Physical and Biochemical Characterization of Sweet Corn Ears of Four Varieties Grown in Senegal

Nafissatou Diop Ndiaye, PhD
Institut de Technologie Alimentaire,
Route des Pères Maristes, Dakar - Hann, Sénégal
Mady Cisse, PhD
Université Cheikh Anta Diop de Dakar (UCAD)-Ecole Supérieure Polytechnique (ESP). Avenue Cheikh Anta Diop, Dakar
Fatou Diop Mbacke
Institut Sénégalais de Recherche Agricole (ISRA)-Centre pour le Développement de l'Horticulture (CDH)
Abou Diop
Centre de Formation Professionnelle en Horticulture (CFPH). Route de Cambérène, PA
Saliou Ndiaye, PhD
Ecole Nationale Supérieure Agronomique-Université de Thiès
Thomas Thompson, PhD
Virginia Tech College of Agriculture and Life sciences

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Abstract

Sweet corn is an underutilized crop for human consumption in Senegal. In this study, physical and biochemical characterization were performed on four sweet corn ear varieties grown at three different fertilization rate of 15N-15-P-15K. Treatment F1 was 40 tons/Ha horse-dung + 200 kg/Ha of 15N-15P-15K, treatment F2 was 30 tons/Ha horse-dung + 150 kg/Ha of 15N-15P-15K) and treatment F3 was 50 tons/Ha horse-dung + 250 kg/Ha of 15N-15P-15K. Results showed that Yosemite cultivar gave the highest number of kernels/ear (672.3), followed respectively by Legacy (642), Excellis Garrison (585.6) and Infinity (573). Furthermore, treatments using fertilizer 3 (F3: 50 tons/Ha horse-dung + 250 kg/Ha of 15N-15P-15K) led to the highest number of kernels/ear in all cultivars used. Interestingly, Legacy cultivar gave more reducing sugars (5.1 ± 0.8 $g.100g^{-1}$) with treatment F1; treatment F3 provided less reducing sugars (2.1 ± 0.6 $g.100g^{-1}$) and more starch (14.4 ± 0.5 $g.100g^{-1}$). Overall, physical and biochemical characteristics were influenced to at least some extent by fertilization treatments related to the cultivar used. Yosemite and Legacy cultivars would be more suitable for canned sweet corn production in the conditions studied. Sangalkam seems to be more suitable for sweet corn production.

Keywords: *Zea mays saccharata*, Shrunken-2, Number of kernels/ear, Sugars

Introduction

Sweet corn is an underutilized crop in Senegal, but increasing its production and cultivation could have major benefits for the economy. Sweet corn is primarily used as a fresh market product or it is preserved through canning or deep freezing processing (Alan et al., 2014). Many studies have already been conducted on sweet corn (Hale et al., 2005; Mullins et al., 1999; Simonne et al., 1999; Azanza et al., 1996; Wong et al., 1994). In Senegal, sweet corn was introduced in 2004 (Sy Diouf, 2013) and contributed significantly to the diversification of exported horticultural crop varieties. Sweet corn was identified as a crop with high potential in Senegal and as one of the most important niche markets of the agricultural sector (Sow et Lagnane, 2011). In Senegal, sweet corn is essentially produced for exportation in the Northern area (Senegalese valley rift) to Europe where it is marketed. Senegalese exportation (with 7% of post-harvest losses nationally) was respectively 8,546; 10,124 and 12,253 metrics tons in 2013, 2014 and 2015 (DHORT, 2016). The sweet corn farming industry has been challenged with two major problems. First, five big private foreign companies occupy the industry and local small farmers have not had access to farming opportunities. Second, Senegal imports cans of sweet corn for national market. Specific data on imported sweet corn cans is not available. However, the Senegalese Agency for Foreign Commerce provided between 28.7 to 305 tons in the period of 2012 to 2015 (SAFC, 2016).

