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Journal of Agricultural Engineering and Food Technology
Print ISSN: 2350-0085; Online ISSN: 2350-0263; Volume 2, Number 2; April-June, 2015 pp. 86-89

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Nutritional Evaluation of Hydroponically Grown Barley Fodder

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Abstract—*A study was conducted to evaluate the nutritional improvement of hydroponically grown barley fodder. Barley seed was sprouted and grown in a semi intensive hydroponic unit of 75% shed net with internal design of 6.0ft Height x 8.2ft Width x30.3 ft Length and with 0.4 % slope .The internal structure was fitted by 1.8 ft Length ×1.0 ft Width ×0.15 ft Height size hydroponic plastic tray fixed with semi-automated sprayer irrigation for 7 and 8 day periods and sampled for chemical analysis. The study was conducted at the Instructional Livestock farm of the department of Animal Husbandry and Dairy science, D.B.S.K.K.V., Dapoli, Dist – Ratnagiri (M.S) India. The crude protein had increasing trend and remained highest on 8th day of growth (13.89%) which was higher (P<0.05) than the percentage in seed form (11.11%). The ether extract content of hydroponics barley fodder in 8th day (3.6%) was highest (P<0.05). The crude fiber content of the barley seed was 8.9% and increased (P<0.05) up to 14.2% on 8th day of growth in hydroponics system. The Neutral detergent fiber content of the barley seed was 20.1 at zero day and increased to 35.3% on 8th day of growth in hydroponics system and was higher (P<0.05) to barley fodder grown under controlled environment (31.25%). The total ash and acid detergent fiber contents are 4.1% and 16.45% in 8th day growth stage respectively. It can be concluded that hydroponics barley fodder can be grown in Konkan region using semi intensive green house and shown significant nutritional improvements of fresh fodder weight, crude protein and ether extract content.*

Keywords: *Cultivation, Barley Hydroponics, Nutrient*

1. INTRODUCTION

As livestock population increases, large gap exists in between requirement and availability of feed and fodder. India is short in dry fodder by about 23.46 per cent, green fodder 62.76 per cent, concentrate 30 per cent. It is a well accepted fact that feeding animals is incomplete without including green fodder in their diet [19]. Green fodder is an essential component of the livestock ration; otherwise the productive and reproductive performance of animals is adversely affected. Therefore, for sustainable livestock farming, quality green fodder should be fed regularly to the dairy animals[5]. However, the major constraints in production of green fodder are decreasing land size for fodder cultivation, scarcity of water, more labor requirement, non-availability of same quality green fodder throughout the year, fertilizer requirement and seasonal cataclysm [6]. As a solution to the unpredictable weather patterns, growing hydroponics fodder allows us to take control of our livestock feed regime and maintain sustainability[17].

Hydroponics is an advanced technology in agriculture which makes agriculture possible everywhere and proven technology adopted across the world by progressive dairy farmers. Adopting the technology of hydroponics is the need of the hour as it ensures less water requirement, less input and fast growth in limited space[1]. The hydroponic growing room is a system that has been specifically developed to disregard the external calamities and sprout barley seeds and produced highly nutritious and quality fodder as livestock feed. While sprouting and growth of the hydroponics fodder, a complete loss of seed coat has been shown during transforming into the fodder plant [3]. As the productivity of the livestock in a farm is highly dependent on the nutritive value of dry and green fodder, a study was carried out to evaluate the hydroponically grown barley fodder.

2. MATERIALS AND METHODS

2.1 Hydroponic System and Seed Sprouting

The inestigation was conducted at the Instructional Livestock farm of the department of Animal Husbandry and Dairy science of Agriculture College and a hydroponic unit was constructed using 75% shed net cover with external structure of 10.0 ft. height x 10.0 ft. width x 34.0 ft length, and internal rack structure was with 6.0 x 8.2 x 30.3 ft height, width and length respectively with 0.4 % slope. The internal structure was equipped with 360 plastic hydroponic trays having capacity of 360 trays, size of 1.8 ft length × 1.0 ft width × 0.15 ft height equipped with semi-automated sprayer irrigation. This system was constructed as a semi-intensive using 75% shed net and the remaining 25% was used for proper aeration. In order to manage and control the internal temperature of the green house, proper spraying of water was carried out two times per day manually to get a range of 22 - 27^0C and up to 70% relative humidity.

