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Performance evaluation and sensory acceptability of improved cooking banana varieties in low land areas of South Omo Zone, Ethiopia

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ABSTRACT

Cooking banana is a type of banana mainly cultivated for its fruit, which is eaten as cooked as a vegetable in many food insecurity areas. The experiment was conducted at Dasenech Woreda where food insecurity and malnutrition is the main problem to evaluate the performance of cooking banana varieties for Fruit yield and boiling suitability. Four improved cooking banana varieties (Cardaba, Nijiru, Matoke and Kitawira) were used as a treatment and arranged in RCBD with three replications. All the growth, agronomic and sensory acceptability data were subjected to analysis of variance (ANOVA) using SAS 9.0 computer software. The analysis of variance (ANOVA) revealed significant ($P \leq 0.05$) differences among the varieties on day of flowering, day of maturity, plant height, fruit weight, number of hands per bunch, bunch weight and total fruit yield. The early date flowering (112) and date of maturing (203.33), as well as the highest number of hands per bunch (8.66), were observed on the variety Matoke. The higher mean value of average fruit weight (168.33 g), bunch weight (15.66 kg) and total yield (23.46 ton ha⁻¹) were observed on the variety Kitawira followed by Mattoke. For panelists scoring preference, the sensory acceptability means scores of boiled Mattoke, Cardaba and Nijiru varieties showed positive acceptability value from like slightly (Nijiru) to like very much (Mattoke) while Kitawira showed a negative acceptability level. Therefore, the variety Mattoke was identified as the early maturing, moderately yielder and best sensory quality accepted as compared to other varieties that could be recommended to demonstrate in the study area.

Keywords: Cooking banana, Sensory, Fruit yield, Variety

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Introduction

Banana (*Musa balbisiana*) is the common name for herbaceous plants of the genus *Musa* and for the fruit they produce. Banana plants are monocotyledons, perennial and important crops in the tropical and subtropical world region (Onwuka *et al.*, 2015). Banana categorizes as dessert, plantain and cooking banana type. The cooking banana or ripe as a fruit, and it is also used to produce beer and wine (Rishirumuhirwa, 2010). Cooking banana varieties is one of the most important food crops cultivated and plays a major role in ensuring food security and rising incomes (Uazire *et al.*, 2008). It is a source of energy with carbohydrates accounting for 22–32% of the fruit weight and rich in vitamins A, B₆, and C as well as minerals particularly potassium, magnesium, phosphorus, and folate (Chandler, 1995; Honfo *et al.*, 2007).

Banana production is concentrated in the southern Nation Nationalities and people's representative region of Ethiopia and the major production comes from small-scale growers. Currently, 95,954.13 hectares of land are covered by banana in Ethiopia, from which 898,354.81 ton are produced and the larger producers are found in Southern Nations Nationalities and Peoples Regional State (SNNPRS) which is 15,358.74 hectares of land covered and 118,253.68 tons are produced (CSA, 2020).

The low land area of South Omo Zone has exclusive access to Omo riverbanks, it is a blessed with favorable soils and is irrigational for the production of fruit crops like a banana. However, the peoples in the low land area of South Omo Zone are predominantly agro-pastoralists, who complement their income and food from livestock production with the cultivation of sorghum on the flooded banks of the Omo. They

experienced severe food insecurity for many years due to varied climatic conditions, traditional production systems and a lack of sound research in the study area.

Production of cooking banana in food insecurity areas plays an important role in ensuring adequate food supplies, addressing micronutrient deficiencies and producing raw materials for animal feed opportunities for the study area (Adebawale and Sanni 2013). Adeniji *et al.* (2010) also reported that cooking bananas are used to combat food insecurity in developing countries. Concerning the above importance, the objective of the present study was to test the adaptability of the improved cooking banana varieties and their suitability for boiling to pave the way for food and nutritional improvement in the agro-pastoral area of South Omo Zone.