Sweet corn is source of fibers (2.3 to 4.25 $g.100g^{-1}$) and vitamin B9 (23 to 88 $\mu g.100g^{-1}$); it has a moisture content of 70% and a total carbohydrate content of 23%, with 27% of the total carbohydrate content comprised by starch (Aprifel, 2012; Lertrat and Pulam, 2007; Szymanek et al., 2006; Péron, 2006). Nevertheless, the chemical composition of sweet corn kernels is related to weather conditions, ripeness and storage methods (Salunkhe and Kadam, 1998). According to Szymanek (2012), optimum kernel moisture ranges from 70 to 76% for whole kernels used for canning or freezing. Sweet corn quality (fresh or processed) is determined by the combination of aroma, texture and flavor. In this regard, sugar and starch contents strongly affect taste and sweetness, which is important for flavor (Alan et al., 2014; Szymanek, 2012; Lertrat and Pulam, 2007; Azanza et al., 1994; Wong, 1994; Flora and Wiley, 1974). In other words, sugar content and its conversion into starch is related to moisture content, which has a drastic impact on taste (Szymanek, 2012; Wong, 1994). Three types of sweet corn cultivars exist on the basis of their sugar contents: sugary *(su*, normal sweet cultivars with 4 to 6% sugar contents), sugary enhancement (*se*, cultivars with 6 to 8% sugar content) and shrunken-2 (*sh2*, 8 to 12% sugar content, considered very sweet) (Warzecha, 2003). After harvesting, sugary cultivars rapidly lose their kernel quality due to moisture loss and conversion of sugar into starch. Compared to shrunken cultivars, a slow conversion of sugar into starch is observed (Azanza et al., 1996, Carey et al., 1982, 1984).

In Senegal, there is a lack of knowledge about local sweet corn varieties despite the work done by Diallo et al., (2016), who studied the response of five sweet corn cultivars (Prime plus, Shy 1036, Colombus, GSS and JKMH-45) to different fertilization treatments experimented in Saint-Louis (Senegal). Nevertheless, this study was focused only on agronomic parameters including: height 30 days after sowing, 50% flowering rate, height of higher ear, 60 days silk quality after sowing, number of ears/plant and number of kernels/ear. This current research was carried out to determine physical and biochemical characteristics of four shrunken-2 sweet corn cultivars grown with three different fertilization treatments. Results were intended to be used as guidelines for future production of sweet corn in the Senegalese canning industry. We chose shrunken-2 (sh2) phenotype because its kernels produce more sugars at harvest maturity (Creech, 1965). Furthermore, sh2 phenotype can keep its high contents of sugar for a long postharvest period (Garwood et al., 1976). In addition, consumers prefer its taste in comparison with su or se phenotypes (Evensen and Boyer, 1986; Showalter and Miller, 1962).

Materials and methods

Sweet corn production

Four *sh-2* yellow sweet corn cultivars: *Excellis Garrison F1* (Syngenta seeds), *Legacy* (Starke Ayres), *Infinity* (Harris Moran seed company) and *Yosemite* (Starke Ayres) were studied in 2013 and 2014. Fields of the Senegalese Institution for Agricultural Research were used as experimental stations. They were located at Sangalkam (14° 46’ 52¨N; 17° 13’40¨W; 7 m) and Ndiol (16° 8’ 22’’N; 16°19’5’’W; 7 m), respectively, in Niayes and Senegalese Rift Valley Region. The soil in Sangalkam station was clayey, rich and fertile with high demand for water (Delsoin, 2014). Meanwhile in Ndiol, the soil was sandy, dry and poor (Diallo *et al.*, 2016). A Fisher’s randomized complete block design (RCBD) with four repetitions was used for each cultivar. Each block had 15 plots, and each plot was 27 m^2 (9x3) and had 5 lines separated by an alley of 1 m width. This allowed for the elimination of edges effects. Seeds were sown in Ndiol on November 29, 2013 and in Sangalkam on January 24, 2014. A planting density of 50, 000 plants/ha was applied with a spacing of 75 cm x 25 cm. Three different fertilization rates of 15N-15P-15K available in the market were used in combination with horse-dung. Treatment F1 was 40 tons/Ha horse-dung + 200 kg/Ha of 15N-15P-15K, treatment F2 was 30 tons/Ha horse-dung + 150 kg/Ha of 15N-15P-15K) and treatment F3 was 50 tons/Ha horse-dung + 250 kg/Ha of 15N-15P-15K. **Table 1** shows an estimate of the total amount of N, P, K resulting from the fertilizer used and horse dung application. Sprinkling irrigation was used every two days. Ears were harvested after 101 days at maturity stage and brought to the laboratory for analysis.

