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Influence of ATFD salt on nutritive value of hydroponic bajra (*Pennisetum glaucum*) fodder

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Abstract
Hydroponics is a smart alternative technology to combat fodder scarcity especially for small farmers with less or no land. The nutritious, palatable and digestible hydroponic green fodder as compared to conventional fodder helps the farmer to tide through phases of scarcity and thus prevent long term production and reproduction losses. A study was planned to evaluate the influence of the Agitated Thin Film Drier (ATFD) salt on nutritive value of hydroponic bajra production. The experimental hydroponic fodder group (ATFD Salt) was prepared by inclusion of the salt at the rate of 50 gms per 3 kg of seed. Eight trays (four control trays and four treatment trays) were used for production of hydroponic bajra fodder production. The results of the proximate composition, biomass yield and root to shoot ratio of the two groups were compared using an unpaired t-test. There was no significant difference ($p>0.01$) in the biomass yield between the control and treatment group. There was significant difference ($P< 0.05$) among shoot length and highly significant difference ($P< 0.01$) among root and root to shoot length ratio. There was no significant ($p>0.05$) difference in the moisture, crude fibre, ether extract and total ash content, however there was a significant ($P< 0.05$) difference in crude protein, acid insoluble ash (AIA) and nitrogen free extract (NFE) composition. ATFD salt did not affect the biomass yield of the hydroponics fodder, whereas a high significant difference in the root to shoot length improved the scope for better palatability. There is scope for further research on use of the salt at different stages of fodder growth to utilize the higher mineral content of the residue.

Keywords: ATFD salt, bio mass yield, hydroponic bajra fodder, *Pennisetum glaucum*

1. Introduction
The major constraint to animal production in India is lack of feed and fodder, which is more pronounced during lean months. Hydroponic fodder could be a substitute to reduce the gap of fodder demand and supply especially for small farmers with very less agricultural land. This technology is best suited for arid, semi-arid and drought prone areas and guarantees sustainable, resilient and hassle-free production of green fodder year-round (Shit, 2019) [10]. It is a scientific method of growing plants or crops in the absence of soil in a controlled environment (*in-vitro* condition) (Sneath and McIntosh, 2003) [11]. In this method the stored nutrients in the endosperm of the seed is utilized for the growth of fodder and no additional supplementation is required. Several research carried out on hydroponic fodder production is on the yield, method of production and palatability of the green fodder produced. The technology of hydroponics green fodder research is in its infancy, and further research on supplementation of nutrients, method of irrigation, water conservation etc. are needed. Though hydroponic fodder has been approved as a nutritious green fodder suitable for various livestock species (Jemimah *et al.* 2015) [5], further research on the role of supplementary nutrients on the yield, palatability, nutritional value and quality of the green fodder produced will throw light on augmenting the efficiency of this system in livestock feeding and nutrition. There is a paucity of studies on this aspect of effect of supplementation on hydroponic fodder production.
Bajra is one of the drought resistant grains thus more suitable for hydroponic fodder production. In comparison to maize or wheat that is uncultivable in harsh conditions, bajra is cultivatable in areas with drought, low soil fertility, high salinity, low pH or high temperature (National Research Council, 1996) [9]. However the deep rooted system enhances the need for additional macro and micro nutrients. In general, the cost of hydroponic fodder production is more than that of the conventional green fodder production systems due to excess seed rate required. Improving the efficiency of fodder production through supplementation of nutrients

should be planned in such a way as to minimize the cost of green fodder through increase in quantity of fodder produced and decrease in the cost of inputs used.

Use of by-products as nutrient supplement will ensure lower cost of production of hydroponic fodder as these are available at very little or no cost. ATFD salt is one such supplement obtained from the nutraceutical industry as a left out after growth of micro algae. The micro algae are grown in the presence of organic nutrient and minerals. After the sufficient algae growth in the ponds, the algae are harvested and the water is allowed to pass through membrane filter. The filtered water is sent to algal ponds and concentrated water is sent to multiple effect evaporators for further concentration and finally passed through Agitated Thin Film Drier (ATFD) to remove the moisture content. The salt obtained by this process is termed as ATFD salt is available in abundant quantity. ATFD salt is rich in micro and macro minerals and available as byproduct (IAN Project Report, 2019) and only use at present is as compost. By virtue of their high mineral content, this salt could be actively incorporated in the agricultural procedures to increase the growth of the plants.

