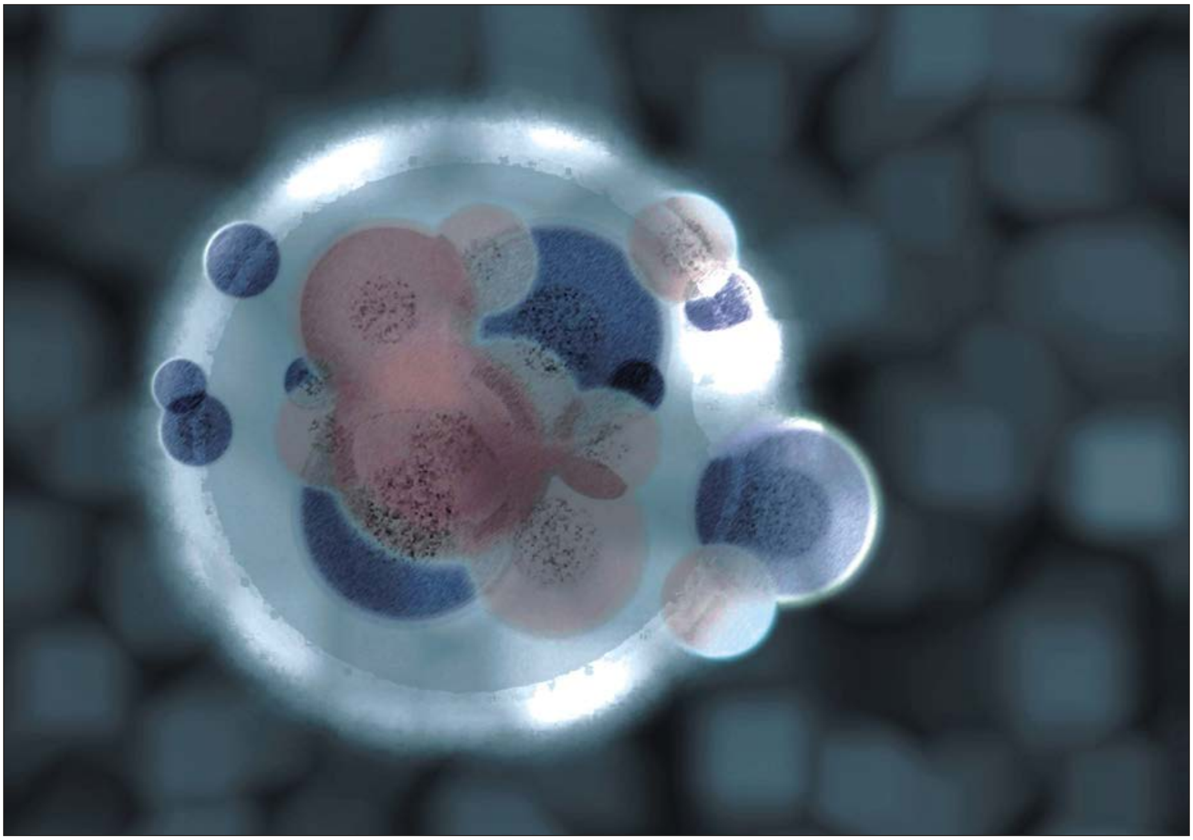

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# Evaluation of Pearl Millet Accessions for Yield and Nutrient Composition

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**Abstract:** An experiment was carried out in 2001 and 2002 at the Forage and Crop Residue Research Programme of the National Animal Production Research, Institute, Shika, Nigeria, to evaluate the yield components and nutrient composition of three accessions of pearl millet (Mokwa, Bunkure and Kankara). The three accessions were planted in completely randomized block design in three replications. Sowing was carried out in both years of the trial at the rate of 4 kg seeds per hectare on 10×7.5 m plot. Parameters assessed included plant height, number of tillers/culm, percentage green, leaf:stem ratio, fodder yield (fresh and dry weights). CP, CF, EE, NFE, ash, P, Ca and Mg. Results showed that at 116 post-planting, there were varietal differences in height, tillering ability, leafiness and greenness, which were found significant ($p<0.05$). The Bunkure accession which was taller, greener and higher in number of tillers had the highest fodder yield of 9.07 and 7.32 t ha$^{-1}$ of fresh weight and dry weight, respectively. In the three accessions there were no significant differences ($p>0.05$) in the leaf:stem ratio. Differences between accessions in terms of EE, NFE and P were not significantly different ($p>0.05$) while significant differences were noticed in ash, CP, CF and Mg content of the millet accessions.

