



# Combined application of organic and inorganic fertilizers influenced biochemical qualities of fruit juice from yellow passion fruit (*Passiflora edulis* Deg.) genotypes

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## Abstract

Globally, the utilization of passion fruit juice is on the increase because of the organoleptic, tremendous nutritional and biochemical qualities which can be influenced by fertilization among other factors. Hence, the study investigated the influence of combined application of organic and inorganic fertilizers (0, 10, 20 t/ha PM, 5 t/ha PM+200 kg/ha NPK 15-15-15, 10 t/ha PM+200 kg/ha NPK 15-15-15 and 400 kg/ha NPK 15-15-15) on the nutritional and biochemical qualities of fruit juice from two yellow passion genotypes ('Conventional' and KPF-4). Five matured, ripe and dropped fruits were directly picked under the yellow passion fruit vines which previously received the afore-mentioned fertilizers. Proximate and physicochemical compositions of fresh fruit juice from the fruits were assayed. Results were analyzed using split-plot design in completely randomized design, with genotype as main plot while fertilizer was assigned to sub-plots. Juice from Conventional genotype significantly ( $p < 0.05$ ) had highest crude fibre (0.495%), moisture (79.83%), K (2.61 mg/100 mL) and Na (1.318 mg/100 mL) with 10 t/ha PM+200 kg/ha NPK application. Highest juice pH of 3.91 (less acidic level) and total titratable acidity (8.223 mg/100 mL) were also produced in Conventional genotype with the application of 10 t/ha PM+200 kg/ha NPK. On the other hand, highest total ash (0.545%) and carbohydrate (20.62%) in juice from KPF-4 genotype were recorded with the application of either 10 t/ha PM+200 kg/ha NPK or 5 t/ha PM+200 kg/ha NPK. The addition of 5 t/ha PM+200 kg/ha NPK produced highest calcium (1469 mg/100 mL) and iron (97.49 mg/100 mL) concentrations but vitamin C was highest with either the application of 20 t/ha PM (29.04 mg/100 mL) and 400 kg/ha NPK (29.33 mg/100 mL). Lowest crude protein, crude fibre, percentage moisture, P, K, Na and Fe concentrations were ascribed to fruits that received no fertilizer. Tannin, saponin and phytate compositions in the juice were reduced by the application of 10 t/ha PM or 400 kg/ha, 10 t/ha PM+200 kg/ha NPK and 10 t/ha, respectively. The study therefore revealed that combined application of poultry manure and NPK fertilizers, especially 10 t/ha PM+200 kg/ha NPK, can improve juice nutritional and biochemical qualities of yellow passion fruits. Further studies on the effect of other forms of organic and inorganic fertilizers combinations on juice qualities of passion fruit were recommended.

**Keywords:** Yellow passion fruit, Juice, Poultry manure, Proximate, Phytochemical.

## INTRODUCTION

There is an increase in the consumption of fresh fruits and vegetables or their juices obviously because of the health benefits of these fruits and vegetables (Bhat and Stammering, 2014; Simforian et al., 2015; Field survey). Passion fruit (*Passiflora edulis* Degener) which belongs to

the family, Passifloraceae, is cultivated majorly because of the edible pulp and juice. The passion fruit can be freshly marketed and the pulp and juice consumed raw or as frozen pulps, jams, yoghurts (da Silva et al., 2015). The juice can also be blend with other fruits in wine and juice industries for the production of other products. Brazil is the world's largest producer of the crop. South Africa and

Kenya ranks the topmost countries in Africa that cultivates the crop in commercial quantity.