Table 1: Available amounts of N, P, K resulted from horse dung and fertilizer application for each treatments

Treatments applied	Available Amounts								
	N (kg/Ha)			P (kg/Ha)			K (kg/Ha)		
	Horse dung	Fertilizer	Total	Horse dung	Fertilizer	Total	Horse dung	Fertilizer	Total
Treatment F1 = 40 tons/Ha fumier de cheval + 200 kg/Ha of 15N-15P-15K	200	30	230	120	30	150	280	30	310
Treatment F2 = 30 tons/Ha fumier de cheval + 150 kg/Ha of 15N-15P-15K	150	22.5	173	90	22.5	113	210	22.5	233
Treatment F3 = 50 tons/Ha fumier de cheval + 250 kg/Ha of 15N-15N-15N	250	37.5	288	150	37.5	188	350	37.5	388

Determination of physical and biochemical characteristics of ears

Physical characteristics were recorded on fresh ears of corn after removing covers leaves according to Szymanek *et al.*, (2006). Records were focused on ear weight, ear length, ear diameter, number of kernels in row, number of rows and number of kernels per ear. Twenty ears were analyzed separately from each combination of variety and treatment. Biochemical analyses were conducted for water content, starch and total and reducing sugars using standards methods (AOAC, 2007; AOAC, 1990).

Statistical analysis

Significant differences ($p<0.05$) of the various analyses were determined using SPSS software (version 20.0) using two ways Anova. Newman-Keuls test was used to detect differences.

Results and discussion

Physical characteristics of sweet corn ears grown at Sangalkam

Results for physical properties of ears from the four studied sweet corn cultivars are presented in **Table 2**. For Excellis Garrison cultivar, physical properties were not significantly affected by fertilization treatment rate. Weights of ears without leaves ranged from 210 to 228 $g.100g^{-1}$ fresh matters with 18 cm length and 47 mm diameter. The number of kernels/row and the number of rows/ear were respectively around 35 and 16. The number of kernels/ear was respectively 573, 547 and 586 for F1, F2 and F3 fertilizer treatments (Table 2). These data were closed to those described on the technical variety sheet from the supplier, which indicated 20 cm length, 50 mm diameter for a number of rows/ear of 16 (Syngenta, 2013). Ear length was closed to those from Challenger cultivar grown in Tennessee (Mullins et al., 1999).