Materials and Methods

Description of the study area

The experiment was conducted at Dasenech district. Geographically, the Dasenech administrative district is founded in the SNNP region and is located around 234 km far from the zonal town of Jinka. Astronomically, Dasenech is found lying roughly between 4°37'–4°48' N and 35°56'–36°20' E with an altitude between 350 - 400 m.a.s.l. The climate in this area is a dominantly arid type with the annual rainfall of ranges from 250 mm to 400 mm and an annual mean temperature ranging from 20–45°C (Yidnekachew *et al.*, 2018).

Treatment and experimental design

Four improved cooking type banana varieties released by Melkassa Agricultural Research Centre in 2006 namely Cardaba, Kitawira, Matoke and Nijiru were used as a treatment in this study. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Each variety was planted on a plot size of 2.5 m x 2.5 m under irrigation conditions. All other agronomic practices were done as per the operation standard recommended for banana production.

Sampling and data collection

To evaluate the adaptability and yield performance of cooking banana, phonological parameters (number of days to flowering, number of days to harvest), growth parameters (Pseudo stem height at flowering and Pseudo stem circumference) and agronomic parameters (finger diameter, finger length, average finger weight, number of hands per bunch, number of fruits per bunch, bunch weight and total yield per hectare) were recorded at flowering and harvesting stage.

Sensory evaluation

For sensory evaluation, a total of 3 kg of sample fruit per variety were washed, the tip of the fruit was removed, the fruit coat was split on one side, and the fruit was allowed to boil in a 600 ml beaker containing 300 ml water and 1 g of salt. After boiling for the specified time intervals, samples were quickly emptied into a kitchen sieve to drain the boiling water and cooled for 10 min at room temperature. The samples were peeled and sliced into 1 cm and the banana slice was subjected to sensory evaluation.

A total of 25 male and female untrained panelists (agro-pastoralists) were used. Each panelist was first briefed with the important sensory evaluation conceptual knowledge. The samples were evaluated based on their texture, taste, color, flavor and overall acceptability. Furthermore, all panelists scored the samples for each quality feature using a hedonic scale (9 like extremely, 8 = like very much, 7= like moderately, 6 = like slightly, 5= neither like nor dislike, 4= dislike slightly, 3= dislike moderately, 2 = dislike very much and 1= dislike extremely (Lawless and Heymann, 2010).

Data analysis

The means value for all treatment phenology, growth, agronomic and sensory acceptability data was calculated from the data collected. Finally, an analysis of variance (ANOVA) was done for all the traits by using the SAS 9.0 computer software. Mean separation was employed depending on the significance of the analysis of variance. Mean separation was done using a list significance difference test.

Results and Discussion

Effect of varieties on phonological and growth parameters

The analysis of variance revealed that different cooking banana varieties had significant ($P < 0.001$) differences in days to flowering and days to harvest. Banana cultivars can generally be categorized as early, medium and late maturing ones. Accordingly, the shortest time taken for flowering (112.00) and days of maturing (203.33) were observed on Matoke; while the longer time taken (196.00) for flowering and maturity (288.33) was recorded from Kitawira followed by Cardaba (179.00) (Table 1). According to Njuguna *et al.* (2008); Yoseph *et al.* (2014), the time taken for plating to maturity for banana cultivars reported is higher as compared to the current result. The maturation period variably might be due to genetic differences and the effect of agro-ecology on which crop is grown. Kamira *et al.* (2016) reported that the time taken for the maturation of banana cultivars declined with decreasing altitude.

The mean result of pseudo-stem height showed significantly ($p < 0.001$) affected by varieties. But, pseudo-stem diameter and the number of functional leaves at flowering were not significantly ($p > 0.05$) affected by varieties. This finding has confirmed the previous report (Yoseph *et al.*, 2014). The longest (3.27 m) pseudo-stem height was recorded from Kitawira,

whereas the shortest (1.78 m) pseudo-stem height was obtained for Nijiru (Table 1). The genotypes of varieties have a consistent effect on plant height. Tumuhimbise *et al.* (2016) also reported that the pseudo-stem height of cooking banana varieties varied from 281.1 m to 341.0 m.

