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Evaluation of fodder pearl millet genotypes for improved nutritional quality in coastal plain zone of Odisha

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Abstract
The present investigation was undertaken to evaluate the nutritional quality of fodder pearl millet genotypes in coastal plain zone of Odisha. Twenty eight genotypes were evaluated in RBD with three replications. The genotypes were harvested at 50% flowering stage and plants were dried properly for analysis of crude protein, dry matter, ash, phosphorus. Copper and zinc content was estimated following atomic absorption spectrophotometer (AAS) method. Dry matter % of the genotypes ranged from 20.65 (PFC 50) to 27.64 (FSFBH-502). The genotype Pusa-2101 recorded the highest crude protein % (9.35). The maximum phosphorus content was observed in IIMR-FB-MC-2022-1 (784.4 ppm). Copper content of the fodder pearl millet genotypes ranged from 1.28 ppm to 6.96 ppm with the genotypic mean of 3.48 ppm. The highest zinc content was observed in case of APFB-9-1 (16.93 ppm). The best genotypes identified for coastal plain zone of Odisha were ADV 2386), VAPFB-9-1 and JPM-18-71.

Keywords: Pearl millet, fodder quality, crude protein, phosphorus, copper and zinc

Introduction
Fodder pearl millet (Bajra) cultivation is vital in India due to its resilience in arid and semi-arid regions, where water scarcity is common. It plays a crucial role in providing nutritious fodder for livestock, especially during dry seasons when other crops may fail. Pearl millet is drought-tolerant, fast-growing, and produces a high biomass, making it an excellent feed source for cattle, goats, and sheep. Additionally, it supports the livelihoods of smallholder farmers and contributes to food security by sustaining dairy and meat production. Its adaptability to poor soils and harsh climates enhances its significance in sustainable agriculture. India faces frequent droughts and water shortages, making pearl millet an ideal crop due to its high drought tolerance and minimal water requirements. It thrives in poor soil conditions where other crops struggle, making it a reliable source of food and income for smallholder farmers in these regions.

One of the primary reasons for its cultivation is its role in livestock feeding. India has one of the largest livestock populations in the world, and ensuring a consistent supply of quality fodder is essential for maintaining the dairy and meat industries. Pearl millet produces a high biomass, providing ample green fodder with good nutritional value, including proteins, fibers, ash content and essential minerals like phosphorus, copper and zinc that support the growth and health of animals like cattle, sheep, and goats

Nutritional quality is crucial for fodder as it directly affects livestock health, productivity, and overall farm efficiency. High-quality fodder ensures adequate protein, fiber, vitamins, and minerals, supporting optimal digestion, growth, reproduction, and milk or meat production. Balanced nutrient content enhances immunity, reducing disease susceptibility and veterinary costs. Poor-quality fodder leads to malnutrition, low productivity, and increased feed supplementation expenses. Digestibility, energy levels, and palatability also impact consumption and nutrient absorption. Selecting nutrient-rich fodder varieties and adopting proper harvesting, storage, and preservation techniques help maintain quality, ensuring sustainable livestock farming and improved economic returns for farmers.

In the present investigation twenty eight pearl millet genotypes were evaluated for their nutritional profile in coastal plain zone of Odisha to identify the best genotypes for fodder quality.

Materials and Methods

The experimental materials comprised of 28 fodder pearl millet genotypes (Table 1).The experiment was conducted in a randomized block design (RBD) with three replications at AICRP on Forage Crops & Utilization, OUAT, Bhubaneswar during the year 2023. The soil of the experimental site was sandy loam with p^H of 4.83. Seeds of 28 genotypes were sown in 6 rows and each row length was 4m. The plot size was 4 m x 1.8 m. Row to row spacing was 30 cm. Fertilizers were applied @ 80: 40: 40 kg of N: P_2O_5: K_2O/ha. Farm yard manure was applied @ 5 tonnes/ha at the time of last ploughing. Irrigation was provided as and when it was required. All the recommended agronomic and crop protection practices were followed to raise a good crop. For fodder purpose harvesting was done at the time of 50% flowering. After harvesting plant samples were dried under sun light for 2 to 3 days and then oven dried to estimate dry matter, crude protein, ash, phosphorus, copper and zinc content as follows. Data on nutritional parameters were analysed following SAS sotware version 9.3. The least significant test was used to decipher effects of treatments at 5% level of significance (p<0.05).

