in table 2 for the experimental layout.

Table 2. Experimental layout for investigation on the dietary effects of hydroponic sprouted fodder on the productive and reproductive performances of turkey

Item/Factor	Experiment. I	Experiment. II	Experiment. III	Experiment. IV
Sub-Title	Dietary effects of legume and non-legume hydroponic sprouted fodder on growth performance	Dietary effects of hydroponic wheat sprouts on growth performance of young turkey	Dietary effects of mineral treated hydroponic wheat sprouts on growth performance of grower turkey	Dietary effects of mineral treated hydroponic wheat sprouts on reproductive performance of turkey
No. of Turkey (age in weeks)	50 (8 weeks old)	75 (8 weeks old) (with another new stock)	50 (16 weeks old) (Same stock from the Expt. II)	45 (6 female + 3 Male in each group);(24 weeks old) (Same stock from the Expt. III)
Treatment groups	5 (T ₁ , T ₂ , T ₃ , T ₄ , T ₅) (10 turkeys in each group)	5 (T ₁ , T ₂ , T ₃ , T ₄ , T ₅) (15 turkeys in each group)	5 (T ₁ , T ₂ , T ₃ , T ₄ , T ₅) (10 turkeys in each group)	5 (T ₁ , T ₂ , T ₃ , T ₄ , T ₅) (9 turkeys in each group)
Replication of treatments	5 (2 turkeys in each group)	5 (3 turkeys in each group)	5 (2 turkeys in each group)	3 (3 turkeys in each group) Female : Male= 2:1
Experimental diets	T ₁ = 100% CCF T ₂ = 95% CCF + 5% HSF (80% M & 20% S) T ₃ =90% CCF +10% HSF (70% M & 30% S) T ₄ =85% CCF + 15% HSF (60% M & 40% S) T ₅ =80% CCF + 20% HSF (60% M & 40% S)	T ₁ = 100% CCF T ₂ = 95% CCF + 5% HSF (W) T ₃ =90% CCF +10% HSF (W) T ₄ =85% CCF + 15% HSF (W) T ₅ =80% CCF + 20% HSF (W)	T ₁ = 100% CCF T ₂ = 95% CCF + 5% HSF (Wm) T ₃ =90% CCF +10% HSF (Wm) T ₄ =85% CCF + 15% HSF (Wm) T ₅ =80% CCF + 20% HSF (Wm)	T ₁ = 100% FCF T ₂ = 95% FCF + 5% HSF (Wm) T ₃ =90% FCF +10% HSF (Wm) T ₄ =85% FCF + 15% HSF (Wm) T ₅ =80% FCF + 20% HS (Wm)
Duration (age in weeks)	12 weeks (8-19 weeks old)	8 weeks (9-16 weeks old)	7 weeks (18-24 weeks old)	6 weeks (30-35 weeks old)
Remarks	<i>The Expt. I. couldn't be continued up to laying period due to the Newcastle disease outbreak, most probably due to the low potency of vaccine.</i>	<i>The stock was purchased again and the experiment was conducted with wheat sprouts only.</i>	<i>The experiment has been continued with mineral treated hydroponic sprouted fodder to study the growth performance of turkey.</i>	<i>The experiment has been continued with mineral treated hydroponic sprouted fodder to study the reproductive performance of turkey</i>
Notes: CCF=Commercial concentrate feed, HSF=Hydroponic sprouted fodder, M=Maize sprouted fodder, S=Sesbania sprouted fodder, W=Wheat sprouted fodder, Wm=Mineral treated wheat sprouted fodder and FCF=Formulated concentrate feed.				

Experimental birds and general management practices

Birds were housed in proper hygienic condition, where proper lighting, ventilation and heating arrangement were insured. Before starting the experiment(s), 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 sprouted fodder was determined on the basis of DM requirement supplied to the turkeys except control group. Feed and sprouts were supplied two times in a day; in the morning between 8:30 to 9:00 AM and in the afternoon between 3:30 to 4:00 PM. To ensure freshness, sprouts were supplied directly from the sprout 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 birds were vaccinated as per turkey vaccine schedule (at day old: ND; at 5 wk: Fowl Pox; at 6 wk: ND and at 8 wk: Cholera vaccine and prior to laying period: ND). The experimental lighting schedule was 16 h light and 8 h dark. Following measures were taken during the experimental period to prevent diseases. All the birds involved in the experiment were treated equally in all respects, except for supplying the amount of concentrate feed and hydroponic sprouted fodder. Turkeys of all dietary treatment groups were fed with isocaloric and isonitrogenous diet. Broiler starter feed (as turkey needs high protein content diet) manufactured by Aftab Bahumukhi Farms Limited, Bangladesh (Table 3 a), was fed to the turkeys of all dietary treatment groups (except *Expt. IV*, where own formulated concentrate feed was provided). The commercial concentrate pellet 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 compositions of the formulated rations are shown in Table 3 b. Initial live weight of each bird was recorded just prior to grouping. The birds were then kept into separate bamboo-made chambers where the birds were reared on slatted floor with deep litter. Live weight was recorded at 7 days interval and daily feed intake, etc. were recorded up to 25 weeks of experimental periods.

Table 3 a. Nutritional composition of commercial broiler starter feed

Nutrients	Amount (5%)
Moisture	12.00
Crude protein (CP)	22.00
Crude fat (CF)	5.00
Calcium	0.90
Av. Phosphorus	0.40
Metabolizable Energy (ME, Kcal/kg)	3100

Source : Aftab Bahumukhi Farms Limited, Bangladesh; ingredient composition was not available due to the company's business secrete.

Table 3 b. Nutritional composition of formulated rations or formulated concentrate feed (FCF)

Items	Amount (kg/100 kg) in Turkey ration at different age (week)						
	0-4	4-8	8-12	12-16	16-20	20-24	Layer
Ingredient Composition							
Maize	41	45	52	56	66	68	58.5
Corn gluten meal (CGN)	10	12	10	7	8	7	3
Rice polish (Auto)	10	10	10	10	7	8	10
Wheat bran	6	6	6	6	6	7	6
Soybean meal (44)	18	18	18	16.5	8	5	10
Vegetable Oil	0	0	1	3	3	3	3
DCP	0.5	0.5	0.5	0.5	0	0	0.5
Meat & Bone meal (45)	1.5	1.5	1	1	1	1	1.5
Protein Con. (Pro-pak)	13	7	1.5	0	0	0	0
Lime stone	0	0			1	1	7.5
Vit-mineral premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lycine	0.1	0.1	0.1	0.1	0.1	0.1	0.1
DL-Metheoinine	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Common Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total amount	100	100	100	100	100	100	100
<i>Total price (Tk/kg)</i>	<i>36.99</i>	<i>31.09</i>	<i>26.91</i>	<i>27.02</i>	<i>29.94</i>	<i>28.90</i>	<i>27.75</i>
Nutrient composition							
Total ME (kcal/kg)	2833	2904	3004	3116	3208	3215	2915
Total CP (%)	28.18	26.16	22.02	19.00	16.5	15.05	14.25
Total Ca (%)	0.32	0.32	0.27	0.27	0.50	0.50	3.08
Total P (%)	0.51	0.53	0.51	0.51	0.36	0.36	0.51

Semen collection and dilution

At the age of twenty six (26) weeks all the toms were trained for semen collection using the abdominal massage technique as described by Burrows and Quinn (1937). The researcher (MS research fellow) himself collected semen every week at the same time, and under the same conditions to minimize stress and maximize the quality of semen. Semen was collected once in a week in the afternoon before insemination. The procedure of semen collection is mentioned bellow:

- i) To start massaging the left hand was placed on the back of the tail and the right hand on the ventral part of the tail or rear part of the abdomen.
- ii) The tom was stimulated by stroking the abdomen and pushing the tail upward and toward the bird's head with the right hand.
- iii) The tom responded and the copulatory organ enlarged and partially protruded from the vent. If the copulatory organ had not protruded, it seemed that the tom was probably not sexually responsive yet and needs more time and massage.
- iv) When tom responded and the copulatory organ exposed, the left hand was placed at the cloaca with the forefingers. At the same time the right hand was used to provide inward and upward pressure beneath the cloaca until the semen was discharged.
- v) The semen was then squeezed out by a short, sliding, downward movement of the left hand and an upward pressure of the right hand. Care was taken so that copulatory organ was not touched and harmed during collection. A tom usually produced an amount of 0.11 to 0.23 ml semen per collection.
- vi) After each collection, the semen was examined visually. Semen with milky appearance and free of fecal materials was collected into plastic conical tubes.
- vii) Special care was taken to avoid contamination of semen with feces, urates, and transparent fluid, which lower the semen quality.

