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Nutritional changes in Anchote [*Coccinia abyssinica* (Lam.) Cogn.] root cultivar under the use of mixed NPSB and FYM fertilizers rates

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ABSTRACT

Anchote (Coccinia abyssinica (Lam.) Cogn.) is a critically important root crop native to Ethiopia on the African continent. In terms of nutrition, economics, medical, and social welfare, it is a highly valued food source that is abundant throughout the Western part country. The nutrient makeup of the crop may be affected by the application of various organic and inorganic fertilizers. The effects of organic and inorganic fertilizers on the nutritional content of the Anchote food crop, on the other hand, are unknown. As a result, during the 2019-20 cropping season, a field experiment was conducted in the southwestern part of Ethiopia to see how the Anchote variety (Desta 01) responded to various levels of NPSB and farmyard manure in terms of yield and nutritional components. Six rates of mixed NPSB fertilizer (0, 58,116,175,233, and 291 kg ha^{-1}) and three levels of Farmyard Manure (FYM) (0, 5, and 10 t ha^{-1}) were treated within the experimental plot in the field to assess the yield and nutritional composition of the Anchote variety. In a randomized complete block design, the experiment was set up in 3 x 6 factorial patterns with three replications.For laboratory analysis, samples of its roots from all three replications were collected separately after the crop maturity and subjected to SAS (version 9.3) software, which was used to assess nutritional characteristics such as dry matter content of roots (DMC) (percent), crude fat (percent), moisture content (percent), total soluble solid (TSS), and total ash (percent). The results of the laboratory analysis revealed that the interaction effects of blended NPSB fertilizer and FYM levels significantly changed nutritional features such as dry matter and moisture content (P0.01). DMC, ash percent, TSS, moisture content, and crude fat were all significantly (P0.01) affected by FYM and NPSB application in the field, whereas the interaction effects of both NPSB and FYM treatment in the field had a significant (P0.01) impact on laboratory parameters like ash and crude fat content of Anchote cultivar. Finally, the results of the laboratory experiment showed that applying blended NPSB fertilizer and FYMtogether to the field had an effect on the quality and nutritional attributes of the Anchote cultivar gathered for laboratory testing in the research region.

Keywords: *Anchote, **Root cultivar**, Blended fertilizer, NPSB, FYM, Nutritional composition, **Quality characters**.*

1. INTRODUCTION

Anchote [*Coccinia abyssinica* (Lam.) (Cogn.)] is one of Ethiopia's most important endemic crops, produced mostly for its edible root in the country's south and southwest [1]. When considering a crop as a food source, the nutritional content is the most important consideration. It's well-known among other root and tuber crops in the Wollega area of the country's Oromiya Regional State. Because of its deep traditional ties with the Oromo peoples of Ethiopia, Anchote is held in high regard in the region. The genus isn't widely investigated in Ethiopia, and there are over eight taxa identified, spread across the country [2]. In Ethiopia, there are roughly ten different species of Coccinia. Only *Coccinia abyssinica*, however, is farmed [3]. It is found in both cultivated and wild forms within Ethiopia [4].

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It is a highly valuable food source that, according to local farmers, aids in the rapid healing of fractured bones and displaced joints due to its higher calcium and protein content than other common and widely distributed root and tuber crops in the country [3]. It is also traditionally thought that its consumption and inclusion in meals helps nursing moms healthier and stronger, allowing them to produce more milk [5].
Anchote, like many other root crops, is never consumed in its raw state [6]. It is shown to be extremely essential in the medicinal, cultural, social, and economic lives of country residents.It's extremely significant in a variety of ethnic meals and diets, especially between September and November in the Wollega zone of the country, because it's primarily and typically gathered during these months. Because other food crops will not be ready for eating during these times, it is highly regarded for its contributions to food security [7]. It has been used by the Oromo people to assemble a variety of food items for their traditional ceremonies, special cuisine for guests, and animal fattening [3].
For leaf and root plant portions of Anchote, the association of several nutrients with protein, organic matter, and ash appears

to reveal a contradiction [8]. The use of inorganic substances has a minor impact on the nutritional components of this root crop. Total ash content is closely proportional to the inorganic element content of Anchote [9]. As a result, samples containing a high percentage of ash are expected to contain significant concentrations of various mineral elements, which are beneficial for speeding up metabolic processes and improving the expansion and development of the entire plant.

Organic manures are a variety of organic soil amendments derived from both livestock waste and crop residues that contain high levels of nutrients that are processed by soil microbes and slowly made available to plants over time [10]. Farmyard manure is another source of nitrogen, as well as other nutrients, that are utilized to improve the soil texture while also enhancing soil fertility [11].