With this background, current study was carried out to determine the influence of ATFD salt on yield and proximate composition of hydroponic bajra fodder.

2. Materials and Methods

The experiment was carried out during the month of February-March, 2021 at the Livestock Farm Complex, TANUVAS, Madhavaram Milk Colony, Chennai, which lies between latitudes 12° 9’ and 13° 9’ and longitudes 80° 12’ and 80° 19’ E with an altitude of 22 m above the MSL. Low cost automated hydroponic device with a production capacity of 20 kg/day designed by University Innovation and Instrumentation Centre, LFC, TANUVAS (UIIC, 2020) was used for the production of hydroponic bajra fodder (Fig 1). Good quality bajra seeds with germination percentage above 95% were selected. The seeds were winnowed to remove chaff and other dust particles. The seeds were dried under sun for 12 hours before use. The standard operating procedure for hydroponics fodder production is presented in table 1.

Table 1: The standard operating procedure for hydroponics fodder production

Day	Standard operating procedure
Day 1	Control group - 3 kg of the dry seeds were soaked in 10 litres of water overnight (8 hours). Treatment group - 3 kg of the dry seeds were soaked in 10 litres of ATFD solution (0.5 g/100 ml) overnight (8 hours).
Day 2	The excess water was drained of, the soaked seeds were packed in gunny bags for germination for the at least 20 hrs. sprinkling water periodically over the gunny bags to maintain moisture content.
Day 3	500gm of germinated seeds each for control and treatment were spread in each hydroponic tray into the lowest row of hydroponic machine.
Day 4-6	The trays were shifted to immediate upper row every 24 hours. The humidity and internal environment of the hydroponic device was maintained using automatic water sprinklers set for spraying at the rate of one minute every hour.
Day 7	Harvest of hydroponic fodder - The total biomass yield in each group from all the replicates were recorded. Representative samples, four each for control and treatment were analysed for proximate composition. Individual plant six each from control and treatment were measured for root and shoot length.

The proximate composition (AOAC, 2000) [2] was carried out for the dry bajra seeds, soaked bajra seeds (8 hours soaking), sprouted bajra seeds (28 hours soaking) and hydroponic bajra fodder finally obtained on the 7th Day. The experimental hydroponic fodder group (ATFD Salt) was prepared by inclusion of salt at the rate of 50 g per 3 kg of seed. Eight trays (four control trays and four treatment trays) were used for production of hydroponic bajra fodder. The results of the proximate composition, biomass yield and root to shoot ratio of the two groups were recorded and compared using an unpaired t-test.

3. Results and Discussion

The major and minor mineral compositions of the ATFD salt used as supplement are presented in the table 2. The major mineral composition of ATFD salt included sodium; 30.22%, magnesium; 1.80%, calcium; 1.18%, potassium; 0.99% and sulphur; 0.72%. Other mineral components found in lower concentration were iron; 67.16 ppm, selenium; 32.35 ppm, manganese; 20.33 ppm and copper; 5.74 ppm.

Table 2: Major and minor mineral composition of salt used as an additive (Mean ± S.E)

Major minerals	Level (%)	Minor minerals	ppm
Calcium	1.18 ± 0.07	Iron	67.16 ± 7.62
Phosphorus	0.01 ± 0.01	Manganese	20.33 ± 1.33
Potassium	0.99 ± 0.06	Copper	5.74 ± 0.31
Magnesium	1.80 ± 0.14	Selenium	32.35 ± 4.66
Sodium	30.22 ± 0.39	Cobalt	Less than 10
Sulphur	0.72 ± 0.07	Zinc	Below 20
Salt	81.17 ± 1.04	Molybdenum	Below 125

The proximate composition of the dry bajra seeds, seeds after soaking for 8 hours and germinated seeds are furnished in table 3. The proximate composition of dry bajra seed were found to be similar to earlier studies for protein (Kaur *et al*. 2014) [7], fat (Chowdhury and Punia, 1997) [3] and ash (Abdalla *et al*. 1998) [1].

