BIOMASS YIELD AND QUALITY OF HYDROPONICALLY GROWN FODDER FROM LOCAL SORGHUM (*Sorghum bicolor* L. Moench) VARIETIES IN GUINEA SAVANNAH ZONE OF NIGERIA

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ABSTRACT

A study was carried out to evaluate hydroponic biomass yield and quality, production cost, and proximate composition of Red, White, and Yellow local sorghum varieties. The experiment was laid out in a completely randomized design (CRD) comprising 3 sorghum varieties as treatments which were replicated 3 times. The results revealed that there was significant difference (P<0.05) in seeds cost and quantity required, fresh and dry fodder yield per square metre. Higher seeds quantity (668.49 g/m²) and seeds cost (₦ 658.29) were observed in yellow sorghum, while the least values (597.82 g/m² and ₦ 354.48) for seeds quantity and cost respectively were recorded in Red sorghum. However, there was no significant difference (P>0.05) among the sorghum varieties in sprout heights and number of leaves. It was also discovered that there were significant differences (P<0.05) in DM, moisture, CF and NFE contents of the seeds. Higher DM of 5.60 % which was statistically similar with 5.20 % found in Red and White sorghum varieties respectively. The highest CF (37.53 %) was observed in Red sorghum, while the highest NFE (30.63 % and 29.87 %) were found in Yellow and Red sorghum, respectively. For the hydroponic fodder produced, the DM, moisture and CF contents differed significantly (P<0.05). The highest DM (68.38%) and CF (37.10 %) were found in Yellow sorghum. While the least DM (51.11 %) and CF (30.03 %) were observed in White sorghum. However, no significant differences were recorded in Ash, EE and CP content of the hydroponic fodder from the three local sorghum varieties. For better yield and moderate production cost, white sorghum variety was recommended.

Keywords: Hydroponic, Sprouts, Fodder, Sorghum, Varieties,

INTRODUCTION

Livestock plays an important role in urban and peri- urban areas for the poor deriving their means of living out of it and for those involved in commercial activities (Ayele *et al*., 2003). However, livestock production has mostly been subsistence oriented and characterized by low reproductive and production performance of the animals. This is mainly attributed to shortage of feed in quality and quantity (Kassahun *et al*., 2016). Feed cost is always the largest single item expenditure in livestock production (Adeniji and Adewole, 2015).

Fodder production on agricultural land is a conflicting issue in countries with food shortages. There is continued competition for the utilisation of land for various agricultural activities. The utilisation of land for fodder crop production may be placed second to the utilisation of land for cereal grains, rice, oilseeds, and pulses, used as crops to feed the ever increasing population and to ensure food security. The increasing demand for cropland to produce food for human reduced the area of land available for natural grazing and forges production (Alemayehu, 2002). Because of these, the chance of obtaining green fodder for livestock is minimal. Green fodder is an essential component of the ruminants' ration to enhance their productive and reproductive performance (Shah *et al*., 2011). Ruminants cannot be sustained on cereal grains alone. Hydroponics forage production is an alternative technology to grow fodder for farm animals (Naik *et al*., 2015). Therefore, this study was aimed at evaluating the hydroponic biomass yield and quality, production cost, and proximate composition of three local sorghum varieties (Red, White, and Yellow).

MATERIALS AND METHODS

Experimental Site: The experiment was conducted in the month of November, 2024 at the Teaching and Research Farm, College of Agriculture and Animal Science, Ahmadu Bello University, Mando-Road, Kaduna. The area is situated at Latitude 10.58°N and Longitude 7.42°E, southern guinea savannah zone of Nigeria. It is characterized with tropical dry-and-wet climate. The wet season lasts for about 6 to 7 months (April to October) with an average annual rainfall of about 1323 mm, with the month of August being the peak of the wet season. Higher rainfall intensity occurs within the months of July and August (60 mm to 99 mm $hour^{-1}$) (Abaje and Oladipo, 2019; Shu'aibu *et al*., 2024). The highest average air temperature of about 28.9°C normally occurs in April while the lowest (22.9 to 23.1°C) occurs in December through January (NiMet, 2023).

Experiment Design: The experiment comprised of three local sorghum varieties (Red, White, and Yellow) as treatments which were laid out in a completely randomized design (CRD). Each treatment was sown in three different plastic trays as replicates. The experiment lasted eight (8) days.