Dry matter content (%)

Plants from each genotype were collected and shade dried until total moisture evaporated. Then plants were kept in hot air oven at 80 °C for 48 hours and their dry weight were weighed.

$$\text{Dry matter \% in sample} = \frac{\text{Weight of dried sample}}{\text{weight of fresh sample}} \times 100$$

Estimation of crude protein content

Protein content of plant sample had been determined by estimating the nitrogen content as per the modified Kjeldahl's method (Jackson, 1967) [3] and multiplying the nitrogen content with a factor 6.25 (Dubetz and Wells. 1965) [2] and expressed on percentage basis for each genotype. The crude protein (CP) contents was analyzed using AOAC (2005) [1].

$$\text{Percent N content in sample} = \frac{(\text{sample titrate - Blank titrate}) \times \text{Normality of HCl} \times 14 \times \text{Volume by digestion} \times 100}{\text{Aliquot of digestion taken} \times \text{sample weight (gm)} \times 1000}$$

Protein % = Nitrogen % × 6.25

Determination of Ash content

2-5 g of dried leaf sample was kept in crucibles of known weight. Crucibles are placed in the muffle furnace at a temperature of 550 °C for 6 hours. After burning of all materials the crucible with white ash was cooled and weighed. The ash content was expressed in terms of the oven-dried weight of the sample. The ash contents was analyzed using AOAC (2005) [1].

$$\text{Total ash \%} = \frac{(\text{weight of empty crucible} + \text{ash}) - \text{weight of empty crucible}}{(\text{weight of empty crucible} + \text{sample}) - \text{weight of empty crucible}} \times 100$$

Determination of copper and zinc content

From the each genotype 0.5 gm quantity of powdered plant sample was taken for wet digestion and the procedure of Nagawade *et al.* (2017) [4] was followed for wet digestion. Cu and Zn content was analysed using an atomic absorption spectrophotometer (AAS) at 324.8 nm (Cu) and 213.86 nm (Zn) for which electron discharge lamp was used. The accuracy and precision of the instrument was calibrated with standards with every 28 samples and the contents was recorded as parts per million (ppm).

Determination of Phosphorus content (ppm)

After ash extraction, the white ash was dissolved in mineral acid (HCl / HNO_3) mixed thoroughly and filtered with filter paper (Whatman No. 1) and volume was made up to 50 ml. 5 ml of aliquot solution was pipetted into 25 ml volumetric flask to which 5 ml of Vanadomolybdate was added. Total phosphorus was determined by Vanadomolybdate yellow colour method at 470 nm wavelength by using a spectrophotometer. A series of known standards of phosphorus were prepared and the instrument was calibrated.

Results and Discussion

Performance of pearl millet genotypes for nutritional quality

Dry matter content (%): Maintaining optimal dry matter content in green fodder is essential for better nutrition, improved digestibility, higher animal productivity, and efficient fodder conservation. Silage-making and hay preparation depend on proper dry matter content to avoid spoilage and microbial growth. Optimal dry matter levels improve rumen fermentation, leading to better digestion and energy release. If DM is too low (too watery), animals may consume less**,** leading to reduced milk production and weight gain. Dry matter % of the genotypes ranged from 20.65 (V10: PFC 50) to 27.64 (V11: FSFBH-502) with a mean value of 24.52 (Fig. 1). The differential response among the genotypes for dry matter content (%) may be attributed due to variation in their genetic make-up. Similar finding was reported by Phogat *et al.* (2012) [5] under salinity condition.

Crude protein content (%)

Crude protein content of any fodder crop is a major quality trait as it is needed for overall development of all dairy animals. Crude protein content of the genotypes is presented in Fig.2. From Fig. 2, it was observed that crude protein content of the genotypes ranged from 6.20 to 9.35% with a mean of 7.71%. Higher protein content improves fodder quality. The genotype V13 recorded the highest crude protein % (9.35) and it was at par with V10 (9.07%) and V14 (8.88%). V8 had the lowest crude protein content (6.20%).