Table 2: Physical characteristics of sweet corn ears grown at Sangalkam

	Excellis Garrison			**Legacy**			**Infinity**			**Yosemite**		
	Treatments			**Treatments**			**Treatments**			**Treatments**		
	F1	**F2**	**F3**	**F1**	**F2**	**F3**	**F1**	**F2**	**F3**	**F1**	**F2**	**F3**
Ear weight (g)	227.8 ± 43.1	212.5 ± 41.1	210.2 ± 35.4	326^{x} ± 45.9	280.9^{y} ± 60.9	326.1^{x} ± 49	262.3 ±43.9	231.8 ±53.4	263.4 ± 55.8	239.9 ± 48.1	243.6 ± 47.5	270.3 ± 47.2
Ear length (cm)	18.0 ± 3.6	18.5 ± 2.3	18.1 ± 2	21 ±1.4	19.6 ±1.7	21.2 ± 3.2	20 ± 2	19.1 ± 2.4	19.4 ± 3	19.4 ± 2	18.9 ± 1.4	19.4 ± 2.2
Ear diameter (mm)	48.7 ± 2.5	47.1 ± 2.9	46.8 ± 2.8	53.2^{xy} ± 2	52^{x} ±2.9	54.4^{y} ± 2.5	50.2 ± 2.4	48.9 ±2.5	50.1 ± 2.7	48.6 ± 2.5	49.1 ± 2.2	49.4 ± 3.2
Number of Kernels/row	35 ± 4.7	32.7 ± 6.1	34.9 ± 4.8	37.3^{x} ± 3.3	32.3^{y} ±6.6	37.3^{x} ±2.8	35.3 ± 3.2	34.2 ±6.7	34.7 ± 5.3	34.3 ± 5.7	35.9 ± 2.8	36.2 ± 3.6
Number of rows/ear	16.3 ± 1.3	16.6 ± 2.4	16.7 ± 1.9	16.7 ± 1.1	16.5 ± 1.6	17.1 ±1.8	16.2 ± 2	16.2 ± 1.7	16.5 ± 1.8	17.4 ± 1.9	17.2 ± 1.8	18.5 ± 2.2
Number of kernels/ear	573.1 ±101.2	547.0 ±128.7	585.6 ± 108.0	623.3^{x} ± 52.3	538.7^{y} ± 140.8	641.8^{x} ± 88.8	573.3 ± 91.1	558.1 ±127.8	573 ±109.4	597.7 ±122	617.2 ±72.2	672.3 ± 120.6

(±) Indicates standard deviations of the means Presence of different letters x, y, z in the same line means that there is significant difference between the three treatments within the same cultivar at α=5%. Numbers without letters means there is no significant difference. F1 treatment = 40 tons/Ha of horse-dung + 200 kg/Ha of 15N-15P-15K. F2 treatment = 30 tons/Ha of horse-dung + 150 kg/Ha of 15N-15P-15K. F3 treatment = 50 tons/Ha of horse-dung + 250 kg/Ha of 15N-15P-15K.

Data recorded for Legacy cultivar showed significantly difference only in ear weight, ear diameter, number of kernels/row and number of kernels/ear. Highest values were obtained in F3 and F1 treatments. Ear diameters of F1 and F3 treatments were slightly higher compared to F2. Ear lengths of these two treatments were slightly higher than those indicated in the technical cultivar sheet (Starke Ayres, 2013a). Differences could be from variations in areas and conditions of cultivation.

For Infinity cultivar, the three fertilizer treatments did not have a significant effect on ear weight, ear length, ear diameter, number of kernels/row, number of rows/ear and number of kernels/ear. Lowest values were obtained with treatment F2 in most cases. Ear lengths were slightly highest to those indicated on the technical sheet of Infinity cultivar mentioning 16-18 cm of length (Stark Ayres, 2013b). Treatments (F1, F2 and F3) did not have a significant impact on all physical parameters for Yosemite cultivar. However, ears obtained with treatment F3 represented the highest number of kernels/ear with an average of 672. Average ear length of Yosemite cultivar in the technical data sheet was around 20.5 cm with a number of rows between 16 to 18 (Harris Moran, 2013). Even if many studies were done on sweet corn cultivars, only one reference was found on sweet corn cultivation in Senegal. Diallo et al., (2016) have worked in the same fertilization conditions, but different varieties and cultivation area were used. Considering the number of kernels/ear as the most important physical parameter for production of canning sweet corn, Yosemite and Legacy cultivars were indicated as best using our studied conditions. Furthermore, sweet corn cultivars used in this study were more efficient than Prime plus, Shy 1036, Colombus, GSS and JKMH-45 tried by Diallo et al., (2016) with the same F1, F2 and F3 fertilization treatments. Diallo et al., (2016) reported that the number of kernels/ear was between 304 and 433. With regard to the recommended amount of nitrogen (N) involved in the fertilization of sweet corn, the application rate was different during the development stage of the plant. In Tennessee for example, the rate of N was 101 kg/Ha at planting and 34 kg/Ha when plant height reached between 30.5 and 45.7 cm (Mullins et al., 1999). In our study, the rates of N were 230, 173 and 288 kg/Ha, respectively, for treatments F1, F2 and F3.