Although, the crop is relatively known by few farmers in southeastern Nigeria, the juice is utilized in some fruit markets and smoothie outlets and stores. The distinct aroma and visual characteristics of the passion fruit juice are important for the marketing of the fruits (Abreu et al., 2009; da Silva et al., 2015). It is pertinent to understand the juice qualities when produced because of the nutritional and health benefits. However, the quality of crop produce is determined by pre and post-harvest factors. Soil nutrition is one of these pre-harvest factors since plant roots absorb and translocate needed nutrients from the soil to the sinks (flowers, fruits, etc.). The application of fertilizer had been reported to influence the nutritional and biochemical properties of passion fruit juice (Ani and Baiyeri, 2008; Freire et al., 2014; Ndukwe and Baiyeri, 2016a). There is dearth of information on the influence of complementary application of organic and inorganic fertilizers on the biochemical qualities of juice from yellow passion fruit, especially the Conventional and KPF-4 (a hybrid breed in Nairobi, Kenya). Therefore, the objective of the study was to investigate the biochemical and nutritional qualities of fruit juice from two yellow passion fruit genotypes as influenced by the combined application of organic and inorganic fertilizers.

## MATERIALS AND METHODS

Yellow passion fruits were obtained from an experimental field located in the teaching and research farm of the Department of Crop Science, University of Nigeria, Nsukka. Nsukka lies within longitude 07°29'N and latitude 06°51'E with 400 m above sea level. The total annual rainfall during the field study ranged between 1377 to 1555 mm with bimodal annual distribution. The average minimum and maximum temperatures were 21°C and 31°C, respectively while the average relative humidity ranged between 52.7% to 61.7%.

The experimental field which was established in 2016 involved two yellow passion fruit genotypes (Conventional and KPF-4) and six fertilizer treatments namely no fertilizer, 10 t/ha Poultry Manure (PM), 20 t/ha PM, 5 t/ha PM+200 kg/ha NPK, 10 t/ha PM+200 kg/ha NPK, 400 kg/ha NPK. NPK 15:15:15 fertilizer was used. These fertilizer treatments were applied at a month after transplanting. The experimental layout was split-plot laid out in completely randomized design replicated three times. The main plot was the two genotypes while the sub-plot was the fertilizer treatments. Five passion fruit vines in a single row were staked with the aid of two wooden poles (2 m high) placed at the end of each row with the

help of horizontal rope connecting the wooden poles. Other cultural practices was as described by Ndukwe and Baiyeri (2016b).

Five fresh passion fruits were picked according to the treatment and treatment combinations. They were sent to the laboratory for biochemical and nutritional analyses. The proximate composition (crude protein, crude fibre, crude fat, total ash, moisture, carbohydrate), physicochemical qualities (pH, total soluble solid, total titratable acidity, °Brix, vitamins A and C), mineral concentrations (phosphorus (P), potassium (K), nitrogen (N), calcium (Ca), magnesium (Mg), zinc (Zn), iron (Fe), sodium (Na)), physicochemical characteristics and phytochemical composition (phenol, saponin, tannin, oxalate, phytate) were analysed in quadruplicates. Generally, the protocols of AOAC (2005) were adopted except the determination of phytate content which followed Maga (1982) procedure (Table 1).

The results recorded were subjected to analysis of variance following the procedure outlined for split-plot experiment in completely randomized design using GENSTAT (2007). Separation of treatment means were done using Least Significant Difference (LSD) at 5% level of significant.

## STATISTICAL ANALYSIS

The results recorded were subjected to analysis of variance following the procedure outlined for split-plot experiment in completely randomized design using GENSTAT (2007). Separation of treatment means were done using Least Significant Difference (LSD) at 5% level of significant.

**Table 1.** Physicochemical characteristics of composite soil sample of the experimental site and poultry manure used during the studies.

Soil properties	Top soil (0-20 cm)	Poultry manure
<b>Physical properties</b>		
pH (H <sub>2</sub> O)	5.7	8.1
pH (KCl)		
Organic carbon (%)	1.39	13.95
Organic matter (%)	2.06	24.06
Sand (%)	85	-
Silt (%)	9	-
Clay (%)	6	-
Textural class	Sandy loam	-
<b>Chemical properties</b>		
Nitrogen (%)	0.13	3.64
Available phosphorus (ppm)	8.39	0.39 (%)
Potassium (meq/100 g)	0.11	3.88
Calcium (meq/100 g)	8.8	28.4
Magnesium (meq/100 g)	1.2	12.2
Sodium (meq/100 g)	0.07	1.72
Cation exchangeable capacity (meq/100 g)	16	-
Base saturation (%)	63.63	-
Al <sup>3+</sup> (meq/100 g)	Trace	-
H <sup>+</sup> (meq/100 g)	1.4	-