Organic manures have a number of advantages, including improving soil physical qualities, soil water holding capacity, and organic carbon content, in addition to providing high-quality nutrients to the soil [12]. As a result, combining inorganic and organic fertilizers is regarded to be more desirable and advantageous in terms of Anchorquality features. As a result, the study was conducted and disbursed with the goal of determining how varied rates of NPSB and farmyard manure affected the quality features of the Anchote cultivar.

2. MATERIALS AND METHODS

2.1. Description of the study area:

During the year 2018-19, the experiment was done in Jimma town at JUCAVM experimental site Horticultural Garden, Oromia Regional State, Ethiopia, under irrigation conditions between September and January. The research region is located at an altitude of 1710 m above mean water level, with approximate geographic coordinates of 06°36' N and 37°12' E. It has an annual average rainfall of 1500 mm at this time of year, with mean minimum and maximum temperatures of 11.4°C and 26.8°C throughout the year. Around the year, the mean minimum and maximum ratios were observed to range from 39.92 percent to 91.4 percent [13]. After the crop reached sufficient maturity, the entire crop was harvested, and Anchote root samples were collected from each replication independently and sent to the Food Science laboratory of Jimma University, College of Agriculture and Veterinary Medicine (JUCAVM) in Ethiopia for analysis of nutritional data.

2.2. Description of the experimental material:

Desta 01 was the Anchote cultivar employed in this experiment. It was released in 2018 by the DebreZeit Agricultural Centre, Ethiopia Institute of Agriculture Research (DZARC/EIAR). The variety has a creamy root flesh color and is more adaptable in the country's mid-lowlands to highlands.

2.3. Treatments and experimental design:

The Ethiopian government has adopted NPSB compound fertilizer, which contains Nitrogen, Phosphorous, Sulphur, and Boron in a ratio of 18.9 % N, 37.7 % P_2O_5, 6.9 % S, and 0.1 B as the main source of phosphorous [14]. According to government recommendations, the majority of farmers in the country use NPSB compound fertilizers as the main source of phosphorus for a variety of grown crops in order to increase productivity. Six levels of NPSB fertilizers (0, 58, 116, 175, 233, and 291 kg ha^{-1}) were used, as well as three levels of farmyard manure (FYM) (0, 5, and 10 t ha^{-1}). As a source of fertilizer, locally available and adequately decomposed farmyard manure (FYM) was made available. The study was set up in a Randomized Complete Block Design (RCBD) with 6 x 3 factorial patterns and was reproduced three times. Within each block, each treatment combination was assigned to the experimental units at random. There were 54 experimental unit plots devoted to the 18 treatment combinations, each measuring two meters by two meters (four square meters) and with a spacing of 40 centimeters between rows and 10 centimeters between plants. Similarly, a gap of 0.5 m was maintained between the two unit plots, and a distance of 1 m was maintained between the two blocks for proper separation.

2.4. Experimental procedures:

Within the month of September 2018, the experimental field was cleared and plowed twice with an oxen plow, and plots were prepared and leveled manually. Seeds were planted at a depth of 5 cm in well-prepared plots with five rows in each bed. On September 30th, 2018, sowing was completed. FYM was made up of well-dried waste collected from the JUCAVM animal farm and stored and heaped for proper decomposition before being applied to the trial plots.The manure was used and applied after it turned brown, was thoroughly decomposed, had a low bad odor, and was applied one month prior to sowing on the designated treatments or plots. This was done to ensure that the organic manure had completely decomposed. Similarly, during the sowing period, blended NPSB fertilizer was applied at defined rates and the right depth of placement was maintained inside the soil. With two seeds per hill, seeds were planted directly on the prepared beds. For the higher plant change sphere, all relevant agronomic and cultural operations such as watering, weeding, hoeing, and stacking activities were carried out suitably. When the crop produced a vine, it was stacked to allow the Anchote vine to mature. Living plants, live fences, dead timber poles, or wire poles created for the purpose are used to stack. The crop was produced under irrigation management, so water was applied according to the crop's needs until it reached maturity. Harvesting was completed in February 2019 when about 90% of the plants in a particular plot had reached physiological maturity (at >90%) and the leaves were approaching senescence. The entire crop was harvested when it reached maturity, and rootsamples were collected from each replication separately and sent to the Food Science Laboratory of Jimma University, College of Agriculture and Veterinary Medicine (JUCAVM) in Ethiopia for nutritional data analysis.