Physical characteristics of sweet corn ears grown at Ndiol

Table 3 presents data recorded from ears collected at Ndiol. Excellis Garrisson cultivar showed significant difference in ear weights for F1 and F2 fertilizer treatments with the highest value for F2 treatment (177.4g). In Table 3, average ear length was 14 cm with an average diameter of 45.5cm. Average number of kernels/ear was 355. Ear characteristics of Legacy and Infinity cultivars were not influenced by fertilization treatments. For Yosemite cultivar, significant differences were recorded for ear weights and diameters, with highest values obtained with F2 treatment. Number of kernels/ear was higher in the Infinity cultivar when F2 treatment was applied. Results from the two stations used in this study, showed that Sangalkam area was more suitable for sweet corn production. For all sweet corn cultivars tested, ear characteristics obtained from Sangalkam were higher. Regarding sweet corn processing, the number of kernels/ear represents a key physical parameter for selecting suitable varieties. Yosemite and Infinity cultivars were selected as more suitable, according to results in Sangalkam (with F3 treatment) and Ndiol (with F2 treatment), for canning processing.

Table 3: Physical characteristics of sweet corn ears grown at Ndiol

	Excellis Garrison			Legacy			Infinity			Yosemite		
	Treatments			Treatments			Treatments			Treatments		
	F1	F2	F3	F1	F2	F3	F1	F2	F3	F1	F2	F3
Ear weight (g)	128.4 [a] ± 47.2	177.4 [b] ± 48.5	153.6 [ab] ± 37.1	179.1 ± 47.1	139.1 ± 42.4	185.4 ± 61.6	164.1 ± 45.8	187.4 ± 42.4	180.2 ± 35.4	174.3 [a] ± 56.2	232.8 [b] ± 60.5	190.1 [ab] ± 55.2
Ear length (cm)	13.6 ± 2.2	14.7 ± 2	14.1 ± 2.7	14.9 ± 2.3	13.4 ± 1.6	15.2 ± 2.9	14.4 ± 1.8	14.3 ± 1.3	17 ± 8.2	15.1 ± 2.3	16.3 ± 2.3	14.6 ± 2.5

Ear diameter (mm)	43.5 ± 5.1	47.6 ± 3.1	45.4 ± 3	47.4 ± 2.7	45.7 ± 2.3	47.8 ± 4.1	47.4 ± 3.4	46.9 ± 2.5	45.1 ± 8.2	47.3 [a] ± 3.2	51.6 [b] ± 2.2	50.6 [b] ± 4.9
Number of Kernels/row	20.9 ± 6.3	24.2 ± 5.1	23.5 ± 5.8	26.6 ± 5.7	21.4 ± 6.6	27.1 ± 7.3	25.6 ± 5.6	26.8 ± 3.9	27.2 ± 5.3	24.1 ± 6.1	25.8 ± 9.5	25.5 ± 6.3
Number of rows/ear	15.5 ± 4.5	16.0 ± 2.1	14.3 ± 2.1	15.3 ±1.2	14.9 ±1.9	15.4 ± 2.3	16.7 ± 2.2	17.7 ± 1.8	16.6 ± 2.4	14.9 ± 1.9	16.3 ± 2	15.5 ± 2.1
Number of kernels/ear	339.1 ± 197.6	386 ± 89.2	340 ± 105.4	404.8 ± 84.1	317.7 ± 98	419.6 ± 139.7	433.1 ±132.6	480.4 ±113.4	453.5 ±112.6	363.9 ± 113.6	428.6 ± 167.4	397.9 ± 116.1

(±) Indicates standard deviations of the means. Presence of different letters a, b, c in the same line means that there is significant difference between the three treatments within the same cultivar at α=5%. Numbers without letters means there is no significant difference. F1 treatment = 40 tons/Ha of horse-dung + 200 kg/Ha of 15N-15P-15K. F2 treatment = 30 tons/Ha of horse-dung + 150 kg/Ha of 15N-15P-15K. F3 treatment = 50 tons/Ha of horse-dung + 250 kg/Ha of 15N-15P-15K.