- viii) Semen was used within 30 minutes of collection. Collected semen from 5 males was pooled in an equal amount according to required semen volume to eliminate the effect of individual variability of gamete donors.
- ix) Semen was diluted using semen diluent (Table 3 c) at the ratio of 1:2 and kept in a water bath at 37°C before using for AI.

Table 3 c. Composition of the semen diluent

Ingredients	Amount
Sodium chloride (g)	9.5
Potassium chloride (g)	0.2
Calcium chloride (g)	0.26
Sodium bicarbonate (g)	0.2
Distilled water (liter)	1
Glucose (g)	1

Artificial insemination (AI)

The females were inseminated by “venting” as described by Hafez (1985). Venting was done by applying pressure to the left side of the abdomen around the vent in such a way that it causes the cloaca to come out and the oviduct to protrude. Then a plastic syringe with 0.02 ml semen was inserted into the oviduct and semen was delivered. AI was made once in a week between 15:00 to 16:00 hours to avoid the presence of a hard shelled egg in the uterus. Insemination was done at the depth of 1.5 cm to 2 cm of vent.

Data collection

Data on egg production, egg weight, fertile and infertile egg, early embryonic mortality, late embryonic mortality, survivability of poults were recorded according to following procedures.

Egg collection and calculation

Laying nest with the dimension of 24 inches wide, 24 inches deep and 24 inches tall were placed in each pen for hens. The front edge of nest was made 6-8 inches tall so that the bedding materials stayed in place and eggs did not roll out of the box. At the beginning of the laying period, some hens did not lay eggs in the nest boxes, rather laid on the floor. However, the eggs were duly collected from the floor and recorded properly. Production of floor eggs was reduced gradually.

Eggs were collected 3 times daily. Collected eggs were marked according to treatment with date. Eggs were stored in egg crates, placed in a cooler at approximately 15°C temperature and 75% relative humidity prior to incubation. After collection eggs were sorted out to remove cracks, extra small and large ones. Egg weight was recorded once a week.

Treatment wise both egg production and mortality were taken into account to measure egg production percent. The laying rate was calculated as the number of eggs divided by hen days during a production period and expressed as a percent, *i.e.* hen day egg production (HDEP) method was used to calculate egg production percent because, it is mostly used for the scientific studies and truly reflects the production capacity of the available birds in the house. Following formula was used for egg production calculation.

$$\text{Egg production} = \frac{\text{Total number of eggs laid during the period}}{\text{Total number of hendays in the same period}} \times 100$$

Incubating, candling and hatching of eggs

Eggs with standard size were selected for incubation in every week. The incubator used for incubating the eggs was a locally made one which was used for incubating duck eggs for many years. This was a forced-air incubator which had a built in fan to circulate the air. The set eggs were candled on the 10th and 25th day of incubation. Proper cleaning, disinfection and fumigation were conducted before setting of eggs. Following temperature and humidity were maintained during incubation period:

- i) Setting Temperature: 38°C up to 25 days of incubation
- ii) Hatching Temperature: 37°C from 26-28 days of incubation
- iii) Setting Relative Humidity: 60% up to 25th day of incubation
- iv) Hatching Relative Humidity: 65-70% from 26-28 days of incubation.

Eggs were turned five times a day until the last 3 days before hatching. At 26th day, eggs were transferred from setting tray to hatching tray. During the hatching period, the humidity in the incubator was increased by spraying a small amount of water. The temperature of the added water was maintained same as that of the incubator so that no stress occurred on the eggs.

During candling it was observed whether the embryo was located in the large end of the egg, where blood vessels radiate under the surface of the shell. In case of fertile eggs the embryo appeared as a dark spot that became larger as incubation progressed when mainly a dark mass and the air cell were seen. Infertile eggs on the contrary, transmitted light brightly. At the end of incubation period (28 days) the eggs after candling, were classified and recorded as follows:

- i) *Fertile eggs*: During candling these eggs showed well defined blood vessels.
- ii) *Infertile eggs*: Eggs were clear and containing milky white albumen, no embryo or brownish albumen.
- iii) *Early embryonic death*: Eggs showed a small dark area and disrupted blood vessels. These embryos developed for several days and then died. Often deteriorating blood vessels appeared as a dark ring around the eggs. These embryos were without visible formation of eyes.
- iv) *Late embryonic death*: Embryos were without movement but with large black eyes, breakdown of the blood vessels and lack of feather formation.
- v) *Dead in shell*: Death occurred at the end of the incubation process because of difficult positioning for pipping, inability of absorbing the yolk sac and transmitting of breathing air.

All dead embryos were considered as fertile. Hatched poults were collected, counted and weighed using an electronic scale.

Reproductive performance measurement

Fertility and hatchability were calculated using following formulae:

The fertility levels of each treatment flock was calculated as outlined by Sotirov *et al.* (2002) and recorded in percent:

$$\text{Fertility} = \frac{\text{Number of fertile eggs}}{\text{Number of eggs set}} \times 100$$

The hatchability levels per treatment was calculated as outlined by Hafez (1985) and Wilson (2008) and recorded in percent:

$$\text{Hatchability} = \frac{\text{Number of poults hatched}}{\text{No. of fertile egg at candling}} \times 100$$

10.3 Economic sustainability of feeding hydroponic sprouted fodder

To determine the economic sustainability cost benefit analysis of turkey production on the diet supplemented with hydroponic sprouted fodder was made in BDT and on the basis of market price during the experimental period of financial year, 2017-18. The profitability index, rate of return on investment, depreciation cost and capital turnover were calculated using the following formulae:

Profitability index

Profitability index (PI) means the net farm income (NFI) per unit of gross revenue (GR) and the ratio was calculated as follows: $PI = \frac{NFI}{GR}$

Rate of return on investment (RRI)

Rate of the 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 was calculated using the following equation:

$$RRI = \frac{NFI}{TC}$$

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

Depreciation cost

Depreciation cost was measured using the following equation:

$$\text{Depreciation cost} = \frac{\text{Purchase price}}{\text{Number of useful years of the asset}}$$

Capital turnover (CTO)

Capital turnover was measured using the following equation:

$$CTO = \frac{TR}{TC}$$

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

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±SEM. Differences were considered significant at level of P<0.01 and P<0.05.

11 Results and discussion:

11.1 Results:

11.1.1 Biomass yield and nutrient composition of the different sprouted fodders

Biomass yield and nutrient composition of hydroponic maize, sesbania and wheat (treated with minerals or not) sprouted fodder fed to the experimental turkey are presented in Table 4. The biomass yields of hydroponic wheat sprouted fodder were significantly ($P < 0.05$) higher than the biomass yields of maize or sesbania on fresh or DM basis. The percentage of dry matter (DM) and ash were higher ($P < 0.01$) in mineral treated or non treated hydroponic wheat sprouted fodder than maize or sesbania sprouted fodder. But, the highest content of crude protein (CP) and the lowest content of nitrogen free extract (NFE) were observed in sesbania compared to maize or wheat sprouted fodder. Whereas, the amount of organic matter (OM), ether extract (EE) and crude fiber (CF) did not differ significantly ($P > 0.05$) among the sprouted fodder. Therefore, the diet supplemented with hydroponic sprouted wheat fodder was chosen for further study on productive and reproductive performances of turkey.