Table 1: List of pearl millet genotypes

Sl. No	Genotype	Source
V1	JHPM-23-2	IGFRI, Jhansi
V2	ADV 2386	Advanta Seeds
V3	SBH 105	Rasi Seeds, Hyderabad
V4	APFB-9-1	Hyderabad
V5	FBL-9	PAU, Ludhiana
V6	JPM-18-82	JNKVV, Jabalpur
V7	Giant Bajra	MPKV, Rahuri
V8	FBL-10	PAU, Ludhiana
V9	IIMR-FB-MC-2022-1	IIMR, Hyderabad
V10	PFC 50	PAU, Ludhiana
V11	FSFBH-502	Foregan Seeds
V12	IIMR-FB-MC-2022-2	IIMR, Hyderabad
V13	Pusa-2101	Pusa, IARI
V14	JHPM-23-1	IGFRI, Jhansi
V15	AFB-3	ANGRAU, Hyderabad
V16	SBH 002	Rasi Seeds
V17	JPM 18-37	JNKVV, Jabalpur
V18	ADV 2285	Advanta Seeds
V19	JPM-18-74	JNKVV, Jabalpur
V20	UPC 23-1	GBPUA & T, Pantnagar
V21	JHPM-22-2	IGFRI, Jhansi
V22	FBL-7	PAU, Ludhiana
V23	FSB2021-1	Foragen Seeds
V24	JPM-18-71	JNKVV, Jabalpur
V25	ADV175020	Advanta Seeds Pvt Ltd.
V26	BAIF Bajra 1	BAIF, Urulikanchana
V27	FBL-7	PAU, Ludhiana
V28	RBB-1	Rajasthan

Ash content (%)

The genotypes exhibited significant differences in their ash content. Ash content of the genotypes ranged from 0.11% to 0.25% (Fig. 3) with a mean of 0.183%. Lower the ash content higher will be the fodder nutritional quality. The highest ash content was observed in V28 (0.25%) and it was at par with V9, V11 and V27 (0.24%). V19 had the lowest ash content (0.11%).

Copper content (ppm)

Copper is an important mineral of animal nutrition. It is essential in animal feed for enzyme function, red blood cell formation, and immune system support. Copper deficiency can lead reduced fertility and depigmentation. Copper content of the fodder pearl millet genotypes ranged from 1.28 ppm to 6.96 ppm with the genotypic mean of 3.48 ppm (Fig. 4). The highest copper content was observed in case of V6 (6.96 ppm) and it was at par with V3 (6.73 ppm) and the lowest copper content genotype was V26 (1.28 ppm).

Zinc content (ppm)

Zinc is essential in animal feed for growth, immune function, and reproduction. Adequate zinc levels improve digestion, feed efficiency, and disease resistance. Zinc is very important mineral (micro nutrient) of animal nutrition that enhances fertility capacity. Zinc content of the fodder pearl millet genotypes ranged from 8.59 ppm to 16.93 ppm with the genotypic mean of 13.37 ppm (Fig. 5). The highest zinc content was observed in case of V4 (16.93 ppm) and the lowest zinc content genotype was V27 (8.59 ppm).

Phosphorus content (ppm)

Phosphorus is very important mineral (macro nutrient) of animal feed. Phosphorus is essential in animal feed as it supports bone development, energy metabolism, and reproductive health. It plays a key role in milk production, enzyme function, and nutrient utilization. Phosphorus content of the fodder pearl millet genotypes ranged from 285.3 ppm to 784.4 ppm with the genotypic mean of 495.3 ppm (Fig.6). The maximum phosphorus content was observed in V9 (784.4 ppm) and it was significantly higher than others. The lowest phosphorus content genotype was V27 (285.3 ppm).