Biochemical characteristics of sweet corn ears grown at Sangalkam

Table 4 shows data obtained for moisture content, reducing sugars, totals sugars and starch for four sweet corn cultivars grown at Sangalkam under three different fertilization treatments. All data were expressed in $g.100g^{-1}$ fresh matter. For Excellis Garrison, water content (79.4 ± 1.1 $g.100g^{-1}$) from ears in treatment F1 was higher, followed by ears in treatments F3 and F2. Reducing sugar contents were similar for treatments F1 and F2 (2.9 $g.100g^{-1}$) and higher for treatment F3 (4.4 ± 0.2 $g.100g^{-1}$). Total sugar contents were significantly different ($p<0.05$) between F1, F2 and F3 treatments with higher values in treatment F3 (8.6 ± 0.7 $g.100g^{-1}$) followed by treatment F2 (6.7 ± 0.5 $g.100g^{-1}$) and treatment F1 (4.9 ± 0.2 $g.100g^{-1}$). Starch content was lower in treatment F3 (10.9± 0.7 $g.100g^{-1}$) and similarly higher in treatments F1 and F2 (13.7 ± 0.2 $g.100g^{-1}$). Water content was the same in treatments F2 and F3, and higher in treatment F1 with 80.7 ± 1.2 $g.100g^{-1}$ for Legacy cultivar. Reducing sugar contents were higher in treatment F2, with an amount of 5.3 ± 0.8 $g.100g^{-1}$, compared to treatments F1 and F3. Total sugar contents were the same in treatments F1 and F3 and lower in treatment F2 (4.8 ± 0.6 $g.100g^{-1}$). Starch content ranged from 12.1 to 14.4 with the highest value in treatment F3. Fertilizer treatments did not have effects on water (76.5 ± 1.1 $g.100g^{-1}$) and starch (13.4 ± 0.4 $g.100g^{-1}$) contents of Infinity cultivar. Reducing sugars were similar in treatments F2 and F3 (3.7 ± 0.2 $g.100g^{-1}$) and lower in treatment F1 (2.5 ± 0.3 $g.100g^{-1}$). Total sugar contents were significantly different ($p<0.05$) in treatments F1, F2 and F3 with highest values in treatment F3 (7.3 ± 0.3), followed by F2 (5.7 ± 0.4 $g.100g^{-1}$) and F1 (4.4 ± 0.4 $g.100g^{-1}$). Water content was higher in treatments F2 and F3 (around 80 $g.100g^{-1}$) compared to treatment F1 (78.7 ± 0.9) for Yosemite cultivar. Reducing sugar contents were the same in treatments F1 and F2 with highest value (3.4 ± 0.3 $g.100g^{-1}$) in treatment F3. Total sugars were higher in treatment F1 (8 ± 0.5 $g.100g^{-1}$) than those recorded for treatments F2 (6.9 ± 0.4 $g.100g^{-1}$) and F3 (6.3 ± 0.8 $g.100g^{-1}$). Starch content was higher in treatments F1 and F2 (13.2 ± 0.6 $g.100g^{-1}$) compared to treatment F3 (11.6 ± 0.4 $g.100g^{-1}$). Water contents for Yosemite cultivar were slightly higher than those reported by Szymanek (2012) for Candle sh2 variety (76.4%). For Excellis Garrison, Infinity and Legacy cultivars, moisture contents were closed to those recorded for Crisp-N-Sweet 710 (75.9%), FMX (76.4%) or Summer sweet 7210 (76.9%) varieties (Wong *et al.*, 1994). About total sugars and starch contents, our results were higher than those reported by Szymanek (2012) for Candle sh2 variety (3.6% and 2.73% respectively for total sugars and starch). Differences could be from variations in harvest date or conditions of cultivation.