Clean seeds of barley (*Hordeum vulgare* L.) were washed and soaked in tap water for 12 hours, and then put in gunny bag for 24-36 hours till root emerged. Thereafter, sprouted seeds were spread on the hydroponic tray at a rate of 350 gram per tray .Two growth periods of 7th and 8th days were considered for evaluation of the trays contained green fodder. During the study period, the fresh fodder were weighed to estimate the yield, conversion ratio and sampled to evaluate nutrient composition on each batch. Representative samples (100g each) from three replication and eight observations were oven-dried at 103 °C for dry matter estimation, ground to pass a 1-mm mesh screen sieve and stored for chemical analysis. Clean barley seed (*Hordeum vulgare* L.) was used to grow fodder inside the green house by hydroponics technology in eight days. The average plant height on 8th day was 26 cm. The samples were analyzed for the nutrients content *viz* Dry Matter (DM), Crude Protein (CP), Crude Fiber (CF) , Total Ash (TA) as per [2] and Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) as per [22]. The obtained data was analyzed using CRD design of Statistical Analysis System [18].

3. RESULTS AND DISCUSSION

3.1 Hydroponic barley fodder

Results of the study showed that the green barley fodder with lush vegetation can be produced in 8 days from planting to harvest using hydroponic technique. A total of 8-9kg of hydroponics barley fodder was produced out of 1kg barley seeds. These results were in agreement with the report of [11] as was cited by [20], as they used one kg of grain hydroponically and produced 6 to 10 kilograms of fresh green fodder and better than the findings of [9], where they reported 7.21 kg at day 8. There is no other media to grow the hydroponics fodder in the hydroponics unit except the normal water and plastic trays purposely designed for cultivation and growing of hydroponics fodder. Barley seeds were placed on trays with 1.5 - 2cm thickness and the trays have a drainage ports to collect water used in soaking barley seeds. Used water was allowed to drain out for collection in order to be used again [15].

3.2 Chemical composition

There was a significant difference ($p<0.05$) between the original barley seed and green fodder for DM, where it was 13.64 per cent in case of green hydroponic fodder at 8th day of growth but 93.61 per cent at zero sprout (barley seed). The DM content of hydroponics fodder was significantly ($p<0.05$) reduced by increasing the growing periods from 7 to 8 days. The amount of fresh green fodder obtained per kg of planted barley seed was increased severally due to the large uptake of water while sprouting of the seeds, denoted as a highly reducing of DM percentage in hydroponics green fodder. These results were in agreement with the findings of [12] and [8] as was cited by [9], who reported a significant difference in wet weight and dry weight of the hydroponic fodder.

Table 1: The yield and chemical composition of Barley in each observation (% DM basis)

		Obs 1	Obs 2	Obs 3	Obs 4	Obs 5	Obs 6	Obs 7	Obs 8	Mean	SE
Fresh weight (kg)	Barley seed	1 kg.	1 kg.	1 kg.	1 kg.	1 kg.	1 kg.	1 kg.	1 kg.		
	HGF (7 days)	8.42	8.31	8.51	8.26	8.56	8.33	8.41	8.56	8.42	0.041
	HGF (8 days)	8.96	8.92	8.88	9	9.3	8.78	8.97	8.87	8.96	0.054
Dry matter (%)	Barley seed	93.6	91.02	93.45	93.75	96.18	93.09	94.93	94.42	93.81	0.530
	HGF (7 days)	14.13	13.04	14.44	13.65	14.56	14.67	14.43	14.12	14.13	0.193
	HGF (8 days)	13.64	13.53	13.57	13.67	13.73	13.68	13.79	13.51	13.64	0.035
Crude Protein (%)	Barley seed	11.11	11.26	10.81	11.01	11.41	11.21	10.56	11.51	11.11	0.111
	HGF (7 days)	13.01	12.89	13.21	13.23	12.87	12.91	13.1	12.86	13.01	0.054
	HGF (8 days)	13.89	13.88	13.83	13.87	13.91	13.93	13.91	13.9	13.89	0.011
Ether Extract (%)	Barley seed	1.68	1.56	1.67	1.81	1.76	1.61	1.53	1.82	1.68	0.039
	HGF (7 days)	2.78	2.67	2.82	2.75	2.71	2.83	2.87	2.81	2.78	0.024
	HGF (8 days)	3.6	3.58	3.57	3.61	3.62	3.61	3.59	3.62	3.6	0.007
Crude Fiber (%)	Barley seed	8.9	8.6	8.3	9.21	9.32	7.98	9.78	9.11	8.9	0.206
	HGF (7 days)	1.41	1.41	1.39	1.4	1.42	1.41	1.42	1.42	1.41	0.004
	HGF (8 days)	14.2	14.16	14.3	14.26	14.09	14.14	14.21	14.24	14.2	0.024