2.5. Nutritional data collection in the laboratory

2.5.1 Dry matter content of roots (DMC) (%):Five roots of different sizes were collected at random from each plot, weighed, washed, peeled, sliced (cut into thin slices), and dried in a dry oven at 72 ° C for 24 hours until a constant weight was reached. Root dry matter content was estimated as the ratio of the weight of dried roots to the fresh weight of the same sample root expressed as a percentage, which was later used in all quality parameters working.

$$DM(\%) = \frac{WTDM}{WTFW} X100$$

Where: DM (%) = Percent Root Dry Matter, WTDM = Weight of dried sample roots, WTFW = Fresh Weight of the same sample before drying.

2.5.2. Crude fat (%): The official method 4.5.01 was utilized to determine the crude fat utilizing the ether extract method with a soxhlet extraction device [15]. Each of the extraction thimbles

(Whatman International LTD Maidstone, England) was weighed with two grams of moisture-free sample and covered in a two-centimeter layer of fat-free cotton.

For the extraction process, cleaned and dried receiving beakers were weighed and filled with 70 ml of diethyl ether (Sigma-Aldrich, USA) before being placed into the soxhlet apparatus (Shanghai Qianjian Instrument Co., Ltd). The ether in the receiving beakers was allowed to evaporate for at least 30 minutes in a drying oven (CintexPrecision, India) at 92^{0}C before being cooled inside desiccators after four hours of extraction. Finally, the crude fat content in percent was calculated using the following formula:

$$\textbf{Crude fat}(\%) = \frac{(\textbf{We} - \textbf{W0})}{(\textbf{Ws} \times \%\ \textbf{DM}) \times \textbf{100}}$$

Where:

We: weight of the aluminum cup

W_0: Weight of dried aluminum

Ws: weight of the sample

D_M: dry matter percent

2.5.3. Moisture content (%): The official technique 925.09 was used to assess moisture content {16]. Aluminum crucibles were cleansed and dried in a drying oven before being placed in desiccators to cool (CSN-SIMAX). First, the mass of each dried crucible was determined (M_1), and then approximately 5g of the sample was weighed in a clean and dried crucible (M_2) using an analytical balance (Adventurer, OHAUS, China). After that, the crucibles containing the samples were placed in a 105°C oven to dry the samples to a consistent weight (M_3). Finally, the moisture content was estimated using the equation below:

$$\text{Moisture Content }(\%) = \frac{M2-M3}{M2-M1}*100$$

Where;

M_3: Mass of the crucible and the sample after drying

M_2: Mass of the crucible and the sample before drying

M_1: Mass of the crucible

2.5.4. Total soluble solid (TSS): The total soluble solid in Anchote root extract was evaluated using a Hand Refract meter. A sensitive balance was used to weigh two grams of its root powder. Two milliliters of distilled water were added to the beaker and stirred with the produced powder. After fully mixing, the soluble form of the product was placed on a soft cloth and squeezed to determine the total soluble solid using a refractometer.

2.5.6 Total ash (%): The total ash content was determined using the official method 923.03, [16]. The crucibles were cleaned and dried in a 100°C oven, then cooled in desiccators before being weighed using an analytical balance (LA 204, Measure tech). (M1). Using a 4-gram sample (M_2), the crucibles were extensively charred on a hot plate at a low temperature beneath a hood (Nordia, London E17 6AB) and then placed in a muffle furnace (Carbolite CSF, 1200) at around 550^{0}C for around five hours until the sample transformed to grayish-white ash. The crucibles containing the ignited sample were cooled inside desiccators to obtain the final mass (M3) (CSN-SIMAX). Finally, the total ash content was determined with the help of the following equation:

$$\textbf{Ash}(\%) = \frac{\textbf{M3} - \textbf{M1}}{\textbf{M2} = \textbf{M1}}\textbf{X100}$$

Where:

M_1: Mass of the dried dish.

M_2: Mass of the dish and the sample

M_3: Mass of the dish and the sample after ashing

1.2. Data analysis

Using SAS (Statistical Analysis Software) version 9.3, all measured data were validated for assumptions of analysis of variance and submitted to analysis of variance (ANOVA) [17]. The Least Significant Difference (LSD) test was used to separate the means at a 1 % level of significance.

2. RESULTS AND DISCUSSION

3.1. Soil physicochemical properties of the site study

3.1.1. Pre-planting soil chemical properties and farmyard manure result

One representative composite sample was taken at a depth of 0-30 cm diagonally across the experimental field using an auger before planting and bulking. The sample was air-dried and ground using a pestle and mortar and sieved with a 2 mm mesh. Farmyard manure was also analyzed for chemical composition. Working samples were analyzed and determined for selected physico-chemical properties mainly texture, soil pH, cation exchange capacity (CEC), total N, available P, and organic matter and texture using standard laboratory procedures. The organic matter content of the soil was determined by the volumetric method [18].