Table 4: Water, reducing sugars, total sugars and starch contents of sweet corn ears grown at Sangalkam

	Excellis Garrison			Legacy			Infinity			Yosemite		
	Treatments			Treatments			Treatments			Treatments		
	F1	F2	F3	F1	F2	F3	F1	F2	F3	F1	F2	F3
Water content ($g.100g^{-1}$)	79.4 ^{a} ± 1.1	75.03 ^{b} ± 1.04	76 ^{c} ± 1.4	80.7 ^{a} ± 1.2	76 ^{b} ± 0.6	77.6 ^{b} ± 0.9	77.1 ± 1.4	75.8 ± 0.7	76.6 ± 1	78.7 ^{a} ± 0.9	80.6 ^{b} ± 0.9	80.3 ^{b} ± 0.2
Reducing sugars ($g.100g^{-1}$)	2.9 ^{a} ± 0.6	2.8 ^{a} ± 0.6	4.4 ^{b} ± 0.2	2.1 ^{a} ± 0.6	5.3 ^{b} ± 0.8	6.7 ^{a} ± 0.3	2.5 ^{a} ± 0.3	3.7 ^{b} ± 0.2	3.7 ^{b} ± 0.4	2.3 ^{a} ± 0.2	2.6 ^{a} ± 0.6	3.4 ^{b} ± 0.3
Total sugars ($g.100g^{-1}$)	4.9 ^{a} ± 0.2	6.7 ^{b} ± 0.5	8.6 ^{c} ± 0.7	6.2 ^{a} ± 0.7	4.8 ^{b} ± 0.6	6 ^{a} ± 0.5	4.4 ^{a} ± 0.4	5.7 ^{b} ± 0.4	7.3 ^{c} ± 0.3	8 ^{a} ± 0.5	6.9 ^{b} ± 0.4	6.3 ^{b} ± 0.8
Starch ($g.100g^{-1}$)	13.7 ^{a} ± 0.2	13.7 ^{a} ± 0.2	10.9 ^{b} ± 0.7	12.1 ^{a} ± 1.3	12.3 ^{a} ± 0.9	14.4 ^{b} ± 0.5	13.2 ± 0.5	13.8 ± 0.3	13.1 ± 0.04	13.2 ^{a} ± 0.6	13.1 ^{a} ± 0.4	11.6 ^{b} ± 0.4

(±) Indicates standard deviations of the means. Presence of different letters a, b, c in the same line means that there is significant difference between the three treatments within the same cultivar at α=5%. Numbers without letters means there is no significant difference. F1 treatment = 40 tons/Ha of horse-dung + 200 kg/Ha of 15N-15P-15K. F2 treatment = 30 tons/Ha of horse-dung + 150 kg/Ha of 15N-15P-15K. F3 treatment = 50 tons/Ha of horse-dung + 250 kg/Ha of 15N-15P-15K.

Biochemical characteristics of sweet corn ears grown at Ndiol

Table 5 shows data recorded on water content, reducing sugars, totals sugars and starch contents for the four sweet corn cultivars grown at Ndiol under three different fertilization treatments. For Excellis Garrisson, there were no significant differences between treatments F1, F2 and F3 for water content, reducing sugars, total sugars and starch. For Legacy, water content was the same for treatments F1 and F3 and slightly lower in F2. Reducing sugars were higher in treatments F2 and F3 than in F1. Total sugars were lower in F2 than in treatments F1 and F3. Significant differences ($p<0.05$) were noticed between treatments F1, F2 and F3 on starch content with the highest in F1 treatment. Considering Infinity cultivar, water content and total sugars were the same in treatments F1, F2 and F3. Reducing sugars were higher in F3 treatment while starch contents were higher in treatments F2 and F3. Yosemite showed ears with higher total sugar content in treatment F1 and high starch content in treatment F2. Fertilizer treatments did not affect reducing sugar contents. Total sugar contents were significantly different ($p<0.05$) in treatments F1, F2 and F3 with highest values in treatment F3 (7.3 ± 0.3).