Sowing procedures and hydroponic fodder production: The seeds of three local Sorghum varieties for this study were procured from local market in Kawo and Mando, Kaduna. The seeds were cleaned from debris and other foreign materials. Green fodder from the three local sorghum varieties were hydroponically produced using plastic trays. The trays were fabricated by longitudinally dividing five 25 litre-sized plastic Jerry cans into two equal halves each (46 cm x 20 cm). Measured quantity of seeds were soaked in 3.5 % Sodium Hydrochloride solution 1 ml to 70 ml of water for 20 minutes. The soaked seeds were then rinsed and thoroughly washed to remove all the dirt and foreign materials using fresh clean water obtained from a bore hole. The seeds were then soaked in clean borehole water for 24 hours, after which they were spread evenly on the planting trays. The trays were arranged on a wooden rack in an airy, naturally lit room (Martins *et al.*, 2023). The seeds were irrigated twice daily in the morning and evening (at 8:00 am and 5:00 pm) by gently sprinkling with known volume of water obtained from borehole using a perforated bottle water container. The planting trays were perforated at one end to allow for draining of excess water.

Data Collection and Proximate Analysis: Data on seeds weight, sprouts height and total fresh and dry fodder yields were recorded. Hydroponic fodder samples were collected, oven dried at 65°C for 48 hrs (Fazaeli *et al.*, 2012) and analysed on Dry Matter (DM) basis for Nitrogen, Ether Extract (EE), CF and Ash according to AOAC (2000). CP was calculated as N×6.25 (AOAC, 1990). NFE content was calculated using the formula; NFE = 100- CP-EE-Ash-CF (Traughber *et al.* 2021).

Statistical Analysis: The data on fodder yield and yield components, production cost, and proximate composition were subjected to Analysis of variance (ANOVA) using a computer statistical package, (SAS, 2008). Whenever the ANOVA declares significant difference among treatments, Fisher's Least Significant Difference tests (LSD) at α=0.05 was used to compare the treatment means.

RESULTS AND DISCUSSION

Fodder yield and yield components: The results of fodder yield, yield components and production cost (Table 1) revealed that there were significant (P<0.05) differences among the three local sorghum varieties in seeds cost and quantity, fresh and dry fodder yield per square metre. Higher seeds quantity (668.49 g/m^2) and seeds cost (₦ 658.29) were observed in yellow sorghum, while the least values (597.82 g/m^2 and ₦354.48) for seeds quantity and cost respectively were recorded in Red sorghum. However, there was no significant difference (P>0.05) among the sorghum varieties in sprout heights and number of leaves. Shu'aibu and Hamidu (2017), and Anonymous, (2024) stated that the production cost of a hydroponic fodder can vary significantly depending on crop variety, its production type and complexity.

Proximate composition of the hydroponic fodder: Table 2 shows the results of proximate composition of both the seeds and hydroponic fodder. It was discovered that there were significant difference (P<0.05) in DM, moisture, CF and NFE contents of the seeds. Higher DM of 5.60 % which was statistically similar with 5.20 % were found in Red and White sorghum varieties respectively. The highest CF (37.53 %) content was observed in Red sorghum, and the highest NFE (30.63 % and 29.87 %) contents were found in Yellow and Red sorghum respectively. Whereas, for the hydroponic fodder produced, the DM, moisture and CF contents of the three local sorghum varieties differed significantly (P<0.05). The highest DM (68.38 %) and CF (37.10 %) were found in Yellow sorghum. While the least DM (51.11 %) and CF (30.03 %) were observed in White sorghum. However, no significant difference was recorded in Ash, EE and CP content of the hydroponic fodder from the three local sorghum varieties. Saini (2012) attributed the increase in moisture in the body of the plant during germination to growth activities in the root and stem. The factors that affect the NFE value are ash, crude fiber, crude protein, and extract ether levels. Aqilla *et al.* (2021) stated that NFE comprises carbohydrates, amino acids, and vitamins. Pan *et al.* (2016) stated that during germination and growth, plants use carbohydrate reserves, which are assimilated by their metabolic activities, thereby increasing the crude protein fraction. Factors that affect protein content are harvesting age, type of seed, and plant food reserves.