Total N was analyzed using indigestion, distillation and titration method as described by Ethio SIS [19], by oxidizing the organic matter in concentrated sulfuric acid solution (0.1N H2SO4). The pH of the soil was determined on 1:2:5 (weight/volume) soil samples to water ratio using a pH meter [20]. Cation exchange capacity (CEC) was measured titrimetrically by distillation of ammonium that was displaced by sodium from NaCl solution [21]. On the other hand, available phosphorus in Farm yard manure was determined by using procedures of Ethio SIS for estimation of available Phosphorus in soils by extracting with Sodium Bicarbonate [19].

Selected physio-chemical properties of soil of the experimental site are presented in Table 2. The site has clay textural class with a particle distribution of 46% clay, 34% silt, and 20% sand. Soil pH (H_2O) was 5.5 which wasmoderately acidic and moderately alkaline in the case of FYM (7.43) [21]. This shows that essential plant nutrients are fixed in soil colloidal practices and nutrient was unavailable to plant growth. The organic carbon (OC) content was 3.65 % which was medium in the soil and in the case of FYM and it was31.68 very high. The soil of the study area had low level (0.31 %) of nitrogen and a medium level (3.65 %) of organic carbon matter while under the FYM (2.73 %) total nitrogen and (31.68 %) organic carbon matter in very high manner were observed.

Table 1: Physicochemical properties of the experimental site soil and farm yard manure (FYM) before planting.

Parameters	Values		Rating	Reference
	Soil	FYM		
Chemical analysis				
pH	5.5	7.43	Moderately acidic and moderately alkaline	Landon (1991)
OC%	3.65	31.68	Medium and very high	Hazelton and Murphy (2007)

OM%	6.29	54.63	Medium and very high	Hazelton and Murphy (2007)
TN	0.31	2.73	Very high and very high	EthioSIS (2014)
CEC	29.59	115.42	High and very high	Landon (1991)
AV.P(ppm)	16.60	2223.8	High and very high	Ethio SIS (2014)
Soil texture				
Sand	20%			Anderson and Ingram,1993
Clay	46%			
Silt	34%			
Textural Class		Clay loam		

3.1.1. Post-Harvest Soil Chemical Properties

3.1.2.1 Soil pH and cation exchange capacity (meq/100g)

The highest soil pH value (6.88) was observed at the treatment treated by 291 kg ha^{-1} blended NPSB plus 10 t ha^{-1}farm hard manure fertilizer in a combination form. This was equal with the value obtained from the treatment that received 233 kg ha^{-1}blended NPSB plus 10 t ha^{-1} farmyard manure fertilizer. On the other hand, the lowest pH value (6.03) was recorded from the control treatment. The pH values of all treatments are less than the pH value of farm yard manure (7.43) and greater than the pH value initial soil (5.5) (Table 2). Therefore, the result obtained shows that the application of organic and inorganic fertilizers has a positive effect on the decrement of soil acidity.

The highest soil cation exchange capacity (CEC) value (30.76) was obtained by combined application of 291kg ha^{-1} blended NPSB fertilizer in addition with 10 tha^{-1} FYM followed by three treatments 233 kg ha^{-1} blended NPSB fertilizer and 10 tha^{-1} FYM, 175 kgha^{-1}blended NPSB fertilizer along with 10 tha^{-1} FYM and 116 kg ha^{-1} blended NPSB fertilizer plus 10 tha^{-1} FYM that have equal value of (30.39). Apart from that, the lowest CEC value (24.56) was scored at the control treatment. CEC values of all treatments are less than CEC value of FYM (115.42) (Table 2). Hence the result obtained showed that FYM hasmore positive effect than blended NPSB fertilizer with regard to increasing CEC. The current finding is in agreement with that of [22] who reported that the application of organic matter as soil amendment resulted in positive and significant increase in soil chemical properties such as soil pH and cation exchange capacity (CEC) [23], also identified that application of NPK alone showed a decreasing trend of pH, whereas integrated use of inorganic and organic sources considerably improved the soil pH.

3.1.2.2. Soil organic carbon (%) and organic matter (%)

The highest soil organic carbon (OC) value (3.16) was obtained from the combined application of 291 kg^{-1}blended NPSB fertilizer and 10 t ha^{-1} farm yard manure and combined application of 233 kg ha^{-1}blended NPSB fertilizer and 10 t ha^{-1}farmyard manure. On the other hand, the lowest organic carbon value (2.457) was recorded from the control treatment. Organic carbon results of all treatments increase as rates of farm yard manure and blended NPSB increases. (Table 2). Since FYM has high OC value (31.68) it may have direct effect organic carbon results of each treatment. On other hand, the highest organic matter (OM) value (5.45) was recorded from the combined application of 291kg ha^{-1} plus 10 t ha^{-1} farm yard manure fertilizer. Similarly, the lowest value (4.23) was obtained from the control treatment. Since the value of organic matter available in farm yard manure was greater that the value of organic matter in all treatments the variation formed thought to due to application of farm yard manure fertilizer. Addition of organics along with inorganic fertilizers showed significant improvement in total N content of the soils [22]. In the present study, OM application to soil increased soil pH, phosphorus availability, cation exchange capacity (CEC) and soil organic carbon content [24].