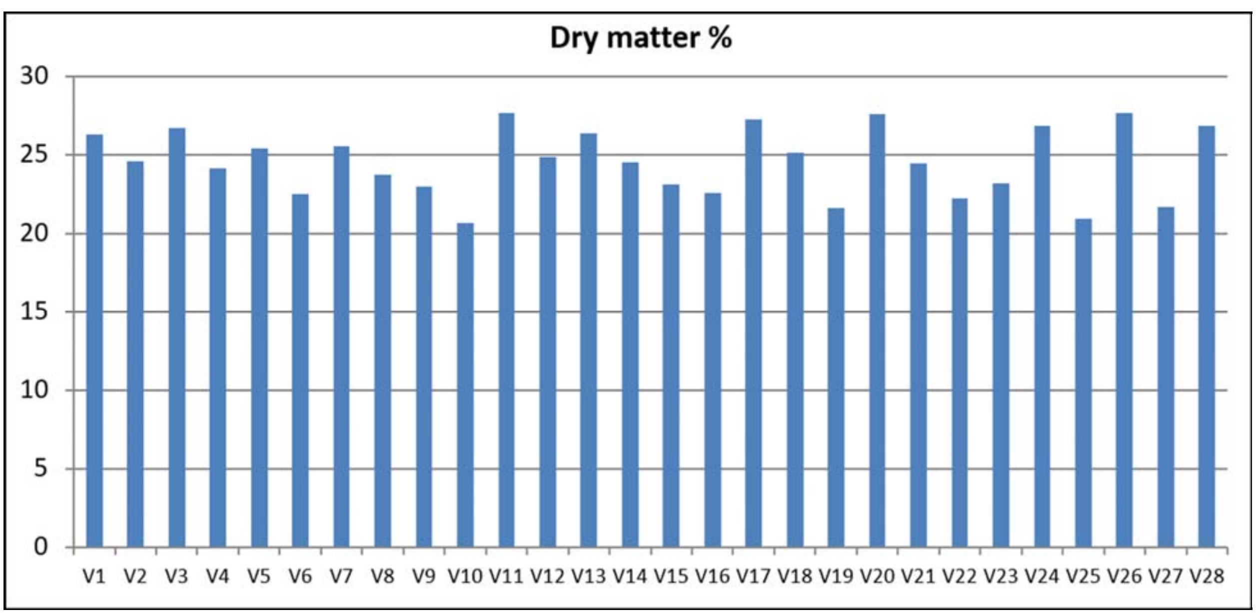

Fig 1: Variation in dry matter content (%) of fodder pearl millet genotypes

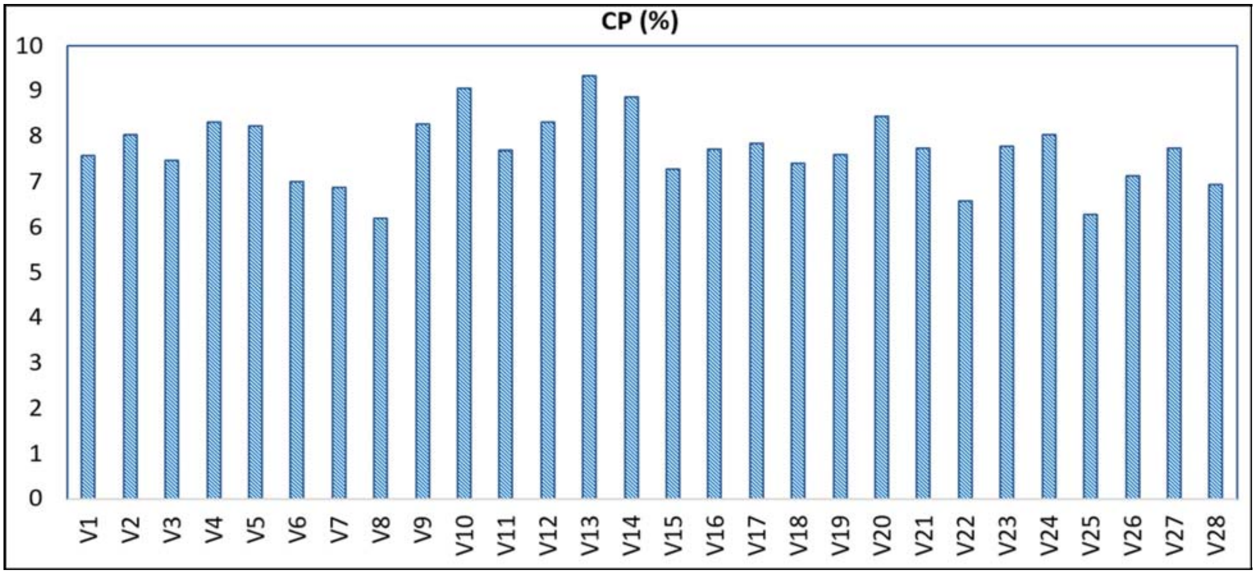

Fig 2: Variation in crude protein content of fodder pearl millet genotypes

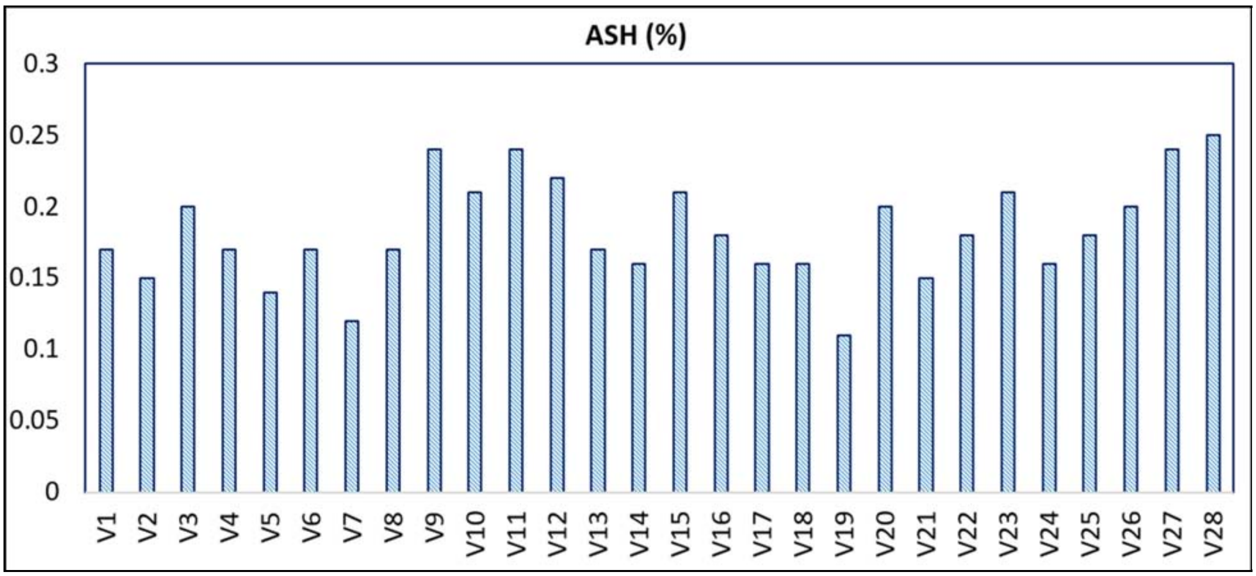

Fig 3: Variation in ash content of fodder pearl millet genotypes

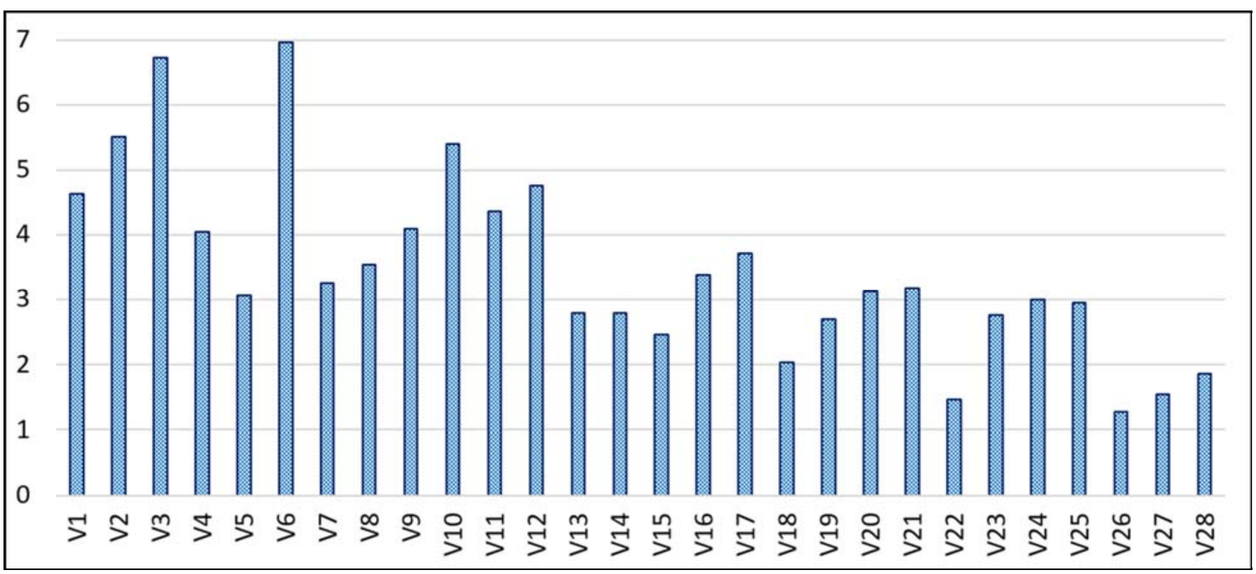

Fig 4: Variation in copper content of fodder pearl millet genotypes

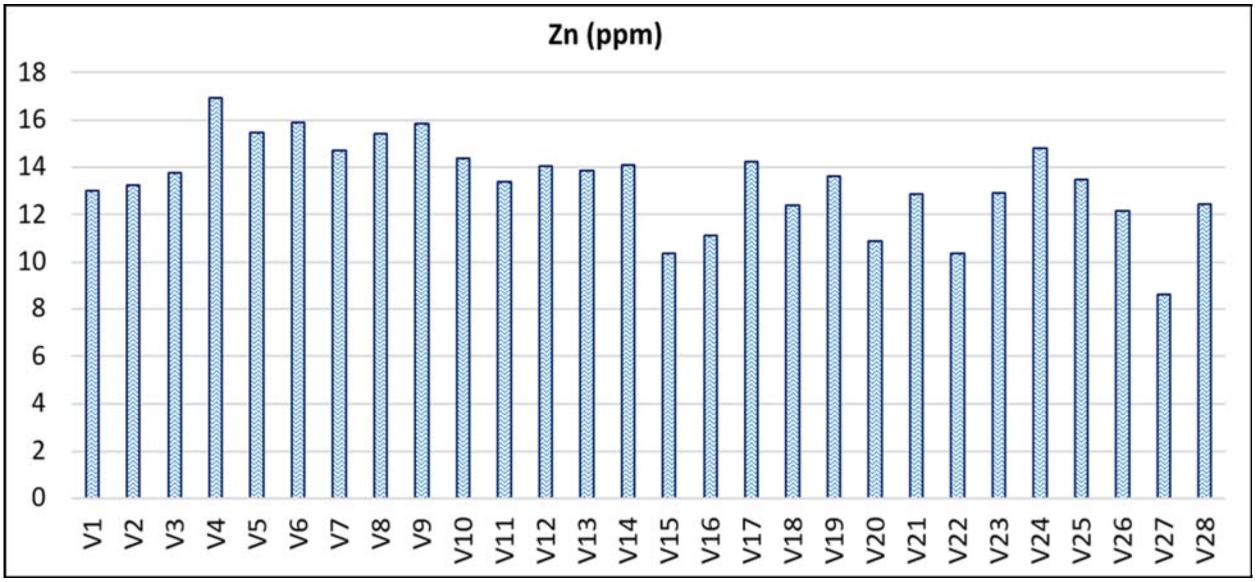

Fig 5: Variation in zinc content of fodder pearl millet genotypes

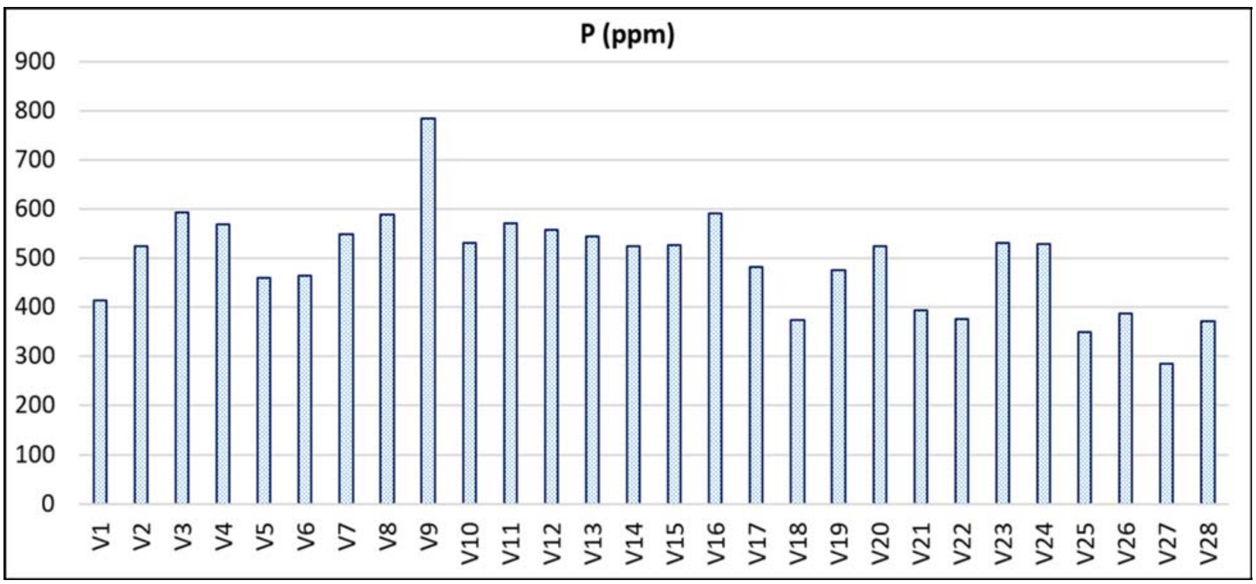

Fig 6: Variation in phosphorus content of fodder pearl millet genotypes

Nutritional index of the genotypes was estimated for selection of the best genotypes as follow Variation for each nutritional