**Key words:** Accessions, evaluation, millet, nutrient, yield

## INTRODUCTION

Pearl millet (*Pennisetum americanum*) is a hardy, dual purpose, staple crop in crop livestock production systems of the arid zones especially in India where severe drought stress is a regular feature and timing and intensity of drought are unpredictable (van Oosterom *et al*., 1996) and can grow in most places where other crops will not. It tolerates rocky sandy soils (Egharevba, 1979) which are prevalent in Nigerian semi-arid region, the major livestock producing area of the country. Irvine (1979) and Agboola (1979) described pearl millet as suited to the drier semi-arid environments because it can germinate under relatively low soil moisture conditions and can thrive with an annual rainfall of 250 mm. However, van Ooesterom *et al.* (2006) suggested that under severe stress with restricted assimilated supply, high tillering small panicled landraces are better able to produce a reproductive sink than are large panicled ones. It is indigenous and adapted to the Sahel and the Sudan savanna zones of Nigeria.

Forage yields of pearl millet vary very widely from less than 3 tonnes to over 20 tonnes of dry matter per hectare depending on the climate, soil, fertilizers and cultivars with an average dry matter (DM) yield of 7-10 t ha$^{-1}$ on well managed farms (Bogdan, 1979). Ghosh (2004) reported an experiment in which the highest green fodder yield in intercrops was recorded in pearl millet with two cuts (16.5 t ha$^{-1}$) followed by pearl millet with one cut (11.8 t ha$^{-1}$). Blummel *et al.* (2003) reported up to 6.0 t ha$^{-1}$ in a breeding experiment comparing a number of pearl millet cultivars. In Australia cv. *Katherine pearl* selected from material received from Ghana, showed outstanding performance in the Northern Territory where it averaged almost 13 t DM ha$^{-1}$ during 11 years of trials, the maximum yield being about 22 t DM ha$^{-1}$ (Barnard, 1972). Also in New South Wales, cv. *Tamworth* a hybrid cultivar developed from *Gahi-1* gave an average yield of about 9.7 t DM ha$^{-1}$, out yielding the *Katherine* and *Ingrid* cultivars when they were grown for comparison in the New South Wales (Barnard, 1972). Under the semi-arid environment in Nigeria, the highest yield of 6.84 t DM ha$^{-1}$ was obtained from the cultivar *ex-Gashua* millet cut at the height of 20 cm (Barnard, 1972). The 20 cm cutting height gave the highest yield because it had more effective regeneration of plants after each cutting.

The present research reports the results of experiments performed to evaluate the fodder yield potential of three accessions of pearl millet in the Northern Guinea savanna of Nigeria.

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## MATERIALS AND METHODS

In 2001 and 2002 an experiment was conducted at Shika, in the Northern Guinea savanna of Nigeria to examine the potential of late pearl millet for fodder production and nutrient composition.

The trial was conducted at the National Animal Production Research Institute, Shika, Nigeria (11°12'N. 7°33'E). Annual rainfall varies from 800-1300 mm with long-term average of 1050 mm and approximately 95% occurring in May-October. The wettest month, has a mean maximum temperature of 27.5°C, whereas the mean maximum temperature during the hottest month, April, is 35.2°C. The soil of the experimental site is a ferruginous tropical soil which developed over schists, gnesis and quartzites (Klinkenberg and Higgins, 1968). Table 1 shows the rainfall received during the trial years and the long-term means for the experimental area. Three accessions of pearl millet: Mokwa, Bunkure and Kankara, were used in field trials. The accessions belong to the group of Maiwa which are photoperiod sensitive and late-maturing (over 120 days) and are usually found in high and low altitudes areas (Egharevba, 1978). The three accessions were planted in completely randomized block design in three replications.

Sowing was done on 6th and 8th June, in 2001 and 2002, respectively, at the rate of 4 kg seeds per hectare on 10×7.5 m plot. Within the plots, planting was done on ridges 75 cm apart while spacing within ridges was 25 cm between plants. Fertilizer were applied at the rate of 50 kg N $ha^{-1}$. The source of N and P were Calcium ammonium nitrate (36% N) and Single superphosphate (18% $P_2O_5$), respectively. Weeding was done manually with hoes at 3 and 6 weeks post-planting to control undesirable plants. Field samplings were carried out within the growing period to monitor phenological development and fodder production. Sampling for forage yield components was carried out at 116 days post-planting for the three late millet accessions. The yield components investigated include plant height, tiller production, greenness, leaf:stem ratio and fodder yield (fresh and dry weights).