3.1.2.3. Soil total nitrogen (%) and available phosphorus (ppm)

The highest soil total nitrogen (TN) result (0.272) was recorded due to combined application of 291kgha^{-1}blended NPSB fertilizer plus 10 t ha^{-1} farm yard manure, combined application of 233 kgha^{-1}blended NPSB fertilizers and 10 t ha^{-1} cattle manure and combined application of 175 kgha^{-1}blended NPSB fertilizers and 10 t ha^{-1} farm yard manure. Apart from that, the lowest TN value (0.22) was recorded from the control treatment. Total nitrogen result of all treatments was much less than total nitrogen values of farm yard manure (2.73) (Table 2). The laboratory values of treatments showed that numeric variation is small with different levels of farm yard manure relative to different level of blended NPSB fertilizer. This may be due to the limited availability of nitrogen from farm yard manure and the free availability of nitrogen from blended NPSB fertilizer.

The highest soil available phosphorus value (35.63) was revealed as the result of combined application of 291 kg ha^{-1}blended NPSB fertilizer plus 10 t ha^{-1} farm yard manure (FYM). Otherwise, the lowest available phosphorus value (15.1) was revealed from the control treatment. Available phosphorus values of all treatments were much less than the available phosphorus value of farm yard manure (2223.79) fertilizer (Table 2). The laboratory values of treatments showed that numeric variation is small with different level of blended NPSB fertilizer relative to different level of farm yard manure. This may be readily availability of phosphorus from farm yard manure as it is found in inorganic form. Biederman and Harpole [25] reported that the addition of organic matter to soils resulted, increased soil phosphorus (P), total soil nitrogen (N) and total soil carbon (C). Phosphorus and potassium in manure are mostly present in the inorganic form.

Table 2:Post analyzed soil data of soil samples

FYM rate t ha^{-1}	NPSB rate Kg ha^{-1}	pH	OC (%)	OM (%)	TN (%)	P (ppm)	CEC meq/100g
0	0	6.03sa	2.46 m	4.23 m	0.22 m	15.10 h	24.56 m
58	0	6.10 sa	2.46 m	4.23 m	0.22 m	15.56 h	26.18 h
116	0	6.12 sa	2.46 m	4.23 m	0.22 m	15.60 h	26.56 h

175	0	6.14 sa	2.63 m	4.54 m	0.23 m	15.87 h	26.50 h
233	0	6.15 sa	2.63 m	4.53 m	0.23 m	16.72 h	26.58 h
291	0	6.19 sa	2.63 m	4.54 m	0.23 m	17.38 h	26.96 h
0	5	6.23 sa	2.63 m	4.55 m	0.23 m	18.50 h	27.18 h
58	5	6.45 sa	2.63 m	4.58 m	0.23 m	18.55 h	27.96 h
116	5	6.46 sa	2.63 m	4.54 m	0.23 h	19.44 h	27.96 h
175	5	6.50 sa	2.81 m	4.84 m	0.24 h	20.42 vh	28.56 h
233	5	6.53 sa	2.81 m	4.84 m	0.24 h	24.42 vh	29.18 h
291	5	6.56 sa	2.81 m	4.84 m	0.24 h	27.40 vh	29.18 h
0	10	6.67 sa	2.81 m	4.84 m	0.24 h	28.14 vh	29.57 h
58	10	6.71sa	2.98 m	5.14 m	0.26 h	29.44 vh	29.78 h
116	10	6.76 sa	2.98 m	5.14 m	0.26 h	31.12 vh	30.39 h
175	10	6.78 sa	3.16 m	5.45 m	0.27 h	31.79 vh	30.39 h
233	10	6.88 sa	3.16 m	5.45 m	0.27 h	31.92 vh	30.39 h
291	10	6.88 sa	3.16 m	5.46 m	0.27 h	35.63 vh	30.76 h
CV		9.8	13.4				
LSD (0.05)		NS	NS				

Sa = strongly acidic, m= moderate/medium, h = high, vh = very high, pH=power of hydrogen, N=Nitrogen, P = Available phosphorus, PPM = Pascal per millennium, OC=organic carbon and OM=organic matter