**RESULT**

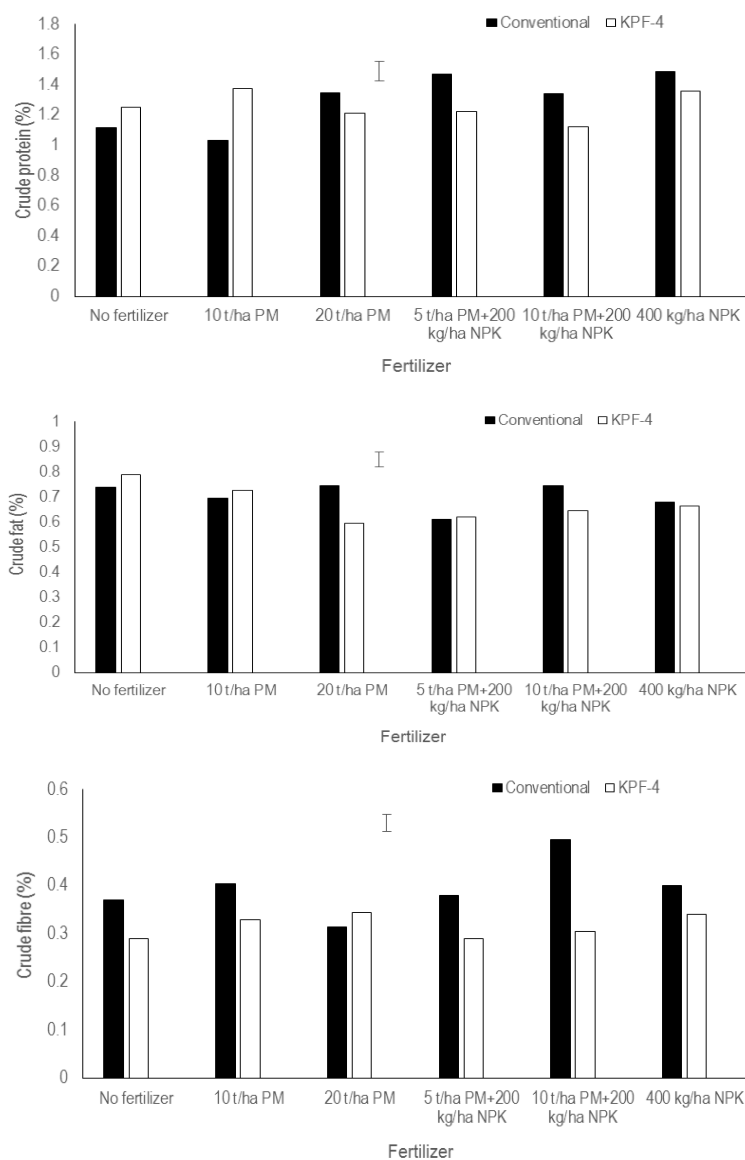
**Proximate Composition of Fruit Juice**

The proximate compositions of the juice were significantly influenced by genotype and fertilizer interactions (Figures 1 and 2). The highest mean value of crude protein (1.49%) was recorded by the juice of Conventional genotype with 400 kg/ha NPK. This did not significantly differ with the mean value (1.47%) obtained from the application of 5 t/ha PM+200 kg/ha NPK. Crude fat (0.79%) was highest in KPF-4 with no fertilizer application. The percentage juice crude fibre (0.495%) and moisture content (79.83%) were significantly ( $p < 0.05$ ) highest in the conventional with combined application of 10 t/ha PM+200 kg/ha NPK. The