Table 1: Rainfall distribution (mm) in (2001-2002) and medium-term (1989-1999) means for Shika, Nigeria

| Months | Medium-term mean | 2001 | 2002 |
|---|---|---|---|
| April | 36(6)* | 58(8) | 79(3) |
| May | 120(9) | 76(14) | 315(16) |
| June | 175(14) | 177(12) | 163(13) |
| July | 250(12) | 250(16) | 243(12) |
| August | 279(24) | 274(29) | 81(8) |
| September | 172(13) | 203(17) | 81(8) |
| October | 42(5) | 58(7) | 43(4) |
| Total | 1074(83) | 1096(94) | 1307(71) |

*Values in parentheses are number of rainy days

Prior to sampling at 116 days post-planting, the number of tillers per plot was counted, the height of 10 randomly selected plants was measured using a measuring tape from the plant's base to the tip of the tallest foliage and the leaf:stem ratio calculated from the same 10 plants. Percentage greenness was estimated by comparing the 10 randomly selected plants with plants having 100% green leaves.

Sampling for yield estimation was done by cutting plants within a 1 $m^2$ quadrat with hand sickles to a height of 10 cm above ground level from each plot. The samples from each quadrat were weighed using a hanging spring-balance scale and a baft bag which was also weighed. Sub-samples of 150-200 g of the fresh material were oven-dried at 65°C for 48 h and reweighed to estimate dry matter yield.

Thereafter, dry samples of the forage were taken, milled to pass through a 1 mm sieve. Proximate analysis of crude protein (CP), ash, crude fibre (CF), ether-extract (EE) and N-free extract (NFE) were determined by the methods of AOAC (1984). Calcium (Ca), Phosphorus (P) and Magnesium (Mg) concentrations were measured by wet digestion oxidation described by AOAC (1975).

The values presented in this research represent the averages for the 2 years of the trial. The results were similar in both years. The data were subjected to the analysis of variance procedure and the means compared by the Duncan's Multiple Range Test as described by Steel and Torrie (1980).

## RESULTS

**Yield components and nutrient composition:** Table 2 shows the yield components of three late maturing pearl millet accession at 116 days post-planting. Varietal differences in height, tillering ability and greenness were significant ($p<0.05$). The Bunkure accession which was taller, greener and higher in number of tillers had the highest fodder yield of 9.07 and 7.32 t $ha^{-1}$ of fresh weight and dry weight, respectively. Followed by the Bunkure

Table 2: Yield components of three late-maturing pear millet accessions grown in the sub-humid savanna of Nigeria at 116 days post-planting

| | Millet accessions | | | |
|---|---|---|---|---|
| Yield component | Mokwa | Bunkure | Kankara | SEM |
| Plant height (cm) | $161.70^c$ | $196.10^a$ | $170.95^b$ | ±0.81 |
| Tiller (No. culm) | $22.63^c$ | $26.17^a$ | $25.80^b$ | ±0.11 |
| Leaf (No. culm) | $47.77^c$ | $77.95^a$ | $60.65^b$ | ±0.19 |
| Green (% of total leaves) | $74.12^c$ | $78.87^a$ | $75.95^b$ | ±0.11 |
| Leaf: stem ratio | 0.50 | 0.50 | 0.50 | ±0.00 |
| Fresh fodder yield (ton/ha) | $7.58^c$ | $9.07^a$ | $8.70^b$ | ±0.09 |
| Dry matter yield (ton/ha) | $6.20^c$ | $7.32^a$ | $7.08^b$ | ±0.07 |

Within rows, values followed by different letter(s) are significantly different ($p<0.05$)

accession in terms of fodder production were the accessions Kankara and Mokwa with fresh weight of 8.70 and 7.58 t $ha^{-1}$ and dry weight of 7.08 and 6.20 t $ha^{-1}$, respectively. With the exception of leaf:stem ratio, where there was no significant differences ($p>0.05$) between the accessions, all other yield components were found to be significant ($p<0.05$) in the three accessions.

Differences between accessions in nutrients such as EE, NFE and P were not significantly different ($p>0.05$), while significant differences were noticed in ash, CP, CF and Ca contents of the millet accessions (Table 3).

**Interactions:** Table 4 shows the interactive effects between year of trial and accession on yield components of millet accessions. With the exception of the leaf:stem ratio component which had shown no significant interaction ($p>0.05$) between the year of establishment and accession, all other yield components were significantly different ($p<0.05$). In both years of the trial, the Bunkure accession produced the tallest and greenest plants, followed by accession Kankara and Mokwa, respectively. There were also significant interactions in ($p<0.05$) fodder yields of the three accessions of the millet. In the fresh weight, the significant differences were produced by Mokwa accession in both years of the trial.