3.1. Tuber dry matter (%)

The administration of both blended NPSB and farmyard manure fertilizers in the unit plots of the filed significantly altered root dry matter content (P0.01) in the laboratory, according to the results of analysis of variance (Table 3). Similarly, the interaction effects of those two nutrient sources had a significant (P0.01) impact on the root dry matter content which was analyzed in the laboratory of the Anchote cultivar used in the study. The results of a combined application of both 233 kg ha^{-1} NPSB and 10 t ha^{-1} farmyard manure fertilizer yielded the highest tuber dry matter content (28.45%), followed by the worth (25.75%) obtained from a combined application of 291 kg ha^{-1} blended NPSB and 10 t ha^{-1} FYM fertilizer yielded the second highest tuber dry matter content (28.45%}(Table 4). Similarly, the bottom root dry matter content (17.37%) was recorded at the control plot that was kept without fertilizer application, but it was not statistically different from the value (18.34%) obtained as a result of the combined application of 58 kg ha^{-1} blended NPSB and 0 t ha^{-1}farmyard manure fertilizer (Table 4).

The treated plot had the greatest value of root dry matter content, outperforming the control, blended NPSB, and FYM fertilizer by 63.73 percent, 30.44 percent, and 18.59 percent, respectively. However, increasing the various rates of farmyard manure from zero to ten tons per hectare allowed for a 25.94 percent increase in root dry matter. Similarly, increasing the rate of NPSB mixed fertilizer application from 0 to 233 kg ha^{-1} was observed to enhance the life of the crop andwas found to extend the foundation dry matter by15.96 (%). (Table 4)

The use of combined effects of inorganic and organic fertilizers has a favorable influence on root enlargement and elongation, allowing the crop to contain more dry matter, which may be the explanation for the increase in the greatest root dry matter content seen at the treated plot. As a result, the dry matter content of the roots of the treated plots increases more than that of the untreated plots. Dry matter content increased as NPK levels increased [26]. Fertilizer application increased the dry matter accumulation in water yam [27]. Similar results reported that the most effects of NPS blended fertilizers and cattle manure significantly influence the dry matter content of tubers of potato [28].

3.2. Ash content (%)

The administration of both blended NPSB fertilizer and farmyard manure significantly altered the tuber ash content percentage (P<0.01), according to the analysis of variance (Table 3). The interaction effects of those two factors were similarly highly significant (P0.01). The highest ash percentage (5.21%) was obtained as a result of a combined application of 233 kg ha^{-1} blended NPSB and 10 t ha^{-1} farmyard manure fertilizer, which was not statistically different from the values (5.14 percent and 4.91 percent) obtained by a combined application of 175 kg ha^{-1} blended NPSB and 10 t ha^{-1} FYM and 291 kg ha^{-1} blended NPSB, respectively. When 0 kg of NPSB was combined with 5 $tha^{-1}$of FYM, the tuber ash content was lower (3.35 percent) (Table 4).

The results show that applying both organic and inorganic fertilizers to the crop increased the amount of ash available in the crop. This could be owing to the fact that both mixed NPSB and FYM fertilizers contain distinct components that the crop could absorb. The presence of inorganic phosphorous in both fertilizers, which enables better root development, and FYM improves the structure of the soil, which allows the roots to grow freely and possibly higher penetration within the soil, could be the reason for the increase in ash content with the application of blended NPSB fertilizers with a combination of FYM. As a result, it will have facilitated the absorption of various minerals and nutrients from the soil. Poultry manure application reduced ash content considerably [29]. Ash concentration ranged from 3.41 to 4.68, with the best ash content coming from a poultry manure application of 4 t ha^{-1}. NPSB treatment increased from 0 to 239 kg ha^{-1}, and ash level in the sweet potato variety (Kulfo) increased from 4.47 to 5.11 percent, indicating that ash content increased from 4.47 to 5.11 percent [30].

3.3. Moisture content (%)

The findings of the analysis of variance revealed that the most significant impacts of blended NPSB and farmyard manure fertilizers on the moisture content of Anchote cultivars were extremely (P0.01) (Table 3). Similarly, the interaction effects of farmyard manure and blended NPSB fertilizer had a significant (P0.01) impact on Anchote cultivar moisture content. The control received the highest score (8.2%), followed by the worth (8.03%) achieved from the combined application of 58 kg ha^{-1} and 0 t ha^{-1} FYM fertilizer (Table 4). The lowest value (4.4 percent) was achieved from a combined application of 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM fertilizer, followed by the highest value (4.57 percent) obtained from a combined application of 233 kg ha^{-1} NPSB and 10 t ha^{-1} FYM fertilizers.When compared to manage, 7.89 percent farmyard manure, and 20% blended NPSB fertilizer, the moisture content of Anchote cultivar was increased by 86 percent due to the combined application of blended NPSB and farmyard manure fertilizers (Table 4).