Table 1: Hydroponic fodder yield, yield components and production cost

Parameter	Local Sorghum Varieties			LSD	LS
	Red	White	Yellow		
Seeds quantity (g/m^2)	597.82^c	646.74^b	668.49^a	2.173	*
Cost of seeds (₦/m^2)	354.48^c	360.24^b	658.29^a	0.459	*
Sprout height (cm)	11.05	11.62	8.370	1.2	NS
No of leaves	2.00	2.00	2.00	0.011	NS
Fresh fodder yield (g/m^2)	1303.23^b	1559.49^a	1051.52^c	1.736	*
Dry fodder yield (g/m^2)	738.11^b	797.01^a	719.00^b	21.903	*

$^{a, b, c,}$ Mean values in the same rows with different superscript are significantly (P<0.05) different. LSD = Least significant difference. LS = Level of significance. * Significantly differ. NS = Not significantly different

Table 2: Proximate composition of three local varieties of sorghum

Parameter (%)	Local Sorghum Varieties			LSD	LS
	Red	White	Yellow		
Grains/Seeds					
DM	5.60[a]	5.20[ab]	4.97[b]	0.52	*
Moisture	94.40[b]	94.80[ab]	95.03[a]	0.52	*
Ash	8.17	6.67	5.27	3.043	NS
EE	8.43	5.67	8.57	4.078	NS
CP	17.13	18.1	17.57	1.622	NS
CF	37.53[a]	33.80[ab]	30.33[b]	3.613	*
NFE	23.00[b]	29.87[a]	30.63[a]	2.374	*
Hydroponic Fodder					
DM	56.64[b]	51.11[c]	68.38[a]	1.998	*
Moisture	43.36[b]	48.89[a]	31.62[c]	2.004	*
Ash	5.47	6.23	5.57	3.549	NS
EE	5.93	10.1	5.47	9.882	NS
CP	16.77	16.38	15.8	2.468	NS
CF	34.83[ab]	30.03[b]	37.10[a]	5.121	*
NFE	28.77	28.07	29.33	7.276	NS

[a, b, c,] Mean values in the same rows with different superscript are significantly (P<0.05) different. LSD = Least significant difference. LS = Level of significance. * Significantly differ. NS = Not significantly different

CONCLUSION

From results of this study, it can be concluded that white sorghum showed better green and dry fodder production with relatively moderate cost under hydroponic conditions than the other varieties. White sorghum was therefore considered the best choice that can be used for production of hydroponic green fodder with better dry matter yield. There was also need for further research to investigate the fodder yield and quality with extended growing periods, as well as the acceptability and feeding value of hydroponic sprouts from sorghum varieties so as to ascertain the profitability or otherwise in their utilization for commercial and or subsistence animal production.

REFERENCES

Abaje, I.B. and Oladipo, E.O. (2019) Recent Changes in the Temperature and Rainfall Conditions over Kaduna State, Nigeria. *Ghana Journal of Geography*, 11, 127-157.

Adeniji, A.A Adewole, O.A (2015). Effects of Feeding Graded Levels of Brewers Dried Grains with or without Probiotics Supplementation in Replacing Groundnut Cake in The Diet of Weaner Rabbits. *Journal of Natural Sciences Research* (Online). Vol.5, No.7, 2015.

Alemayehu M and Getnet A (2012). The evaluation of forage seed production in Ethiopia. In: Getnet Assefa, Mesfin Dejene, Jean Hanson, Getachew Anemut, Solomon Mengistu Alemayehu Mengistu (eds), Forage seed research and development in Ethiopia. Ethiopia institute of Agricultural research, Addis Ababa, Ethiopia. Pp 15-32.

Anonymous (2024). The Economics of Hydroponics: Evaluating Costs and Profitability for Hydroponic Farms. https://hydroponicharmony.com/the-economics-of hydroponics/?feed_id=4035&_unique_id=65f40a8dd5591

AOAC (2000). Association of Official Analytical Chemists. Official methods of analysis of the association of official analytical Chemists International 17th edn. Association of Official Analytical Chemists International, Arlington, VA, USA.