Table 5: Water, reducing sugars, total sugars and starch contents of sweet corn ears grown at Ndiol

	Excellis Garrison			Legacy			Infinity			Yosemite		
	Treatments			Treatments			Treatments			Treatments		
	F1	**F2**	**F3**	**F1**	**F2**	**F3**	**F1**	**F2**	**F3**	**F1**	**F2**	**F3**
Water content ($g.100g^{-1}$)	78.9 ± 0.6	78.9 ± 0.6	78.9 ± 0.7	77.6 ^{a} ± 0.8	76 ^{b} ± 0.8	77.8 ^{a} ± 0.5	77.9 ± 0.7	78.6 ± 0.6	78.9 ± 0.8	78.7 ^{a} ± 0.8	77.4 ^{ab} ± 0.9	75.6 ^{b} ± 1.5
Reducing sugars ($g.100g^{-1}$)	3.4 ± 0.2	3.5 ± 0.6	3.8 ± 0.7	3.7 ^{b} ± 0.5	4.6 ^{a} ± 0.3	5.2 ^{a} ± 0.3	4.6 ^{a} ± 0.3	3.7 ^{a} ± 1	5.8 ^{b} ± 0.6	5.7 ± 1.3	4.9 ± 0.6	5.4 ± 1.03
Total sugars ($g.100g^{-1}$)	5.2 ± 0.5	6.2 ± 0.7	6.1 ± 0.7	7.3 ^{a} ± 0.1	6 ^{b} ± 0.6	6.7 ^{a} ± 0.4	5.7 ± 0.6	6.2 ± 4.4	5.7 ± 2.1	7.8 ^{a} ± 0.6	6 ^{b} ± 0.5	6.4 ^{b} ± 0.5
Starch ($g.100g^{-1}$)	11.7 ± 0.7	11.9 ± 0.4	11.3 ± 0.8	11.2 ^{a} ± 0.04	10 ^{b} ± 0.3	9.4 ^{c} ± 0.2	11.1 ^{a} ± 0.2	12.2 ^{b} ± 0.2	12.1 ^{b} ± 0.3	10.2 ^{a} ± 0.2	13.5 ^{b} ± 0.2	11.04 ^{a} ± 1

(±) Indicates standard deviations of the means. Presence of different letters a, b, c in the same line means that there is significant difference between the three treatments within the same cultivar at α=5%. Numbers without letters means there is no significant difference. F1 treatment = 40 tons/Ha of horse-dung + 200 kg/Ha of 15N-15P-15K. F2 treatment = 30 tons/Ha of horse-dung + 150 kg/Ha of 15N-15P-15K. F3 treatment = 50 tons/Ha of horse-dung + 250 kg/Ha of 15N-15P-15K.

Conclusion

The number of kernels/ear is one of the most important physical parameters for producing sweet corn suitable for canning. Among the four cultivars tested, F3 fertilization treatment (50 tons/Ha horse dung + 250 kg/Ha of 15N-15P-15K) led to the highest number of kernels/ear. Yosemite cultivar showed the highest number of kernels/ear (672.3) followed respectively by Legacy (642), Excellis Garrison (585.6) and Infinity (573). Water and sugar contents, reported as the main attributes of the sweet corn quality for processing, also represent important parameters to be considered in selecting variety to avoid Mallard reaction and loss in kernel tenderness. Legacy cultivar exhibited, at the same time, the highest content of reducing sugars in treatment F1 and the lowest amount of reducing sugars in treatment F3. Also, Legacy cultivar presented the highest starch content in treatment F3. From these results, Yosemite and Legacy cultivars would be more suitable for sweet corn canning in Senegal. In this regard, Sangalkam could be reported as the best place for sweet corn production. Nevertheless, other studies need to be carried out over several years in order to assess the behavior of studied cultivars in longer terms for canning processing. It would be relevant to consider the edaphic characteristics, in particular by advanced physical and chemical analyses of the soil, for a better adaptation to amounts of fertilization. Further tests need to be conducted in order to collect data on post harvest storage and suitability for sweet corn production as well as canning processing.

Conflict of interest

The authors have not declared any conflict of interests.

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