Table 4. Biomass yield and nutrient composition of the different hydroponic sprouted fodders

Hydroponic Sprouted fodder	Biomass yield (kg/kg seed)		Moisture	DM	Ash	OM	% DM basis			
	Fresh	DM					CP	CF	EE	NFE
Maize	4.40 ±0.82 ^a	0.65 ±0.38 ^{ab}	85.21 ±8.22 ^{ab}	14.79 ±1.52 ^{ab}	2.50 ±0.02 ^a	97.5 ±11.02	10.92 ±1.12 ^a	5.30 ±0.02 ^b	2.94 ±0.04 ^a	78.34 ±7.02 ^b
Sesbania	4.56 ±1.01 ^a	0.43 ±0.26 ^a	90.54 ±9.95 ^b	9.46 ±1.01 ^a	3.41 ±0.03 ^{ab}	96.6 ±10.03	37.26 ±4.2 ^c	7.21 ±0.01 ^c	3.71 ±0.05 ^b	48.41 ±4.43 ^a
Wheat	6.26 ±1.56 ^b	1.17 ±0.62 ^b	81.36 ±9.24 ^a	18.64 ±1.04 ^b	4.09 ±0.02 ^b	95.91 ±11.01	18.10 ±3.01 ^b	3.40 ±0.04 ^a	3.29 ±0.04 ^{ab}	71.12 ±7.03 ^b
Minerals treated wheat	7.83 ±1.84 ^c	1.54 ±0.64 ^c	80.34 ±7.24 ^a	19.66 ±3.14 ^b	5.09 ±0.04 ^b	94.83 ±13.01	18.31 ±4.02 ^b	3.54 ±0.03 ^a	3.27 ±0.06 ^{ab}	70.22 ±6.03 ^b
Level of Significance	*	*	*	**	**	NS	**	**	*	**

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

11.1.2. Dietary effects of hydroponic sprouted fodder on the productive and reproductive performances of turkey

Effect of hydroponic wheat sprouted fodder on live weight and final live weight gain in turkey

Effects of dietary supplementation of hydroponic maize and sesbania sprouts (*Expt. I*), wheat sprouts (*Expt. II*) and mineral treated wheat sprouts (*Expt. III*) on live weight (g) and live weight gain (g/d) in turkeys are presented in Figure 1. The initial live weight of the turkey in different dietary treatment groups was almost similar. The results also express that there was no significant effect of feeding hydroponic wheat sprouted fodder on final live weight of turkey among the dietary treatment groups (T_1 , T_2 , T_3 and T_4) except T_5 group. The final live weight was decreased in the turkey fed with 20% hydroponic sprouted fodder. On the other hand, the live weight gain was almost similar in the turkeys of all groups except T_5 under the three experiments. This could be seen in Figure 1 under *Expt. I* that the

dietary treatment groups T₂ (827.4 g), T₃ (819.464 g) and T₄ (896.46 g) did not differ from control group T₁ (775.33 g) except T₅ (667.9 g) groups. The highest live weight gain (g/d) was found in T₄ group than those of the other groups. Better growth performance was observed during the initial period than the growing period.

Effect of hydroponic sprouted fodder on feed intake and feed efficiency (FE)

Daily feed intake (DM), and feed efficiency (FE) of turkey are shown in Figure 2. It was observed that average feed intake (g) were almost similar in the different dietary treatment groups of *Expt. I* and *II*, except for the T₅ group under *Expt. III*. However, feed efficiency of the turkeys in the different groups was almost similar except for the T₅ group in *Expt. I* and *II*, but in *Expt. III*, feed efficiency of the turkeys of T₃ and T₄ groups were better than that of the T₁ and T₅ groups. In *Expt. I*, the feed efficiency was also almost similar in T₁ (2.68), T₂ (2.60), T₃ (2.70), T₄ (2.78) and except T₅ (3.42) group fed 0, 5, 10, 15 and 20% hydroponic wheat sprouted fodder.

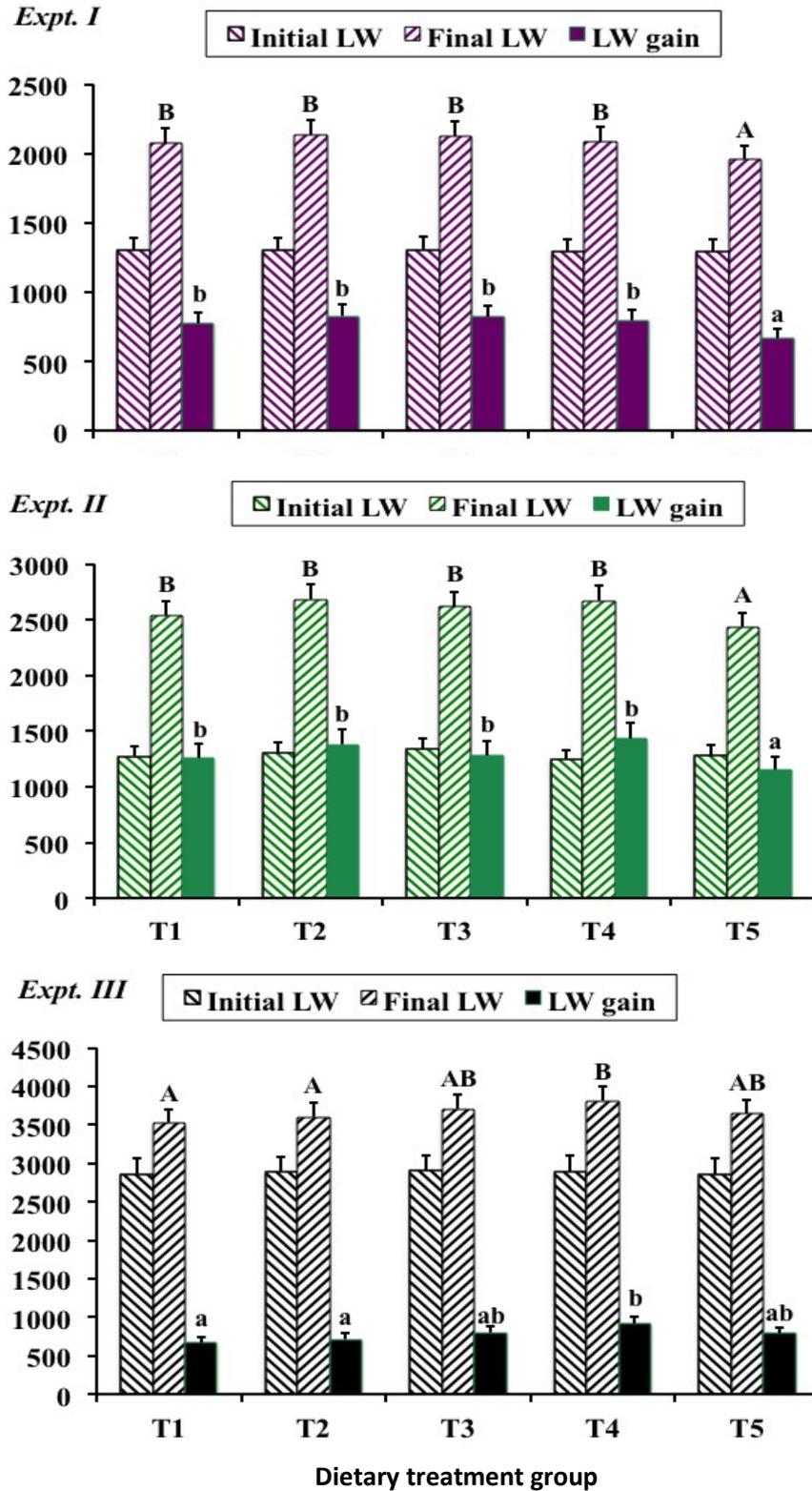


Figure 1. Effect of hydroponic maize and sesbania (*Expt. I*), wheat (*Expt. II*) and mineral treated wheat sprouted fodder (*Expt. III*) on live weight (g) and live weight gain (g) in turkey (Each bar with error bar represents Mean \pm SEM value. Differences were significant at 5% level ($P < 0.05$) of significance)