Aqilla H.R., Latif H, Daud M. (2021). Effect of the use of black soldier fly (*Hermetia Illucens*) and sprouted fodder for chicken (Sf2C) in fermentation feed on the production and quality of hybrid chicken eggs. *J Ilmiah Mahas Pert*; 6(3):79–87; https://doi.org/10.17969/jimfp.v6i3.18260

Ayele Solomon, Assegid Workalemahu, Jabbar M.A., Ahmed M.M.and Belachew Hurissa. (2003). Livestock marketing in Ethiopia: A review of structure, performance and development initiatives. Socio-economics and Policy Research Working Paper 52. ILRI (International Livestock Research Institute), Nairobi, Kenya. 35 pp

Belton, PS. and Taylor, JRN. 2004. Sorghum and millets: Protein sources for Africa. *Trends in Food Science and Technology*, 15(2): 94-98.

Fazaeli, H., Golmohammadi, H.A., Tabatabayee, S.N. and Asghari-Tabrizi, M. (2012). Productivity and Nutritive Value of Barley Green Fodder Yield in Hydroponic System. *World Applied Sciences J.,* 16 (4): 531-539.

Kassahun Gurmessa, Taye Tolemariam, Adugna Tolera, Fekadu Beyene, (2016). Production and Utilization of Crop Residues in Horro and Guduru Districts, Western Ethiopia. Food Science and Quality Management Vol.48, 2016.

Martins, U., Giwa, L.A., Ohanaka, A.U.C., Ukwadinamor, J.U. , Anyanwu, N.J. and Okoli, I.C.(2023). Impact of growth period on the biomass yield and dry matter content in sorghum and millet hydroponic fodders. *International Journal of Agric. and Rural Devpt.* Vol. 26(1): 6688-6693.

Naik PK, Swain BK, Singh NP (2015), Hydroponics: its feasibility as an alternative to cultivated forages. In: Proc. 9th Biennial Animal Nutrition Association Conference on 'Eco-responsive Feeding and Nutrition: Linking Livestock and Livelihood' held at Guwahati, India, pp. 74-87.

NIMET (2023). Nigerian Meteorological Agency, Kaduna Airport, Kaduna State, Nigeria.

Pan L., Li P., Ma X.K., Xu Y.T., Tian Q.Y., Liu L., (2016). Tannin is a key factor in the determination and prediction of energy content in *Sorghum* grains fed to growing pigs. American Soc Anim Sci; 94:2879–89; https://doi.org/10.2527/jas2016-0457

Saini, A. (2012). Forage quality of sorghum (*Sorghum bicolor*) as influenced by irrigation, nitrogen levels, and harvesting stage. *Indian Journal of Scientific Research,* 3(2): 67-72.

SAS (2008). Statistical Analysis System. Statistical Analysis System (SAS/STAT Program, Version 9.1). SAS Institute Inc., Cary, NC.

Shah, V.D., Makwana, M., Sharma, S. (2011).Economics of production, processing and marketing of fodder crops In Gujarat. India Research Study No.144.

Shu'aibu, A.S. and Hamidu, H.A. (2017). Hydroponic fodder production potential from guinea corn, maize, pearl millet and wheat in kaduna, nigeria in: Umar, U.A, , Y. D Ndirpaya, C. Ekuenobe, P. Baushe, M.B Muhammad and S. Usman (eds). The Green Alternative: Agriculture as Engine for Nigeria's Economic Growth. Proceedings of the 51th Con. of the Agric. Soc. of Nig., Held at Agric. Res. Council of Nigeria, Abuja FCT 23 - 27 Oct., 2017.

Shu'aibu, A.S., Hassan, A.H., Dahiru, M.G. and Bature, M.S. (2024). Acceptability ratings and nutritive value of four selected fodder species by yankasa sheep in sub-humid Nigeria. In: O. A. Abu, O. J. Babayemi, M. K. Adewumi (Eds.). The Proceedings of the 49th Annual Con. of the Nig. Soc. for Ani. Prod. (NSAP), held at the Uni. of Ibadan, Nigeria. 24 – 27 March, 2024. P 1645 – 1649.

Traughber, Z.T., Detweiler K.B., Price A.K., Knap K.E., Harper T.A., Swanson K.S., (2021). Effect of crude fiber and total dietary fiber on the calculated nitrogen-free extract and metabolizable energy content of various dog foods fed to client-owned dogs with osteoarthritis. *Am. J. Vet. Res.*; 82(10):787–94; https://doi.org/10.2460/ ajvr.82.10.787