Table 1. Means values for phonological and growth parameters of cooking Banana varieties.

Varieties	NDF	NDM	NDH	PSH (m)	PSC (cm)	NFL
Kitawira	196.00 ^a	92.33	288.33 ^a	3.27 ^a	51.66	10.66
Matoke	112.00 ^b	91.33	203.33 ^b	1.82 ^c	46.00	10.00
Nijiru	120.00 ^b	96.00	216.00 ^b	1.78 ^c	47.00	9.66
Cardoba	179.00 ^a	99.66	279.00 ^a	2.11 ^b	45.66	10.00
Mean	151.83	94.83	246.67	2.24	47.58	10.08
LSD (0.05)	26.25	Ns	28.60	0.19	Ns	Ns
CV %	8.65	5.61	5.81	4.37	5.59	9.20

***NDF=number of days to flowering, NDM= numbers of days to maturity, ***NDH= number of days to harvest, ***PSH= Pseudo stem height, PSC= Pseudo stem circumference, NFL= numbers of functional leaves, LSD= least significance difference, CV= coefficient of variation.

Effect of varieties on different yield parameters

The average finger weight showed significant differences ($p < 0.01$) among the varieties but was not significantly affected by fruit diameter and fruit length. Aseffa *et al.* (2020) confirmed that the finger weight was significantly affected due to

genotypic variation. The maximum average finger weight (168.33 g) was observed on varieties Kitiwira and the minimum average finger weight (147.00 g) was observed on Nijiru (Table 2). This current result contradicts the finding of Belayneh *et al.* (2013), who report that fruit weight ranges from 129 g for Cardaba to 95 g for Kitawira.

Table 2. Means values for yield parameters of cooking banana varieties.

Varieties	FD (cm)	FL (cm)	AFW (g)	NHPB	NFPB	BWT (kg)	TY (ton ha ⁻¹)
Kitawira	5.36	19.33	168.33 ^a	7.66 ^a	92.66	15.66 ^a	23.46 ^a
Matoke	5.16	19.33	152.67 ^b	8.66 ^a	90.66	12.20 ^b	19.52 ^{ab}
Nijiru	5.01	20.00	147.00 ^b	6.00 ^b	91.33	12.46 ^b	19.14 ^{ab}
Cardoba	5.00	19.33	151.33 ^b	6.33 ^b	82.00	11.10 ^b	17.22 ^b
Mean	5.137	19.50	154.85	7.166	89.16	12.85	20.04
LSD (0.05)	Ns	Ns	6.91	1.10	9.62	2.95	3.96
CV %	3.85	6.78	2.23	7.71	5.40	11.51	9.89

FD= fruit diameter, FL= finger length, **AFW= average finger weight, **NHB= number of hands per bunch, NFB= number of fruits per bunch, *BW= bunch weight, *TY=total yield, LSD= least significance difference, CV= coefficient of variation.

On the other hand, the average number of hands per bunch also showed significant variation ($p < 0.01$) among the varieties. The maximum number of hands per bunch (8.66) was recorded for Matoke followed by Kitawira (7.66) and the minimum number of hands per bunch (6.00) was observed on Nijiru (Table 2). A similar result was also reported by Tumuhimbise *et al.* (2018).

The varieties had a significant ($p < 0.05$) difference in bunch weight and fruit yield. The significant difference in bunch weight and fruit yield was similarly reported by Tumuhimbise *et al.* (2016). Among the varieties, Kitawira

registered the highest bunch weight 15.66 kg plant⁻¹; however, the lowest bunch weight 11.10 kg plant⁻¹ was observed on Cardoba (Table 2). The highest total yield 23.46 ton ha⁻¹ was recorded for Kitawira and the lowest 17.22 ton ha⁻¹ was observed on Cardoba (Table 2). The finding showed that the value of yield characteristics varied due to the response of varietal genotype to agro-ecological conditions. The finding is in agreement with Yoseph *et al.* (2014) who reported banana varietal differences in total fruit yield.