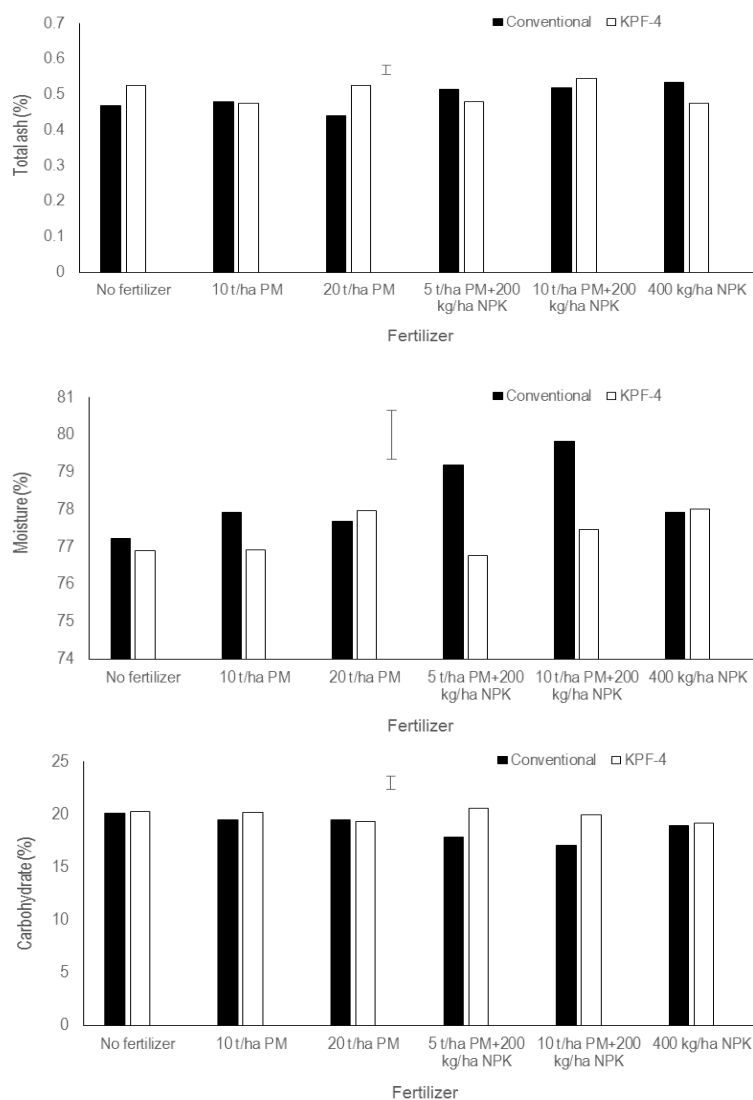
juice total ash (0.545%) and carbohydrate (20.62%) were also highest in KPF-4 with complementary application of 10 t/ha PM+200 kg/ha NPK and 5 t/ha PM+200 kg/ha NPK.

**Mineral Concentrations of Fruit Juice**

Higher juice P, K, Ca and Zn concentrations were obtained from the Conventional than the KPF-4 (Table 2). Fertilizer application influenced the juice P, K, Ca, Na and Zn concentrations (Table 3). The application of 400 kg/ha NPK produced juice with highest concentrations of P (103.51 mg/100 mL) while K (2.61 mg/100 mL) and Na (1.318 mg/100 mL) contents were highest with complementary application of 10 t/ha PM+200 kg/ha



**Figure 1.** Effect of genotype and fertilizer interaction on (a) Crude protein (b) Crude fat and (c) Crude fibre of juice from yellow passion fruit genotypes. Vertical bar=Least significant difference value.



**Figure 2.** Effect of genotype and fertilizer interaction on (a) total ash (b) percentage moisture and (c) carbohydrate of juice from yellow passion fruit genotypes. Vertical bar=Least significant difference value.