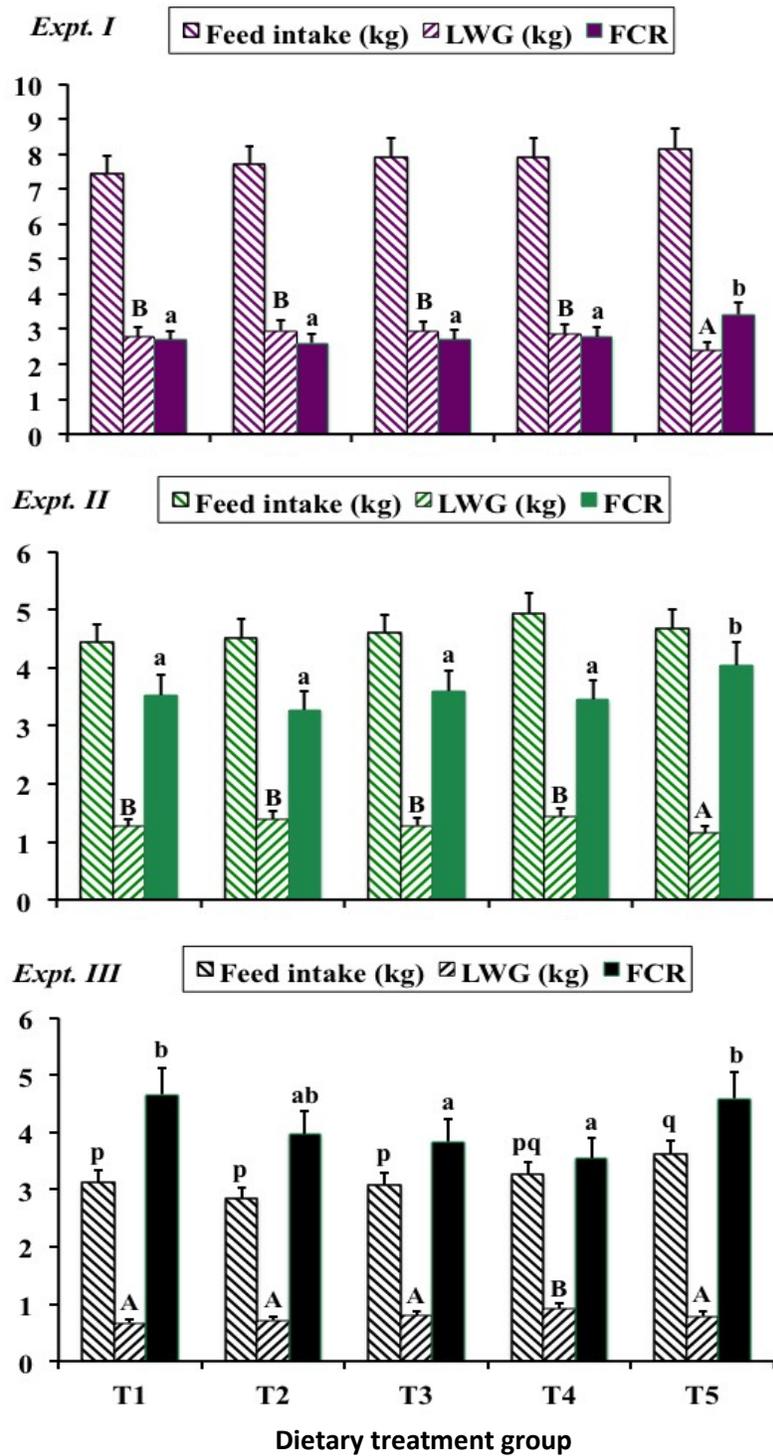


Figure 2. Effect of hydroponic maize and sesbania (*Expt. I*), wheat (*Expt. II*) and mineral treated wheat sprouted fodder (*Expt. III*) on feed intake (kg), live weight gain (kg) and feed efficiency in turkey (Each bar with error bar represents Mean \pm SEM value. Differences were significant at 5% level ($P < 0.05$) of significance)

Effect of mineral treated hydroponic wheat sprouted fodder on reproductive performance

Dietary effect of mineral treated hydroponic wheat sprouted fodder on egg quality parameters are shown in Table 5. The results show that the external and internal characters were not adversely affected in the groups of turkey due to the supplementation of different level of hydroponic sprouted fodder.

Effect of mineral treated hydroponic wheat sprouted fodder on performance of matured female turkey is shown in Table 6. The results revealed that the age at first laying and live weight gain (g/d, 25-33 wk) did not differ significantly ($P>0.05$) among the groups of turkey fed diet with the supplementation of different level of hydroponic sprouted fodder though comparatively better performances were shown in the turkeys fed diet supplemented with 15% hydroponic sprouted fodder. The feed efficiency (on egg production basis) was significantly ($P<0.05$) higher in T_4 group of turkeys fed diet supplemented with hydroponic sprouted fodder (15%) than the other groups.

Table 5. Egg quality measurement

Egg Traits	T₁	T₂	T₃	T₄	T₅
External character					
Egg weight (g)	70.54±0.23	68.98±0.20	68.87±0.21	68.59±0.22	68.45±0.22
Egg length (mm)	62.30±0.13	59.60±0.12	62.00±0.11	61.60±0.14	61.60±0.15
Egg width (mm)	45.20±0.07	43.60±0.09	45.40±0.08	44.20±0.07	44.20±0.08
Shape Index (%)	72.43±0.20	73.08±0.19	73.19±0.18	71.82±0.17	71.80±0.17
Egg surface area (cm ²)	80.16±0.21	73.16±0.20	77.36±0.19	74.50±0.19	75.21±0.20
Shell weight (g)	8.65±0.05	7.99±0.04	8.33±0.05	8.17±0.05	8.10±0.04
Shell thickness (mm)	0.49±0.00	0.53±0.00	0.49±0.01	0.48±0.00	0.44±0.02
Shell ratio (%)	12.26±0.07	12.89±0.06	12.42±0.08	12.85±0.07	12.57±0.08
Internal character					
Albumen length (mm)	107.80±0.29	104.50±0.28	105.60±0.27	102.10±0.27	73.20±0.30
Albumen width (mm)	70.50±0.23	66.70±0.24	68.90±0.23	68.60±0.25	61.00±0.26
Albumen height (mm)	13.38±0.06	13.33±0.07	13.49±0.05	15.48±0.06	16.40±0.05
Albumen weight (g)	38.61±0.17	37.43±0.18	38.81±0.16	37.72±0.16	37.64±0.17
Albumen index (%)	15.01±0.06	15.57±0.07	15.46±0.07	18.13±0.05	24.42±0.08
Albumen ratio (%)	54.74±0.23	57.16±0.21	57.87±0.24	54.60±0.25	58.40±0.23
Hugh unit	110.65±0.25	111.76±0.23	111.49±0.23	112.12±0.21	112.57±0.26
Yolk diameter (mm)	46.10±0.11	46.30±0.12	47.00±0.10	46.10±0.13	47.00±0.11
Yolk height (mm)	24.06±0.05	24.23±0.06	25.20±0.08	24.42±0.07	26.22±0.07
Yolk weight (g)	19.20±0.08	18.56±0.10	19.71±0.09	20.86±0.11	18.71±0.09
Yolk index (%)	52.21±0.13	50.17±0.12	53.59±0.11	52.98±0.14	55.80±0.15
Yolk ratio (%)	27.22±0.12	29.96±0.14	29.40±0.11	32.80±0.13	29.03±0.13
Yolk albumen ratio (%)	49.73±0.15	52.41±0.16	50.80±0.13	50.06±0.16	49.71±0.20