Neutral detergent fiber (%)	Barley seed	20.1	20.11	20.21	20.12	20.22	19.89	20.11	20.04	20.1	0.037
	HGF (7 days)	33.96	33.67	33.55	32.97	34.12	34.63	34.23	34.55	33.96	0.195
	HGF (8 days)	35.3	35.2	35.3	35.31	35.33	35.25	35.45	35.26	35.3	0.026
Total Ash (%)	Barley seed	1.81	1.82	1.83	1.79	1.81	1.78	1.8	1.84	1.81	0.007
	HGF (7 days)	3.65	3.61	3.63	3.67	3.71	3.68	3.65	3.6	3.65	0.013
	HGF (8 days)	4.1	4.1	4.1	4.13	3.97	3.89	4.21	4.3	4.1	0.045
Acid detergent fiber (%)	Barley seed	8	7.9	7.89	8.12	8.11	8	8	7.98	8	0.030
	HGF (7 days)	16.01	16	16.1	15.97	15.87	16.21	16.03	15.89	16.01	0.039
	HGF (8 days)	16.45	16.44	16.38	16.37	16.51	16.53	16.46	14.46	16.2	0.249

*NB.*obs-observation, HGF-Hydroponically Growing fodder

The hydroponics green fodder was looking like a mat consisting of roots, seeds and plants [8] as cited by [9]. There was differences ($P<0.05$) in the nutrients content of seed stage and hydroponics barley fodder during 7th and 8th stages of growth (Table 1). The CP content of the barley seed was 11.11%, while the CP content of the sprouted barley fodder showed an increasing trend with germination time and remained highest ($P<0.05$) on 7th to 8th day (13.01 - 13.89 %) of growth. The increase in protein content may be attributed to the complete change of dry weight(seed form) in to wet weight form while soaking and germination and longer sprouting time was an indicative for the greater losses in dry weight and increasing in protein content [7].

According to [12] as was cited by [20], changes in ash and protein contents occur rapidly from day 4 corresponding with the extension of the radicle (root), which allows uptake of nutrients that are artificially supplied as growing media. The CP contents of barley hydroponics fodder was higher than the reports of the earlier workers [20] and [13]and in agreement with the results of [16] where they reported 13.72% CP and lower than the results of [15] and [21] as 14.69% CP and 16.3% CP in artificially grown barley fodder respectively.

The EE content of barley fodder on 8th day (3.6%) was closer to the findings of [16] where they reported 3.72%, and better than the findings of [10], [15] as the artificially grown barley fodder had 3.4% and 3.18% EE, respectively. The CF content of hydroponics barley fodder was 14.1% in 7th day and increased ($P<0.05$) up to 14.2% on 8th day of growth. The increase in CF content during sprouting of barley might be due to the synthesis of structural carbohydrates such as cellulose and hemicelluloses [4].This result was at variance with the findings of [16] in barley fodder as 16.33% CF.The NDF content of barley seed increased to its maximum level at 8th day (35.3%) of growth in hydroponics system and was in line with the results of [9] where they observed 35.40 % and higher than [8] result of 31.25%. There was an increasing trend in the Total Ash (TA) content of the hydroponics barley fodder with the advancement of the period (4.1%) and this result is in line with the results of [9] where they reported 4.11% and higher than [10] as 3.6%. There was an increasing trend in the Acid Detergent Fiber level from 16.01% in 7th day to 16.45% in 8th day growth stage and superior than the results of [8] of 14.35 ± 0.21 and lower than the findings of [9] of 17.15%.

4. CONCLUSION

From results of this study, it can be concluded that the barley seed showed better fodder production under semi intensive hydroponic system with better improvements of nutrients such as fresh fodder weight, crude protein and ether extract content. Therefore barley seed is considered the better choice that can be used for production of hydroponic green fodder with less water consumption, less labor and high nutritive value.

5. ACKNOWLEDGEMENTS

The authors expressed their sincer thanks to the Associate Dean,College of Agriculture,Dapoli for providing all necessary facilities to complete the research.

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