NUTRITIONAL IMPROVEMENT AND ECONOMIC VALUE OF HYDROPONICALLY SPROUTED MAIZE FODDER

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Abstract: The experiment was aimed to identify the nutritional improvement and economic value of hydroponically sprouted maize fodder. The study was conducted at the Instructional livestock farm, Agriculture College, D.B.S.K.K. Vidyapeeth, Dapoli, Ratnagiri district (M.S), India. Hydroponic cultivation plan was prepared using bamboo stands with three shelves (1 ft^2 distance each) with capacity of 120 plastic hydroponic trays of 30.3 x 8.2 x 6.0 ft length, height and width, internal setup firmed with semi-automated drip irrigation along with 0.4% slope for effective drainage of excess water. After 24-36 hours of germination in a gunny bag, sprouted maize seeds were spread on the hydroponic tray at a rate of 500 grams per tray up on 2 ft^2 size and 1.5-2 cm thickness. Total yield of 8kg hydroponic maize fodder was recorded per kg seed per 8^{th}-day growth periods along with 28 cm height and 6^{th}, 7^{th} and 8^{th}-day green fodders sampled for proximate analysis. The Crude protein content in hydroponic maize fodder was highest ($P<0.05$) as 14.56% than maize seed as 7.6% while Ether extract observed as 4.6% at 8^{th}-day growth periods was highest ($P<0.05$) than seed form (2.80%). The Crude fibre content of dried maize seed was denoted as 6.5% and progressed ($P<0.05$) likely to 10.0% in 8^{th}-day growth where as NFE was 68.47%. The value of Total Ash and AIA content was highest ($P<0.05$) as 2.83% and 0.32% in 8^{th}-day growth stages, respectively. Therefore, maize fodder can be grown in a semi-intensive hydroponic system with less water, less space, low cost and with higher nutritive values of fresh fodder weight, Crude protein, Crude fibre, Ether extract (crude fat) and Nitrogen free extract.

Keywords: Cost, Maize Hydroponic fodder, Maize seed, Nutrient.

Introduction: Fodder is an essential component and profound input in livestock diet. Many types of fodder had been used in ruminant particularly grass and legume species however, due to less availability and low quality fodder, the maintenance and productivity of animals is not fulfilled. Availability of green fodder is attenuated due to sever climate change, unavailability of enough land, deterioration of fertile soil and water resources competition between fodder and cereal crops[12] while demand of green fodder is increasing when fodder availability is limited and necessity of feed for animals and its cost increases causing important livestock losses. Therefore, it is felt as a need of the hour to explore and develop the possibility of improved fodder production in a better way.

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 [2].

Installing of this planting system enabled to produce quality fresh fodder from Corn, Oats, Barley, Wheat and other grains [17]. Nutritional value of sprouted grain improves due to the modification of heterogeneous compounds into intelligible and essential form by minimizing the effect of anti-nutritional factors while sprouting [5]. Sprouting of grains has resulted increase in quantity and quality of protein, sugars, minerals and vitamin. However, the total starch and dry matter percentages of grains had been reduced due to excessive sprouting [10].There is a great nutritional benefit provided by hydroponic sprouted fodder to optimize the general health and performance of young animals while minimizing feed costs [3].A hydroponic system allows the cultivator to target the root system very easily, precisely and directly while producing quality fodder. The interference of soil-borne adulterants and compounds is totally eliminated in a hydroponic cultivation system. Hence, the study aimed at "Nutritional improvement and economic value of hydroponically sprouted maize fodder".

Materials and methods:

Study Site: Experiment was conducted at the Instructional livestock farm, College of Agriculture, Dapoli. Hydroponic cultivation plan was prepared and a hydroponic unit was installed at the dairy farm using 75% green shed net cover for optimum shed and ventilation with internal structure of 30.3 x 8.2 x 6.0 ft length, height and width, respectively with 0.4% slope for effective drainage of excess water. The racks were prepared by using bamboo stands with three shelves (1 ft^2 distance each) with capacity of 120 plastic hydroponic trays, sized 1.8 ft length × 1.0 ft width × 0.15 ft height equipped with semi-automated sprayer irrigation. The trays with holes at the base were to allow drainage of excess water from irrigation. Water used was tap water free from any additives. The temperature and humidity inside the green house was controlled through micro-sprinklers irrigation to maintain a range of 22 - 270C temperature and 70-80% relative humidity. African tall Maize variety (Zea mays L.) was used and soaked for 12 hours in tap water. The metabolic activity of resting seeds initiates and increases while hydrated during soaking[5]. After 24-36 hours of germination in gunny bag, sprouted seeds were spread on the hydroponic tray at a rate of 500 grams per tray sized 1.8 ft^2 and 1.5-2 cm layer thickness. Six (6), seven (7) and eight (8) days were considered for evaluation of the trays produced quality hydroponic fodder. To determine the nutrient composition on each batch, fresh samples (100g each) were taken from 4 treatment and three replications and oven-dried at 100 °C and ground to pass a 1-mm mesh screen sieve and analyzed nutrients content *viz* Dry Matter (DM), Crude Protein (CP), Ether extract (EE), Crude Fiber (CF), Nitrogen free extract (NFE) Total Ash (TA) and Acid insoluble ash (AIA) as per [4]. Data was analyzed using Statistical Analysis System [18].

Results and discussion:

Growing of hydroponic maize fodder: In the specially designed sprouting trays, a total of 8 kg hydroponic maize fodder embedded with white roots and green shoots was produced out of 1kg maize seed (87% germination rate) along with average plant height of 28 cm on 8^{th}-day. There were no media to grow the hydroponic fodder in the hydroponic unit except tap water (chemical free) and sprouting trays purposely designed for cultivation and growing of hydroponic fodder. The amount of water required to grow one kg of hydroponic maize fodder was 1.65-2 liter (if water recycled) and 2-3.3 liter (if water is not recycled) per 8^{th}-day growth period. [15] also coined out 1liter (if recycled) and 3liter (if not recycled) in maize hydroponic fodder. The biomass production conversion ratio was based on the amount of fresh fodder produced per unit of seed used [11], [16]. The conversion ratio depends on factors such as type and quality of seed, overall management, sprinkling frequency, temperature inside the greenhouse, relative humidity and growth period [22]. This result agrees with the ideas of [20] viewed from commercial hydroponic fodder producers achievements as 6–10 kg, while ensured from trial yields ranged 5–8 kg and [11] and [16] also reported as 4-8 kg out of 1kg maize seed. Similarly, [9] reported 6-10kg and [1] and [13] as 7-9 kg of barley hydroponic fodder per kg barley grain. This result was superior to the findings of [15] as 5.5 kg, [15] and [19] as 5–6 kg fresh hydroponic fodder per kg of maize seed and [8] as 4.93 kg at day 6 to 7.21 kg at day 8 barley fodder and [7] as 3.7 kg of 7 day hydroponic barley fodder per kg barley grain. The average plant height 28 cm achieved on 8^{th}-day was in line with the results reported by [15] in maize hydroponic fodder as 20-30cm and [13] in barley hydroponic fodder as 15-30 cm height.

Chemical composition: In the present investigation, there was a significant change ($P<0.05$) in dry matter content of maize seed and maize hydroponic fodder (Table 1). The average DM content of maize seed was found as 95.08% where as maize hydroponic fodder found as 18.25%. The lower % DM of maize hydroponic fodder may be due to the large uptake of water initiates increasing metabolic activity of resting seeds leads to complete loss of dry weight (starch) during germinating cycles of hydroponic fodder [12]. Agreement results denoted by [14] in hydroponic maize fodder as 18.30% DM and higher values reported by [21] in hydroponic maize fodder as 26.07% (moisture content 73.93%). The crude protein content presently observed in hydroponic maize fodder was 14.56% highly superior as compared to 7.6% in maize seed. Sprouting alters the amino acid profile of maize seeds and increases the crude protein content of hydroponic fodder [12]. The present value of crude protein was higher than results reported by [15] in hydroponic maize fodder as 13.30-13.6%, [19] as 13.57% and [14] as 13.30% and lower than findings reported by [21] in hydroponic maize fodder as 16.54%. The ether extract content observed as 4.6% at 8^{th}-day growth period in hydroponic system was higher ($P<0.05$) than at different fodder growth stages and seed form (2.8%) may be due to the peak chlorophyll content noticed at 8^{th}-day growth stages and sampled for determination of ether extract. The values reported by [15] as 3.27-3.50%, [19] as 3.49% and [14] as 3.27% were lower than the present findings while [21] as 6.42% was higher than the present values in hydroponic maize fodder. The crude fibre content of hydroponic maize fodder at 8^{th} -day growth stage (10.0%) was higher ($P<0.05$) than in seed form (6.5%) might be due to the buildup of cellulose, varied proportions of hemicelluloses and lignin in each batch [6]. Comparable CF values were reported by [15] ranged as 6.37-14.10%; lower values denoted by [21] as 8.21% and [14] as 6.3% and higher values by [19] as 14.07% in hydroponic maize fodder. The NFE content of hydroponic maize fodder at