Table 6. Performance of matured female turkey

Performance parameters	T₁	T₂	T₃	T₄	T₅
FCR at 33* weeks of age (on egg production basis)	4.23±0.0 ^b	4.17±0.04 ^b	3.56±0.06 ^{ab}	3.32±0.05 ^a	5.20±0.05 ^c
Live wt. gain (g/d, 25-33 week)	9.43±1.04	8.73±0.97	11.48±1.03	11.90±100	9.32±1.01
Age at 1 st laying (week)	30±1.07	31±1.24	32±1.31	29±1.05	32±1.02

Dietary effect of mineral treated hydroponic wheat sprouted fodder on reproductive performance of turkey hens bred by natural mating (NM) and artificial insemination (AI) are shown in Table 7. The reproductive parameters were not significantly affected for the turkeys fed with mineral treated hydroponic wheat sprouted fodder, by the breeding methods adopted, either natural mating (NM) or artificial insemination (AI) except for the fertility (%) parameter that differed significantly ($P < 0.01$) among the dietary treatment groups. The fertility (%) was significantly higher in all the dietary treatment groups of turkey inseminated artificially than the turkeys inseminated naturally.

Table 7. Dietary effect of mineral treated hydroponic wheat sprouted fodder on reproductive performances of turkey hens bred by natural mating (NM) and artificial insemination (AI)

Variables (%)	Breeding Treatment Groups									
	T ₁		T ₂		T ₃		T ₄		T ₅	
	NM	AI	NM	AI	NM	AI	NM	AI	NM	AI
Av. Egg production (No.)	52.34	50.48	53.24	51.24	54.26	51.48	54.12	50.34	50.24	50.08
	±5.23	±5.34	±6.14	±5.74	±6.84	±5.45	±6.37	±5.13	±5.24	±5.21
Av. Egg weight (g)	70.12	70.05	69.03	68.96	67.98	68.76	68.54	68.96	68.42	68.54
	±7.14	±7.12	±6.13	±6.24	±6.39	±6.47	±6.45	±6.76	±6.67	±6.23
Fertility (%)	39.46	84.36	40.25	85.16	39.38	86.32	39.02	85.38	36.96	84.94
	±3.94 ^a	±8.33 ^b	±4.23 ^a	±8.13 ^b	±3.29 ^a	±8.26 ^b	±3.19 ^a	±8.31 ^b	±3.61 ^a	±8.46 ^b
Hatchability (% on fertile egg)	87.26	86.76	85.94	87.14	86.42	85.36	86.56	87.00	85.98	86.32
	±8.67	±8.54	±8.74	±8.68	±8.18	±8.12	±8.49	±8.11	±8.34	±8.46
Early embryonic mortality	07.52	08.82	08.04	07.18	07.54	07.62	07.16	07.24	08.12	07.92
	±0.68	±0.78	±0.56	±0.57	±0.45	±0.65	±0.69	±0.61	±0.84	±0.79
Late embryonic mortality	06.36	06.18	05.94	06.00	06.48	05.88	07.02	06.44	07.14	05.86
	±0.64	±0.61	±0.34	±0.67	±0.74	±0.54	±0.74	±0.67	±0.77	±0.56
Survivability	96.28	97.00	96.54	94.88	98.08	96.96	95.68	96.32	95.78	96.48
	±9.23	±9.93	±9.94	±9.47	±9.31	±9.49	±9.97	±9.96	±9.57	±9.44
Hatched Poults weight	46.23	45.64	45.98	45.34	46.28	46.12	45.97	45.78	46.34	46.17
	±4.34	±4.13	±4.24	±4.13	±4.34	±3.94	±4.94	±4.32	±4.34	±4.31

11.1.3 Economic sustainability of feeding hydroponic sprouted fodder

Cost-benefit analysis

The cost benefit analysis for productive and reproductive performances of turkey based on dietary supplementation of different levels hydroponic sprouted fodder is shown in Table 8. The net farm income, profitability index, rate of return on investment and capital turnover were significantly higher in case of T₄ group turkey than the other groups.

Table 8. Cost and returns for turkey production (calculation was made in BDT and on the basis of market price during the experimental period of financial year, 2017-18)

Parameters	Dietary treatment groups				
	T ₁	T ₂	T ₃	T ₄	T ₅
A. Variable Costs					
Labor	300	300	300	300	300
Feeds	1225±12.27 ^b	1140±11.47 ^b	1072±10.35 ^{ab}	1002±10.42 ^a	940±09.24 ^a
Hydroponic sprouted fodder	0	12	18	24	30
Medication	5	5	5	5	5
Miscellaneous (water, electricity, transport etc.)	200	200	200	200	200
Total Var. Cost (TVC)	1730±16.37 ^b	1657±17.52 ^b	1595±15.34 ^{aa}	1531±14.27 ^a	1475±14.22 ^a
B. Fixed Costs					
Cost of poult	200	200	200	200	200
Depreciation on housing @5%	12	12	12	12	12
Depreciation on equipment@10%	4	4	4	4	4
Total Fixed Cost (TFC)	216	216	216	216	216
Total cost	1946±19.52^b	1873±18.57^{ab}	1811±10.35^{ab}	1747±17.57^a	1691±16.57^a
C. Revenue					
Sales of spent Turkey	1950±16.23	1980±15.36	1995±19.24	1982±15.35	1940±19.21
Sales of poult	5400±59.5	5600±56.3	5800±49.7	6000±65.3	5200±54.4
Sales of unfertile egg	105	95	88	80	84
Sales of litter	22	22	22	22	22
Total Revenue (TR)	7477±79.2	7697±56.8	7905±59.5	8084±48.4	7246±45.6
Net Farm Income (NFI)	5531±84.4^a	5824±69.5^a	6094±84.3^{ab}	6337±64.5^b	5555±67.4^a
Profitability Index (PI)	0.74±0.003^a	0.76±0.002^a	0.77±0.006^{ab}	0.78±0.003^b	0.77±0.007^{ab}
Rate of return on investment (RRI)	2.84±0.02^a	3.11±0.02^a	3.36±0.05^{ab}	3.63±0.03^b	3.29±0.07^{ab}
Capital Turnover (CTO)	3.84±0.05^a	4.11±0.07^a	4.36±0.08^{ab}	4.63±0.06^b	4.29±0.09^{ab}

Values are Means ± SEM, ^{a,d}Means within a row without common superscripts differ significantly; NS-not significant; statistically significant difference is expressed as *(P < 0.05).

11.2 Discussion:

The effect of feeding hydroponic maize and sesbania sprouts replaced with commercial concentrate feed on growth performance of turkey is discussed in conjunction with the available literature, though there is no sufficient literature available on the effect of hydroponic sprouted fodder on turkey production.

In the present study, the highest live weight gain and final live weight was observed in T₄ group fed 15% sprouted fodder as supplementary feed compared to the turkeys fed only concentrate feed or 20% sprouts supplemented feed (T₅). This variation in live weight gain may be due to the differences in the levels of hydroponic sprouted fodder supplementation to the turkey. There is no previous study with the dietary effect of hydroponic sprouted fodder on productive or reproductive performances of turkey. However, most studies performed by feeding hydroponic sprouted fodder to animals showed similar results to our studies. Moreover, a study performed by Fayed, (2011) to find the effect of feeding barley

grains that sprouted on rice straw on performance of growing Barki lambs showed enhancement on those lambs growth performance. Naik *et al.* (2014) reported that hydroponic sprouted fodder is a rich source of bioactive enzymes and may contain ingredients that help improving the performance of livestock. In our study, a positive effect of feeding hydroponic wheat sprouts at 15% level to turkey was shown, which reflects that this type of feed might be of great benefit to the farmers for increasing profit from the turkey meat industry.