parameter was divided into three groups i.e. low (value below Mean-S.E.), medium (value between Mean-S.E. and Mean + S.E.) and high (value above Mean + S.E.). Then a score “0”, “1” & “2” were used for low, medium and high as per desirability of the parameter (Satpathy *et al*., 2021) [6]. The nutritional index of the genotype (Table 2) was calculated by adding the scored values of all the six parameters considered for this study. Nutritional index of the genotypes ranged from 1 to 10. High value for nutritional index indicated superiority of the genotype from nutritional point of view. Genotypes having nutritional index value of 8 or more than 8 were considered as desirable in coastal plain zone of Odisha. Therefore, V2, V3, V4, V5, V7, V9, V10, V11, V12, V13, V14, V17 and V24 were considered as desirable in coastal plain zone of Odisha. The highest nutritional index (10) was observed in V2 (ADV 2386), V4 (APFB-9-1) and V24 (JPM-18-71) and these three genotypes were the best having balanced nutrient content for animal feed.

Table 2: Nutritional index of fodder pearl millet genotypes

Genotype	CP (%)	Dry matter %	ASH (%)	P (ppm)	Cu (ppm)	Zn (ppm)	Nutritional index
V1	1	2	1	0	2	0	6
V2	2	1	2	2	2	1	10
V3	0	2	0	2	2	2	8
V4	2	1	1	2	2	2	10
V5	2	2	2	0	0	2	8
V6	0	0	1	0	2	2	5
V7	0	2	2	2	1	2	9
V8	0	0	1	2	1	2	6
V9	2	0	0	2	2	2	8
V10	2	0	0	2	2	2	8
V11	1	2	0	2	2	1	8
V12	2	1	0	2	2	2	9
V13	2	2	1	2	0	1	8
V14	2	1	2	2	0	2	9
V15	0	0	0	2	0	0	2
V16	1	0	1	2	1	0	5
V17	1	2	2	1	1	2	9
V18	0	2	2	0	0	0	4
V19	0	0	2	0	0	1	3
V20	2	2	0	2	0	0	6
V21	1	1	2	0	0	0	4
V22	0	0	1	0	0	0	1
V23	1	0	0	2	0	0	3
V24	2	2	2	2	0	2	10
V25	0	0	1	0	0	1	2
V26	0	2	0	0	0	0	2
V27	1	0	0	0	0	0	1
V28	0	2	0	0	0	0	2
Mean							

Conclusion

The evaluation of various pearl millet genotypes for nutritional quality parameters such as dry matter, crude protein, ash content, and essential minerals like copper, zinc, and phosphorus revealed significant variability. The genotypes with superior nutritional traits were identified based on a calculated nutritional index. Notably, V2 (ADV 2386), V4 (APFB-9-1), and V24 (JPM-18-71) emerged as the best genotypes, demonstrating balanced nutrient profiles ideal for animal feed, especially in the coastal plain zone of Odisha. These findings provide a valuable basis for selecting high-quality fodder crops that can enhance livestock productivity.

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