Table 1. Chemical composition of hydroponic maize fodder at each stage (% DM)					
Variables		**Obs.1**	**Obs.2**	**Obs.3**	**Mean±SE**
Fresh fodder weight(kg)	Maize seed	1	1	1	
	Day 6	6.62	6.77	6.87	6.75±0.13
	Day 7	7.20	7.78	7.43	7.47±0.29
	Day 8	7.59	8.14	8.27	8.00±0.36
DM (%)	Maize seed	94.42	95.69	95.13	95.08±0.64
	Day 6	23.44	22.01	22.35	22.60±0.75
	Day 7	20.06	19.78	20.46	20.10±0.34
	Day 8	18.12	18.34	18.29	18.25±0.12
CP (%)	Maize seed	6.87	8.01	7.92	7.60±0.63
	Day 6	12.57	12.66	12.12	12.45±0.29
	Day 7	13.25	14.10	14.32	13.89±0.56
	Day 8	14.23	14.77	14.68	14.56±0.29
EE (%)	Maize seed	2.62	2.76	3.02	2.80±0.20
	Day 6	2.97	3.01	3.50	3.16±0.29
	Day 7	4.01	4.32	4.33	4.22±0.18
	Day 8	4.88	4.61	4.52	4.67±0.19
CF (%)	Maize seed	7.11	6.33	6.06	6.50±0.55
	Day 6	8.13	7.78	8.0	7.97±0.18
	Day 7	8.79	9.65	9.55	9.33±0.47
	Day 8	10.2	9.88	9.92	10.00±0.17
NFE (%)	Maize seed	76.25	80.25	79.51	78.67±2.13
	Day 6	74.89	73.64	75.45	74.66±0.93
	Day 7	70.16	73.57	70.23	71.32±1.95
	Day 8	70.35	67.48	67.58	68.47±1.63
Ash (%)	Maize seed	1.33	1.32	1.28	1.31±0.03
	Day 6	1.95	1.78	1.76	1.83±0.10
	Day 7	2.44	2.60	2.64	2.56±0.11
	Day 8	2.84	2.80	2.85	2.83±0.03
AIA (%)	Maize seed	0.06	0.04	0.05	0.05±0.01
	Day 6	0.21	0.23	0.22	0.22±0.01
	Day 7	0.26	0.29	0.29	0.28±0.02
	Day 8	0.33	0.31	0.32	0.32±0.01

8th-day growth stage was found as 68.47%.This result was in agreement to the reports of [15] ranged as 66.70-75.3%; higher values reported by [14] as 75.32% and lower values by [19] as 66.72% in hydroponic maize fodder. Values of total ash was highest ($P<0.05$) in 8th-day growth stages of hydroponic maize fodder (2.83%) than seed stage (1.31%). Agreement results were reported by [15] as 1.75-3.80% and higher than values reported by [14] in hydroponic maize fodder as 1.75%. The AIA content of hydroponic maize fodder was found as 0.32% than seed form as 0.05%.The AIA content was in line with the findings of [15] as 0.30-0.57% and [19] as 0.33% while higher values of [14] as 0.57% in hydroponic maize fodder, respectively. Cost of the hydroponic fodder production was about 3.95 Rs. per kg fodder, where the seed was purchased from the market. This finding was comparable to the values reported by [15] as 3-3.5 Rs. /kg maize fodder grown in low-cost hydroponic unit.

In conclusion, growing of maize fodder hydroponically in a semi-intensive hydroponic unit saved water, labour and shown a sizeable increment in nutrients such as fresh fodder weight, Crude protein, Ether extract and Nitrogen free extract. Therefore, growing of hydroponic maize fodder proved improved nutrient content with less water, less space used and cost effective.

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