The present study although revealed that the ration supplemented with hydroponic sprouted fodder had no effect on feed intake (DM) however, the supplementary ration improved feed efficiency by increasing live weight gain of turkey. Gebremedhin, (2015) reported that feeding hydroponically grown barley sprouts for growing goats increased total DM intake, FCR, and live weight gain when compared to goats fed with concentrate diets. This result was found most probably due to the increase live weight gain by feeding hydroponic sprouted fodder at 15% level replacing commercial concentrate feed for growth performance of turkey. Present result supports the result of Kide and Weldegerima (2015) who concluded that feeding of hydroponically sprouted maize and barley sprouts up to 40% substitution (DMI) increased the digestibility of nutrients, better FCE and live weight gain of growing goats. Naik *et al.* (2014) reported that FCR in terms of DM, CP and TDN were better in lactating cows fed hydroponic maize sprouts as compared to the control. The slightly improved efficiency observed in lactating graded Murrah buffaloes fed rations supplemented with hydroponic maize sprouts might be attributed to the higher digestibility of hydroponic maize sprouts which may be due to the tenderness of sprouts (Naik *et al.*, 2014) or high enzyme activity in 7- day- old hydroponic sprouted maize sprouts (Chavan and Kadam, 1989). Further, it is reported that the hydroponic sprouted fodders are the rich sources of nutrients and contain a grass juice factor that improves the performance of livestock (Finney, 1982). 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 sprouts.

On the other hand, the reproductive parameters such as average egg production, egg weight, fertility, hatchability, embryonic mortality and survivability of hatched poult were not affected due to the dietary supplementation of hydroponic sprouted fodder.

Under this study, the lower cost of feed observed in dietary treatment groups (T₂, T₃ and T₄) than (T₁) control group. But the total revenue, net farm income, profitability index, rate of return on investment and capital turnover per bird was higher in T₄ than other dietary treatment groups (T₁, T₂T₃ and T₅). Feeding hydroponic sprouted fodder up to 15% level replacing commercial concentrate feed reduced the production cost. This finding could be compared with the study conducted by Chinnam, (2015) who used hydroponic barley as feed for lactating sheep that reduced the cost of feed by 42%. Chinnam (2015) also 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 sprouts (16.80/- per 7 kg) as compared to farm made concentrate mixture (15.24/- per kg). Naik *et al.* (2014) observed that there was higher net profit of Rs. 12.67/- per cow/d on feeding hydroponic maize sprouts (HMF).

12 Research highlight/findings:

- i) Yield and nutrient composition of hydroponic sprouted fodder of maize, sesbania and wheat were determined. The biomass yield of hydroponic wheat sprouted fodder was significantly ($P<0.05$) higher than that of maize or sesbania. The percentage of dry matter (DM) and ash were higher ($P<0.01$) in hydroponic wheat sprouted fodder than maize or sesbania. Whereas, the amount of organic matter (OM), ether extract (EE) and crude fiber (CF) did not differ significantly ($P>0.05$) among the sprouted fodder. Therefore, the diet supplemented with hydroponic sprouted wheat fodder was chosen for further study on productive and reproductive performances of turkey.
- ii) Optimum level of supplementation of dietary hydroponic wheat sprouted fodder was identified to be 15% for cost effective growth and reproductive performances of turkeys. Therefore, it is suggested to use hydroponic wheat sprouted fodder at the level of 15% along with the recommended dose of concentrate for economic production of growing turkey.
- iii) A total of seven concentrate rations were formulated for different age groups of turkey (0-4, 4-8, 8-12, 12-16, 16-20, 20-24 weeks old and breeding hen) that could be used for the heritage type of turkeys available in Bangladesh.

B. Implementation Position

1. Procurement:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
a) Procurement of Incubator set and IPS	01	1,37,000/-	100%	95%	Still not be disbursed the rest of GOB fund to pay IT
b) Procurement of turkey production supplies	Lot	1,00,000/-	100%	95%	

2. Establishment/renovation facilities:

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
Set up of hydroponic lab with steel frame and trays	100%	100%	-	-	Still not be disbursed the rest of GOB fund to pay IT
Repair renovation and maintenance of turkey shed	-	-	100%	100%	

3. Training/study tour/ seminar/workshop/conference organized:

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training					N/A
(b) Workshop					

C. Financial and physical progress

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	370200/-	370200/-	370200/-	0	100%	N/A
B. Field research/lab expenses and supplies	869675/-	794386/-	792522/-	1864/-	100%	Deviation with approved budget due to undisbursed the rest of GOB fund
C. Operating expenses	144001/-	141691/-	141691/-	0	100%	
D. Vehicle hire and fuel, oil & maintenance	0	0	0	0	N/A	
E. Training/workshop/seminar etc.	0	0	0	0	N/A	
F. Publications and printing	115000/-	99000/-	99000/-	0	100%	
G. Miscellaneous	36079/-	35525/-	25000/-	10525/-	100%	
H. Capital expenses	333900/-	278893/-	278893/-	0	100%	
Total	1868855/-	1719695/-	1707306/-	*12389/-	100%	*Refunded

D. Achievement of Sub-project by objectives: (Tangible form)

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output(i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
i) To determine the nutrient composition and biomass yield of hydroponic sprouted fodder	a) Production of hydroponic sprouted fodder b) Nutrient analysis of hydroponic sprouted fodder.	Yield and nutrient composition of hydroponic sprouted fodder of maize, sesbania and wheat determined. The biomass yield and the percentage of dry matter (DM) and ash were of hydroponic wheat sprouted fodder were significantly (P<0.05) higher than that of maize or sesbania. Whereas, the amount of organic matter (OM), ether extract (EE) and crude fiber (CF) did not differ significantly (P>0.05) among the sprouted fodder. Therefore, the diet supplemented with hydroponic wheat sprouted fodder	The knowledge could be used for the formulation of supplementary rations using sprouted fodder of maize, wheat and sesbania.

		was chosen for further study on productive and reproductive performances of turkey.	
ii) To investigate the dietary effect of hydroponic sprouted fodder on productive and reproductive performances of turkey	a) Formulation of the rations for heritage turkey b) A total of 4 experiments were conducted involving 5 treatment groups c) Artificial insemination in turkey hens.	a) A total of seven rations for the different age group of turkey developed b) Optimum level of supplementation of dietary hydroponic sprouted fodder was determined to be 15% for better growth and reproductive performances of turkey c) Better fertility over natural mating achieved in heritage turkey	a) Supplementation of 15% hydroponic sprouted fodder will be beneficial for the turkey farmers. b) Better fertility means higher production that will help in gaining higher economic return.
III) To study the economic sustainability of hydroponic sprouted fodder on turkey production	Cost-benefit analysis of turkey production using supplementary diet with different level of sprouted fodder.	The net farm income, profitability index, rate of return on investment and capital turnover were significantly higher in case of T ₄ group of turkey (fed with 15% hydroponic sprouted fodder supplemented ration) than the other treatment groups.	Hydroponic sprouted fodder (15%) may be used for economic turkey farming (heritage type turkeys) available in Bangladesh.