Effect of varieties Sensory parameters

Sensory quality is an important dimension of the total product quality and is organized by the human senses of sight, smell, taste, hearing and touch. The sensory quality evaluation in this study included acceptance of color, flavor, taste, texture and overall acceptability of boiled cooking banana varieties. The 9-Point Hedonic scale was used to evaluate the acceptability of boiled cooking banana samples. The sensory acceptability data of boiled cooking banana varieties were presented in Table 3. Color acceptability scores showed a significant

difference ($p < 0.05$) with values of 3.08, 3.24, 4.56 and 8.24 on the scale of 9 for varieties Kitawara, Nijiru, kardobe and Mattoke, respectively. All these values showed below acceptability level except Mattoke variety which showed positive acceptability level near like very much. Similarly, texture acceptability scores of boiled cooking banana varieties were significantly ($p < 0.05$) different from each other. The values for Cardoba and Mattoke showed a positive acceptability value near like moderately while the values for Nijru and Kitawara showed below acceptability level.

Table 3. Sensory acceptability of boiled cooking type banana varieties

Varieties	Color	Texture	Taste	Flavor	Overall acceptability
Cardoba	4.56±1.44 ^b	6.84±1.18 ^a	6.08±0.95 ^b	6.04±1.31 ^b	6.80±1.19 ^b
Kitawara	3.08±0.57 ^c	3.04±0.61 ^d	3.64±0.64 ^c	4.16±0.75 ^c	2.88±0.93 ^c
Mattoke	8.24±0.83 ^a	6.36±0.64 ^b	6.56±0.51 ^a	7.20±0.50 ^a	8.36±0.70 ^a
Nijru	3.24±0.43 ^c	4.12±0.66 ^c	5.68±1.11 ^b	6.28±0.79 ^b	6.28±0.84 ^b
CV (%)	18.99	15.88	15.24	14.97	15.33
LSD (0.005)	0.51	0.45	0.47	0.50	0.52

Where, CV = coefficient of variation; values are mean ± SD and mean values followed by the same letter in a column are not significantly different at 5% level of significance; LSD = least significance difference.

Regarding taste, flavor and overall acceptability all four values were significantly ($p < 0.05$) different from one another and indicated positive acceptability levels close like slightly to like very much except the value of Kitawara which had a negative acceptability level. Generally, the sensory acceptability means scores of boiled Mattoke, Cardoba and Nijru varieties showed positive acceptability value from like slightly to like very much while Kitawara showed a negative acceptability level. It is to be noted that the Mattoke variety had the highest scores in the majority of the attributes followed by Cardoba and Nijru. This result is in opposition to the finding of Belayneh *et al.* (2013) who reported that Cardoba was not preferable in terms of color, texture, test and overall acceptability.

Conclusion

The analysis of variance showed that there was a significant difference among the varieties including phenological, growth and yield parameters. The early date flowering (112.00) and date of maturing (203.33), as well as the highest number of hands per bunch (8.66) were observed on the variety Matoke. The higher mean value of average fruit weight (168.33 g), bunch weight (15.66 kg) and total yield (23.46 ton ha⁻¹) were observed on the variety Kitawira followed by Mattoke. For panelists scoring preference, the sensory acceptability means scores of boiled Mattoke, Cardoba and Nijru varieties showed positive acceptability value from like slightly (Nijiru) to like very much (Mattoke) while Kitawara showed a negative acceptability level.

Therefore, the variety Mattoke was identified as the early maturing, moderately yielder and best sensory quality accepted as compared to other varieties that could be recommended to demonstrate in the study area.

Conflict of Interest

The authors declare that they have no conflict of interest with the publication of this article.

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