Table 3: Proximate composition comparison of bajra grain soaked overnight (8 hours) and sprouted in gunny bags (20 hours) with or without mineral salt addition during soaking

Parameter	Bajra	Bajra soaked		Bajra sprouted	
	Dry seeds	Control	Treatment	Control	Treatment
Moisture (%)	10.16	35.66	36.55	25.96	23.10
Crude Protein (%)	7.99	8.03	6.74	7.43	7.00
Crude Fibre (%)	1.66	1.46	1.89	2.30	2.39
Ether Extract (%)	4.69	4.79	5.79	3.91	3.54
Total Ash (%)	1.95	1.56	1.30	1.35	1.06
Nitrogen free Extract (%)	83.71	84.16	84.28	85.01	85.64
Gross Energy (Kcal/kg)	-	-	-	3243	3342
Acid Insoluble Ash (%)	0.46	0.39	0.14	-	-

The fibre content was found to be more in the treatment group where bajra seeds were soaked in solution of ATFD salt. Soaking grains in acidic and alkaline solution has been found to affect inhibitory factors and also mineral bio-accessibility. Jha *et al*. (2015) [6] reported that grain soaking for short duration in acidic or alkaline medium resulted in a decrease in the inhibitory factors without loss in minerals.

The biomass yield, root length, shoot length, root to shoot ratio and proximate composition of hydroponics bajra fodder observed for control and treatment groups are presented in table 4. There was no significant difference ($p>0.01$) in the biomass yield while there was significant difference ($P<0.05$) among shoot length and highly significant difference ($P<0.01$) among root and root to shoot length ratio. The length of plant obtained in the present study was similar to that recorded by Murthy *et al.* (2017) [8] on day 5 for hydroponic bajra fodder.

Table 4: Proximate composition, bio mass yield, shoot length, root length and root to shoot comparison of hydroponics bajra fodder (on day 7) with or without mineral salt addition during soaking (Mean ± S.E)

Parameter	Bajra hydroponic fodder		Significance
	Control	Treatment	
Proximate composition$			
Moisture (%) NS	82.62 ± 0.21	79.72 ± 0.62	0.070
Crude Protein (%)*	9.51 ± 0.09	8.78 ± 0.04	0.010
Crude Fibre (%) NS	7.83 ± 0.03	7.17 ± 0.29	0.235
Ether Extract (%) NS	5.84 ± 0.02	5.85 ± 0.10	0.945
Total Ash (%) NS	2.34 ± 0.01	2.29 ± 0.05	0.653
Acid Insoluble Ash (%)*	0.32 ± 0.02	0.43 ± 0.01	0.048
Nitrogen free Extract (%)*	74.49 ± 0.12	75.91 ± 0.27	0.049
Physical parameters#			
Big mass yield (kg/kg of seed) NS	2.35 ± 0.04	2.40 ± 0.03	0.472
Shoot length (cm) (on 7th day)*	5.4 ± 0.15	6.9 ± 0.52	0.019
Root length (cm) (on 7th day)**	6.3 ± 0.24	4.9 ± 0.34	0.006
Root to shoot ratio**	1.17 ± 0.02	0.71 ± 0.02	0.000

*Significant, **Highly significant, NS- Non Significant

$ Mean of four observations #Mean of six observations

The proximate composition obtained for bajra hydroponic green fodder were in accordance with Jemimah *et al.* (2015) [5], with values of moisture; 74.8%, crude protein; 9.22%, crude fibre; 4.16%, ether extract; 4.57%, total ash; 1.49% and nitrogen free extract 80.56.

In the present study, there was no significant ($p>0.05$) difference between control and treatment groups for moisture, crude fibre, ether extract and total ash content, however there was a significant ($P< 0.05$) difference in crude protein, acid insoluble ash (AIA) and nitrogen free extract (NFE) composition. CP content was found to be lower in the treatment group. On the contrary, Dung *et al*. (2010) [4] reported increase in nitrogen content with use of nutrient solution in hydroponics fodder due to the uptake of nitrogenous compounds. However in their study the nutrients were supplied throughout the growth phase of hydroponic fodder production. Moreover, supplement used in the current study was not a source of nitrogen.

Fig 1: Automatic hydroponic device fabricated for the production of various fodders

Day 3 **Day 7**

Fig 2: Comparisons of control and treatment of hydroponic bajra fodder on Day 3 and Day 7

Fig 3: Comparisons of control and treatment of shoot and root of hydroponic bajra fodder on Day 7

4. Conclusion

The biomass yield of the hydroponics bajra fodder was not affected by ATFD salt. Nevertheless the plant grown with ATFD salt produced fodder with higher shoot length which could improve the palatability of hydroponic bajra fodder. The significant difference in the root to shoot length of the individual plant paves the way for further research to determine the minimum amount of salt required for gaining maximum shoot length and increasing the mineral profile of the hydroponic fodder bajra.

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