This is most likely due to both organic and inorganic fertilizers operating adequately with nutrients like phosphorus, which enhanced root expansion and, as a result, increased root dry matter of the crop, which could have negatively influenced crop moisture content. Asimilar result was observed on Aerial yam [29], which indicated that moisture content was inversely proportional to dry matter in Aerial yam.

3.4. Total soluble solid (TSS)

The total soluble solids content of the bulb is a critical quality indicator (Singh, 2015). The results of the analysis of variance revealed that the effects of blended (NPSB) fertilizer, farmyard manure, and the interaction of the two components had a significant (P0.01) impact on the TSS of Anchote root (Table 3). The highest TSS value (8.67 Bx) was obtained as a result of a combined application of 233 kg ha^{-1} and 10 t ha^{-1} of farmyard manure fertilizer, which was not statistically different from the value (8.35 Bx) obtained from a combined application of both blended 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM fertilizers (Table 4).This value was increased by 27.5 percent when compared to the control, 7.97 percent when compared to farmyard manure, and 14.08 percent when compared to blended NPSB fertilizer. While the control treatment had a lower value (6.8 Bx), it was not statistically different from the value (7.15 Bx) achieved by combining the application of both 58 kg ha^{-1} NPSB and 5 t ha^{-1}FYM fertilizer together (Table 4).This discovery revealed that blended fertilizer has a significant impact on the crop's total soluble solids.

The increased utilization of inorganic nitrogen in both factors, which allows for better scheme development and possibly higher synthesis of plant growth hormones, could be the reason for the increase in TSS content when blended NPSB fertilizers with a mixture of FYM are used. As a result, it should have aided in raising the foundation root's sugar content. Furthermore, the presence of inorganic sulfur in mixed and FYM fertilizers may affect amino acids in the root.Using different crops, several writers came up with results that were very similar. On onion, [31] found that each of the integrated nutrient management treatments had a substantial impact on the total soluble solids. When the dose of K fertilizer was increased, the total soluble solid of the tuber increased [32]. Because organic fertilizers transport the majority of micro and macronutrients essential for plant growth, the highest TSS concentration in root could be due to the maximum moisture content and dry weight of root.

3.5. Crude fat (%)

The major effect of blended NPSB and farmyard manure fertilizer caused a very significant (P0.01) variation in crude fat content, according to the results of the analysis of variance (Table 3). The interaction effects of both fertilizers, on the other hand, were similarly extremely significant (P0.01). The control treatment yielded the highest crude fat (2.12 percent), followed by the worth (1.75 percent) due to the outcomes of a combined application of 58 kg ha^{-1}NPSB and 0 t ha^{-1} FYM fertilizer (Table 4).While the lowest value (0.56 percent) was obtained from the combined application of 291 kg ha^{-1} blended NPSB and 10 t ha^{-1} farmyard manure fertilizer, it was not statistically different from the value (0.73 percent) obtained from the combined application of 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM fertilizers (Table 4).

When compared to manage 33.96 percent farmyard manure and 29.25 percent blended NPSB fertilizer, the combined application of 291 kg ha^{-1} and 10 t ha^{-1} fertilizers resulted in a variation of crude fat of 73.58 percent. Similarly, increasing the various rates of farmyard manure from 0 to 10 t ha^{-1} allowed for a 42.51 percent reduction in crude fat (Table 4). This was most likely achieved because the combined impacts of blended NPSB and FYM fertilizer applied during the experiment may have had a negative impact on fat development inside the root, and nitrogen present in both treatments may have contributed to the reduction in crude fat in Anchote root.

The discovery suggests that the inconsistency of inorganic and organic substances has an impact on the crude fat content of root crops. This finding is similar to that of [26], who found that increasing fertilizer supply lowered potato crude fat %. It was also consistent with [33] findings, which showed that control plots produced the crudest fat, whereas all fertilizer-treated plots (organic, inorganic, and organo-mineral fertilizers) had the same percentage of 0.96, which was not comparable to the control.