Table 3: Nutrient composition of three late-maturing pearl millet accessions at 116 days post-planting

| | Millet accessions | | | |
|---|---|---|---|---|
| Nutrient | Mokwa | Bunkure | Kankara | SEM |
| Crude protein | $7.33^{a}$ | $6.00^{c}$ | $6.88^{b}$ | ±0.09 |
| Crude fibre | $34.25^{b}$ | $35.62^{ab}$ | $35.85^{a}$ | ±0.45 |
| Ether extract | 2.87 | 3.02 | 2.85 | ±0.07 |
| N-free extract | 50.20 | 48.75 | 49.45 | ±0.46 |
| Ash | $9.37^{c}$ | $10.40^{b}$ | $12.57^{a}$ | ±0.09 |
| Phosphorus | 0.20 | 0.20 | 0.20 | ±0.00 |
| Calcium | $0.20^{a}$ | 0.10 | $0.10^{b}$ | ±0.00 |
| Magnesium | 0.55 | 0.57 | 0.57 | ±0.02 |

Within rows values followed by the different letter(s) are significantly different ($p<0.05$)

Table 4: Effect of year and accession on yield components of pearl millet grown in the sub-humid zone of Nigeria

| | | Millet accession | | | |
|---|---|---|---|---|---|
| Yield component | Year | Mokwa | Bunkure | Kankara | SEM |
| Plant height (cm) | 1993 | $160.23^{b}$ | $180.20^{a}$ | $163.13^{b}$ | ±1.14 |
| | 1994 | $196.13^{a}$ | $196.13^{a}$ | $170.97^{b}$ | |
| Tillering (No. culm) | 1993 | $22.67^{b}$ | $25.97^{a}$ | $22.60^{b}$ | ±0.15 |
| | 1994 | $23.37^{c}$ | $26.37^{a}$ | $24.77^{b}$ | |
| Leafiness (%total leaves) | 1993 | $74.10^{c}$ | $78.90^{a}$ | $75.97^{b}$ | ±0.16 |
| | 1994 | $74.13^{c}$ | $78.83^{a}$ | $75.93^{b}$ | |
| Leaf: stem ratio | 1993 | 0.50 | 0.50 | 0.50 | ±0.00 |
| | 1994 | 0.50 | 0.50 | 0.50 | |
| Fresh forage yield (ton/ha) | 1993 | $7.63^{c}$ | $9.10^{a}$ | $8.70^{b}$ | ±0.20 |
| | 1994 | $7.53^{c}$ | $8.70^{a}$ | $8.50^{b}$ | |
| Dry matter yield (ton/ha) | 1993 | $6.20^{c}$ | $7.30^{a}$ | $7.10^{b}$ | ±0.09 |
| | 1994 | $6.20^{c}$ | $7.33^{a}$ | $7.07^{b}$ | |

Within component, values between and within rows followed by different letter(s) are significantly different ($p<0.05$)

Table 5: Effect of years of trial and accession on nutrient composition of three late-maturing millet accessions grown in the sub-humid zone of Nigeria

| | | Millet accession | | | |
|---|---|---|---|---|---|
| Nutrient composition | Year | Mokwa | Bunkure | Kankara | SEM |
| Crude protein | 1993 | $7.33^{a}$ | $6.00^{c}$ | $6.97^{b}$ | ±0.13 |
| | 1994 | $7.33^{a}$ | $6.00^{c}$ | $6.80^{b}$ | |
| Crude fibre | 1993 | $34.20^{b}$ | $35.77^{a}$ | $35.80^{b}$ | ±0.63 |
| | 1994 | $34.30^{b}$ | $35.97^{a}$ | $35.90^{b}$ | |
| Ether extract | 1993 | 2.77 | 3.00 | 2.83 | ±0.10 |
| | 1994 | 2.97 | 3.03 | 2.87 | |
| N-free extract | 1993 | 50.27 | 48.30 | 49.27 | ±0.63 |
| | 1994 | 50.13 | 49.20 | 49.63 | |
| Ash | 1993 | $9.40^{c}$ | $10.33^{b}$ | $12.53^{a}$ | ±0.13 |
| | 1994 | $9.33^{c}$ | $10.47^{b}$ | $12.60^{b}$ | |
| P | 1993 | 0.20 | 0.20 | 0.20 | ±0.00 |
| | 1994 | 0.20 | 0.20 | 0.20 | |
| Ca | 1993 | 0.20 | 0.20 | 0.20 | ±0.00 |
| | 1994 | 0.20 | 0.20 | 0.20 | |
| Mg | 1993 | $0.57^{b}$ | $0.57^{b}$ | $0.60^{a}$ | ±0.00 |
| | 1994 | $0.53^{c}$ | $0.57^{b}$ | $0.63^{a}$ | |

Within nutrient, values between and within rows followed by different letter(s) are significantly different ($p<0.05$)

There were no significant differences ($p>0.05$) in other two accessions, but in the dry weight, there were significant differences between the three accessions of millet in both years of trial and this was found consistent.