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer	01	-	Manual for turkey production
Journal publication	01	-	Dietary effect of hydroponic sprouted fodder on productive and reproductive performance of turkey
Other publications, if any (Theses)	01	02	a) Study on hydroponic cultivation of maize and sesbania sprouted fodder and their effects on growth performance of turkey b) Dietary effects of hydroponic wheat sprouted fodder on growth performance of turkey c) Dietary effect of hydroponic sprouted fodder on the reproductive performance of turkey

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity)

Hydroponic sprouted wheat fodder supplemented (up to 15%) rations for better growth and reproductive performances of heritage turkey in Bangladesh

ii. Generation of new knowledge that help in developing more technology in future

Artificial insemination in turkey with diluted semen

iii. Technology transferred that help increased agricultural productivity and farmers' income

Cultivation of hydroponic sprouted fodder and artificial insemination in turkey

iv. Policy Support

Commercial turkey production by supplementation of hydroponic sprouted fodder and introducing artificial insemination may be an effective tool for meeting up the national demand of animal protein and employment generation and poverty alleviation.

G. Information regarding Desk and Field Monitoring

i) Desk Monitoring (Expert Comments/Suggestions on Annual Progress Report presentation workshops):

Q1 : Wheat as HSF, why not maize.

A1 : Several trials showed that the HSF with maize couldn't be produced well due to the fungal infection during monsoon season; besides this, maize seeds were not so available with reasonable cost.

Q2 : How hydroponic sprouted fodder effect on Turkeys growth?

A2 : Hydroponically-sprouted fodders are rich in carbohydrates, protein, vitamins (Vit E, A, C and B complex) and minerals (Se, Zn, Cr, etc.) which are essential for reproductive health of birds. *(described in Justification section)*

Q3 : Concentrate should be same.

A3 : Poultry diet should be isocaloric and isonitrogenous, so variable concentrate may be provided on the basis of HSF amount.

ii) **Field Monitoring (time& No. of visit, Team visit and output):**

Name of visiting staff	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)
Dr. S.M. ZikrulHaq Ch.	Member Director (Livestock)	March 17, 2018	01 day	Hydroponic wheat sprouted fodder may be used in the ration because, its nutrient contents are higher than maize.
Mohammad Rafiqul Islam, PhD	Principal Scientific Officer	March 17, 2018	01 day	Research progress is good however, rest of the research activities should be completed as early as possible. Balanced rations for turkey should be formulated.

H. Lesson Learned (if any)

I. Challenges (if any)

- i) Disease prevalence in turkey, fungal infection in hydroponic sprouts.
- ii) Cost-benefit analysis was very critical due to fluctuating market of turkey meat and poult.
- iii) The experimental turkeys were heritage type turkey; Hybrid turkeys were not available in Bangladesh.

Signature of the Principal Investigator

Date :

Seal

Counter signature of the Head of the organization/authorized representative

Date:

Seal

References:

- Anonymous, 2015. Fresh nutritious, fodder every day, reliable organic feed, Obs: observation, DM: dry matter, CP: crude protein, EE: ether extract CF: crude fibre, NFE: nitrogen free extract, Ash: ash AIA: acid insoluble ash.
- Association of Official Analytical Chemists, 2007: Official Methods of Analysis of Association of Analytical Chemists, 18th edn. AOAC, Gaithersburg, MD.
- Burrows WA, Quinn JP. The method of obtaining spermatozoa from the domestic fowl. Poultry Science 1935; 14 (4) 251-4.
- Chavan, J. and Kadam, S.S. 1989. Nutritional improvement of cereals by sprouting. Critical Rev. Food Sci. Nutr. 28: 401-437.
- Chinnam HK, 2015. Effects of feeding rations supplementation with hydroponic fodder on nutrients utilization and milk production in lactating graded Murrah Buffaloes. SRI Ventakeswara, Veterinary University, Tirupati. 517-502, (A.P) India.
- Dung, D.D., Godwin, I.R. and Nolan, J.V. 2010 a. Nutrient content and in sacco degradation of hydroponic barley sprouts grown using nutrient solution or tap water. J. Anim. Vet. Adv. 9 (18): 2432-2436.
- Dung, D.D., Godwin, I.R. and Nolan, J.V. 2010 b. Nutrient content and in sacco digestibility of barley grain and sprouted barley. J. Anim. Vet. Adv. 9 (19): 2485-2492.
- Fayed, M.A. 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. Ameri. Sci. 7.
- Fazaali, H., Golmohammadi, H.A., Tabatabayee, S.N. and Asghari-Tabrizi. 2012. Productivity and nutritive value of barley green fodder yield in hydroponic system. World Appl. Sci. J. 16 (4): 531-539.
- Finney, P.L. 1982. Effect of germination on cereal and legume nutrient changes and food or feed value: A comprehensive review. Recent Advance. In Phytochem. 17: 229-305.
- Gebremedhin, W. 2015. Nutritional benefit and economic value of feeding hydroponically grown maize and barley fodder for Konkan Kanyal goats.
- Hafez, E.S.E. (1985). *Reproduction in Farm Animals*. Lea and Febiger, Philadelphia. pp. 494-496. International Organization of Scientific Research-Journal of Agriculture Veterinary Science, 8: 24-30.
- Naik P.K., R.B. Dhuri, M. Karunakaran, B.K. Swain, and N.P. Singh. 2014. Effect of feeding hydroponics. Naik, P.K. and Singh, N.P. 2014. Production and feeding of Anim. Feed Sci. Technol. 13: 183-190.
- Naik, P.K., Dhuri, R.B., Karunakaran, M. and Swain, B.K. and Singh, N.P. 2013a. Hydroponic technology for green fodder production. Indian Dairyman. 65: 54-58.
- Naik, P.K., Dhuri, R.B., Karunakaran, M., Swain, B.K. and Singh, N.P. 2014. Effect of feeding hydroponic maize fodder on digestibility of nutrients and milk production in lactating cows. Indian J. Anim. Sci. 84 (8): 880-883.
- Naik, P.K., Dhuri, R.B., Swain, B.K. and Singh, N.P. 2013c. Water management for green fodder production as livestock feed in Goa. In: Abstracts of International Conference on 'Water Management for Climate Resilient Agriculture' held at Jalgaon, Maharashtra, India, May 28-31, 2012, Pp. 126-127.
- Naik, P.K., Gaikwad, S.P., Gupta, M.J., Dhuri, R.B., Dhumal, G.M. and Singh, N.P. 2013b. Low cost devices for hydroponic fodder production. Indian Dairyman. 65: 68-72.
- Reddy, G.V.N., Reddy, M.R. and Reddy, K.K. 1988. Nutrient utilization by milch cattle fed on rations containing artificially grown fodder. Indian J. Anim. Nutr. 5 (1): 19-22.
- Reddy, Y.R. 2014. Hydroponic fodder production. <http://www.authorstream.com/Presentation/kiranreddy526438-2376257-hydroponic-fodder-production/>
- Sneath, R. and McIntosh, F. 2003. Review of hydroponic fodder production for beef cattle. Queensland Government, Department of Primary Industries, Dalby, Queensland.

- Weldegerima J, A Kide and H Gebremedhin, 2015. Nutritional benefit and economic value of feeding hydroponically grown maize and barley fodder for Konkan Kanyal goats. *Journal of Agriculture and Veterinary Science*, 7: 2319-2372.
- Yvonne Kamanga (Malawi). 2016. YAP proposal # 255: Hydroponic fodder: Increasing milk production and income! YAP-Agripreneur Youth Project. <https://blog.gfar.net/2016/03/09/yap-proposal-242-hydroponic-fodder-increasing-milk-production-and-income-yvonne-kamanga-malawi> .