Table 3: Mean square values of Quality parameters analyzed at laboratory affected by combined application of bothNPSB and FYM

Source of Variation	Df	RDM(%)	ASH (%)	TSS (%)	CF (%)	MC (%)
Rep	2	2.36ns	0.10ns	0.25ns	0.0054ns	0.02ns
NPSB	5	13.98**	1.162**	0.65**	0.32**	1.49**
FYM	2	124.00**	1.93**	0.66**	2.51**	31.72**
NPSB* FYM	10	3.03*	0.17**	0.64**	0.16**	0.08**
Error	34	1.36	0.03	0.12	0.02	0.01

*Where; DF = degrees of freedom; RDM =Root Dry Matter; ASH= Ash, TSS =Total Soluble Solid; CF = Crude Fat; MC = Moisture Content; ns, * and ** implies non-significant, significant and highly significance differences, respectively.*

Table 4: Interaction effects of Blended (NPSB) and Farmyard manure on nutritional parameterswhich were analyzed at laboratory of Anchote cultivar at Jimma during growing season of 2018-2019

Treatments	NPSB kgha^{-1}	RDM (%)	ASH (%)	TSS (%)	CF (%)	MC (%)
FYM t ha^{-1}	0	17.37^{k}	4.25^{fg}	6.80^{h}	2.12^{a}	8.20^{a}
	58	18.34^{jk}	4.43^{def}	8.05^{bcde}	1.75^{bc}	8.03^{b}
	116	21.16^{hi}	4.52^{cdef}	8.00^{bcde}	1.68^{bcd}	7.77^{c}
0	175	20.03^{ji}	4.55^{cdef}	7.63^{defg}	1.55^{cdef}	7.68^{c}
	233	22.28^{fgh}	4.58^{cde}	7.55^{feg}	1.43^{efg}	7.34^{d}
	291	21.77^{ghi}	4.61^{bcd}	8.15^{abcd}	1.50^{defg}	7.00^{e}
	0	22.56^{efgh}	3.35^{i}	7.77^{cdef}	1.49^{defg}	6.90^{e}
	58	22.64^{defgh}	3.68^{h}	7.15^{fgh}	1.18^{hij}	6.25^{f}
	116	22.89^{defgh}	4.05^{g}	8.43^{ab}	1.63^{bcde}	6.10^{gf}
5	175	23.24^{defg}	4.26^{efg}	7.35^{fgh}	1.85^{b}	5.96^{gh}
	233	23.38^{defg}	4.63^{bcd}	8.00^{bcde}	1.61^{cdef}	5.90^{h}
	291	23.64^{cdefg}	4.72^{g}	7.60^{defg}	1.28^{ghi}	5.73^{i}
	0	23.98^{bcdf}	4.03^{g}	7.60^{defg}	1.40^{fgh}	5.40^{j}
	58	24.28^{bcde}	4.50^{cdef}	8.00^{bcde}	1.16^{ij}	5.37^{j}
	116	24.57^{bcd}	4.80^{bc}	7.58^{defg}	1.02^{kj}	5.26^{kj}
10	175	25.38^{bc}	5.14^{a}	8.03^{bcde}	0.89^{kl}	5.10^{k}
	233	28.44^{a}	5.21^{a}	8.67^{a}	0.73^{lm}	4.57^{l}
	291	25.75^{b}	4.91^{ab}	8.35^{abc}	0.56^{m}	4.40^{m}
LSD (0.05)		**1.97**	**0.33**	**0.59**	**0.23**	**0.15**
CV (%)		**5.20**	**4.18**	**4.41**	**10.25**	**1.38**

Where, CV: Coefficient of variations; LSD; Least significance difference: means sharing common letter(s) are not significantly different at 5% level of significance. RDM+ Dry matter Content ofRoot, TSS= Total Soluble Sugar, CF= Crude Fat, MC=Moisture Content

3. CONCLUSION

The study's findings revealed that the combined application of various rates of NPSB blended fertilizer and farm yard manure boosted the nutritional characteristics of the Anchote cultivar, such as dry matter content and TSS. The standard properties of Anchote root were modified by the interaction impact of both fertilizers when varying rates of NPSB blended fertilizer were applied. The dry matter content, TSS, and moisture content in the Anchote cultivar were all impacted by NPSB blended fertilizer and farmyard manure.However, when NPSB fertilizer was administered in combination with farmyard manure fertilizer, greater Anchote quality parameters were obtained than when blended NPSB or farmyard manure fertilizer was treated alone or solely. This is most likely due to the fast availability of nutrients in chemical fertilizers and the organic fertilizer's capacity to improve soil structure. Similarly, using 10 t ha^{-1}farm yard manure fertilizer alone resulted in the greatest value of most Anchote quality criteria.Furthermore, the interaction effect of the two fertilizers allows for the recording of more valuable Anchote quality features. On the other side, when compared to FYM, the use of blended NPSB fertilizer resulted in higher quality Anchote components. Finally, the current study found that using both NPSB blended fertilizer and FYM together improved the quality and nutritional components of the Anchote cultivar and it may be necessary to recommend using both together in the study area to increase yield and quality attributes of the Anchote cultivar.

Data Availability

The raw data collected and analyzed during the study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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