Table 5 shows the interactive effects between year of trial and accession on nutrient composition of millet accessions. There were no significant differences in the interaction for NFE and P. All other nutrient composition were significantly different ($p<0.05$) in the interactions. The CP varied significantly ($p<0.05$) from 7.33 in Mokwa accession to 6.00 in Bunkure in both years of trial. Both Bunkure and Kankara accessions were noticed with higher crude fibre and ether-extract contents, while ash content was highest in Kankara, followed by accession Bunkure and Mokwa, respectively.

## DISCUSSION

The selection of a plant species as a forage material is dependent upon its yield per unit area of land, rate of DM accumulation, nutritional quality and its quality as a forage. Results of this study support previous observations of Bishnoi *et al.* (1993) which observed pearl millet producing 1.5 to 2 times as much as Sudax, grainand forage sorghum. The results obtained from these authors, showed that pearl millet harvested at milk stage contained a similar percentage protein to sudax, grain and forage sorghum. Moreover, the crop has additional advantage of faster growth rate, higher yield and its ability to survive in low rainfall area of the tropics which may encourage its utilization as a forage crop.

In the present study, the millet accessions were found to be prolific, fast growing fodder crops capable of producing adequate fodder for grazing or ensiling within the season of establishment. At 116 days post-planting, the pasturage was in its late vegetative stage with a fresh yield of 7.58. 9.07 and 8.70 t ha$^{-1}$ for accession Mokwa. Bunkure and Kankara, respectively (Table 4). Similarly, at this stage of harvest, the forage of the three accessions of millet had an average of 24.86 tillers/culm and 76.30% greenness. The yield components of these accessions of millet compare favourably with the yield components reported for conventional fodder grasses grown in Nigeria for either hay or silage production such as *A. gayanus*, (Haggar, 1975), *Pennisetum purpureum* (Akinola, 1982) and *Brachiaria decumbens* (Okeagu *et al*., 1989).

The mean nutrient concentrations determined were comparable with the values reported by Bishnoi *et al.* (1993) for pearl millet. Makeri and Ugherughe (1992) have reported Magnesium and Calcium contents of pearl millet to range from 0.19 to 0.87% and 0.41-1.71%, respectively. These values are much higher than the dietary Mg and Ca requirements of beef and dairy cattle which are between 0.04 and 0.18%. The same authors also reported that the crude protein of various cultivars of pearl millet grown under semi-arid conditions of Nigeria ranged from 10.1 to 20.3%. in the first cutting and from 10.8-23.1% in the fourth cutting. These values fall within the acceptable levels for forage pearl millet that have been reported by Whiteman (1980). According to Whiteman (1980), a finishing beef steer of 300 to 500 kg liveweight requires 11% CP, whereas a 550 kg dairy cow, producing 20 kg milk/day will require 15-16% CP. Thus, the crude protein concentration of the three accession of millet obtained in this study, will not meet the dietary protein requirements of beef and dairy cattle, protein supplementation may be necessary.

Perhaps, the low mean nutrient composition obtained in this study may be attributed to late vegetative stage when the plants were harvested. Differences in nutrient composition of different forage species with advancing growth should be considered while determining the optimum stage of utilization to derive maximum benefit without adversely affecting subsequent herbage productivity. Nutrient composition also varies vertically in sward due to endogenous variations in maturity along this axis. The top of the sward, therefore, remains young and contains low amounts of cell wall components. Pear millet cut at the early vegetative stage and analysed in India, (Gaswami *et al*., 1970) contained 6.8-12.8% CP, 0.9-1.8% EE, 29-34% CF and 41-52% NFE; the same plants showed high contents of Ca, 0.29-0.69% and still, higher contents of P, 0.47-0.84%.

In summary, differences between cultivars were relatively small and all 3 accession could be grown. Chemical analysis indicated higher crude protein contents for Mokwa accession, while crude fibre and ash contents, on the other hand was higher in Kankara accession. Bunkure accession had least crude protein and crude fibre contents.

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