Appendix- I
Some pictorial presentation of the project activities

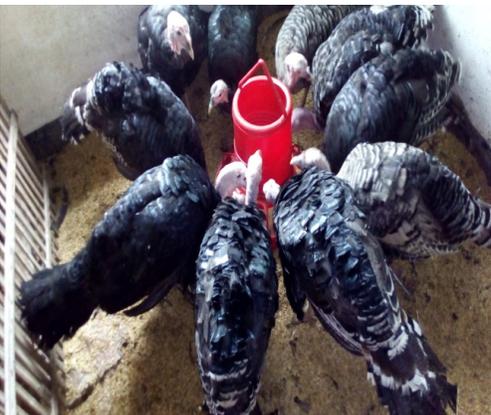


Photo 1. Experimental site and turkeys used in the study

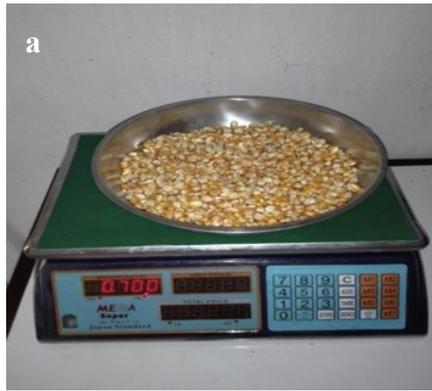


Photo 2. a) Weighing, b) Soaking and c) Germination of seeds



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

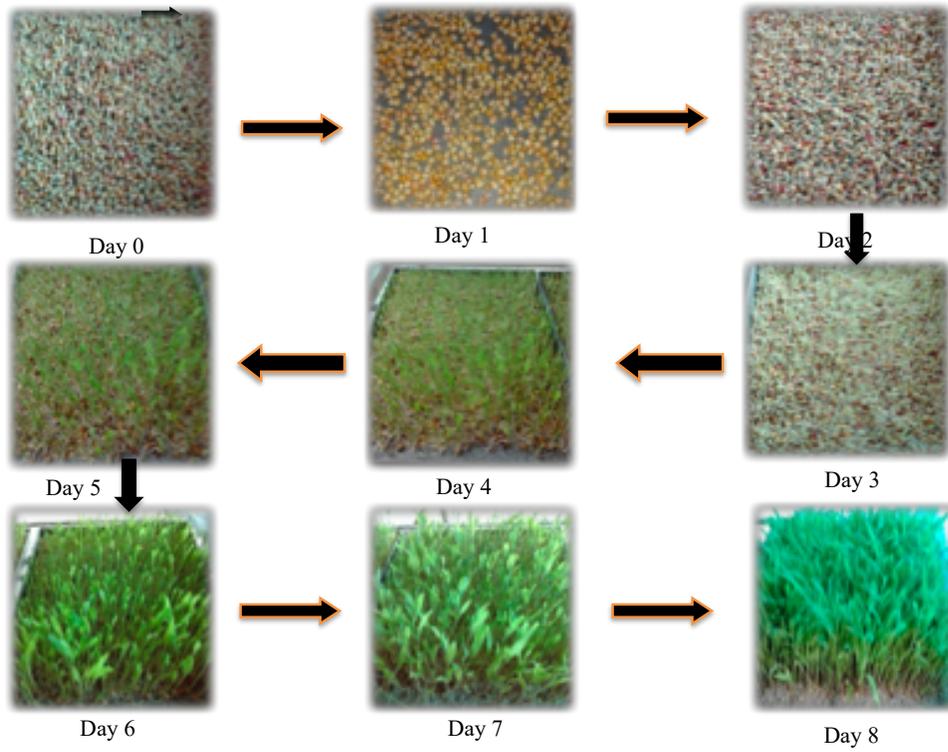


Photo 4. Growth phase of hydroponic maize sprouts

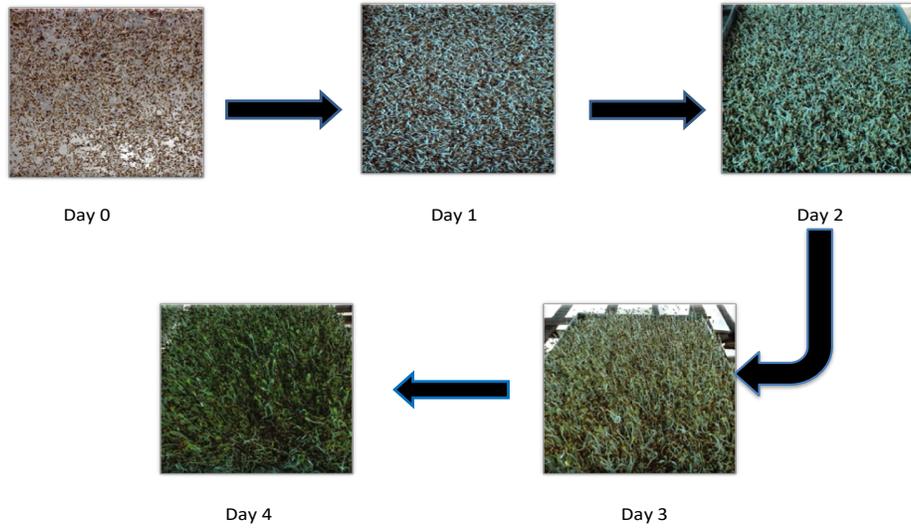


Photo 5 . Growth phase of hydroponic sesbania sprouted fodder



Photo 6. Sprouted fodder mat



Photo. Preparation of hydroponic sprouted fodder sample for proximate analysis



Photo 8. Semen collection from Tom



Photo 9. Natural breeding and artificial insemination (AI)

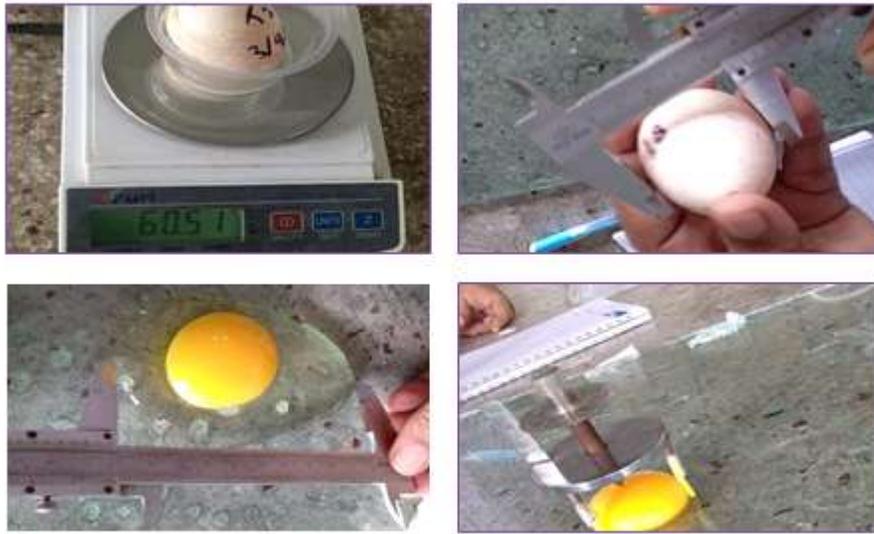


Photo 10. Egg quality measurement

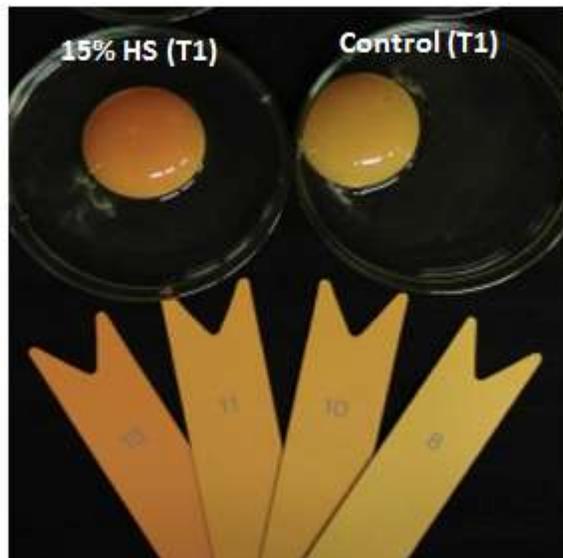


Photo 11. Effect on hydroponic sprouts on yolk color