**Table 2.** Main effects of genotype and fertilizer on mineral concentrations of yellow passion fruit juice as influenced by organic and inorganic fertilizers

Genotype	Mineral concentrations in mg/100 mL						
	P	K	Ca	Mg	Na	Fe	Zn
Conventional	107.26	2.06	1120	1672.8	1.276	91.62	1131
KPF-4	91.19	1.78	1062	1748	1.275	90.14	1083
LSD 0.05	1.24	0.05	20.6	Ns	ns	ns	21.51
<b>Fertilizer</b>							
No fertilizer	95.79	1.3	1131	1738.9	1.235	90.13	1106.3
10 t/ha PM	102.23	1.69	1334	1901.3	1.255	95.18	1087.7
20 t/ha PM	99.91	2.11	924	1897.4	1.31	94.43	1165.3
5 t/ha PM+200 kg/ha NPK	97.74	2.02	1469	1679.8	1.24	97.49	1131.2
10 t/ha PM+200 kg/ha NPK	96.17	2.61	919	1511.3	1.318	83.6	1033
400 kg/ha NPK	103.51	1.81	767	1533.5	1.298	84.42	1118.7
LSD 0.05	0.86	0.05	91	41.7	0.015	3.97	29.48

NPK application. Calcium (1469 mg/100 mL) and iron (97.49 mg/100 mL) concentrations were highest with 5 t/ha PM+200 kg/ha NPK, whereas highest Mg (1901.3 mg/100 mL) and Zn (1165.3 mg/100 mL) concentrations were recorded with the addition of 10 and 20 t/ha poultry manure, respectively.

The interaction of genotype and fertilizer indicated that P concentration was highest in the juice of Conventional genotype with either no fertilizer or 10 t/ha poultry manure application (Table 3). However, K, Ca, Fe, Na and Zn concentrations were highest in juice of Conventional genotype with 10 t/ha PM+200 kg/ha NPK, 10 t/ha PM, 5 t/ha PM+200 kg/ha NPK and 400 kg/ha NPK applications, respectively.

### Juice pH, Total Soluble Solid, Titratable Acidity, Vitamins A and C Compositions of the Fruit Juice

The acidic level of the juice was found to be significantly lower in the Conventional (3.034) than in KPF-4 (2.943) (Table 4). But the juice vitamin A content (1.818 ug/100 mL) was higher in KPF-4 while vitamin C (27.797 mg/100 mL) was higher in the Conventional than KPF-4 genotype.

Fertilizer application influenced the juice pH, total soluble solid, titratable acidity, vitamins A and C compositions (Table 4). The lowest juice acidic level was recorded with the application of 10 t/ha poultry manure which also produced highest total soluble solid (3.158). Similarly, the complementary application of 10 t/ha PM+200 kg/ha NPK produced highest total titratable acidity (8.223 mg/100 mL) in the juice while vitamin C was highest with either the application of 20 t/ha PM (29.04 mg/100 mL) and 400 kg/ha NPK (29.33 mg/100 mL).

The combined effect of genotype and fertilizer revealed that the application of 10 t/ha PM+200 kg/ha NPK produced lowest juice acidity (3.91) in Conventional genotype and highest total titratable acidity (8.57 mg/100 mL) in KPF-4 genotype (Table 5). The application of 10 t/ha PM produced highest total soluble solid (17.755 mg/100 mL) in the Conventional genotype. Highest vitamin C (29.88 mg/100 mL) was also produced in Conventional genotype when 400 kg/ha NPK was applied. When no fertilizer was applied, KPF-4 juice had highest vitamin A (1.975 ug/100 mL).

### Phytochemical Composition of Fruit Juice

All the phytochemical compositions were not significantly

**Table 3.** Interaction effect of genotype and fertilizer on mineral concentrations of yellow passion fruit juice as influenced by organic and inorganic fertilizers

Mineral concentrations in mg/100 mL								
Genotype	Fertilizer	P	K	Ca	Mg	Na	Fe	Zn
Conventional	No fertilizer	114.84	1.52	1224	1790.3	1.235	78.27	1106.9
	10 t/ha PM	114.66	1.79	1615	1968.7	1.25	94.91	1100
	20 t/ha PM	106.03	2.57	706	1790.7	1.305	98.8	1190.1
	5 t/ha PM+200 kg/ha NPK	105.31	1.64	1388	1559.6	1.23	103.12	1129.8
	10 t/ha PM+200 kg/ha NPK	98.55	2.77	961	1427.2	1.315	83.73	996.8
	400 kg/ha NPK	104.18	2.08	823	1500	1.32	90.86	1262.8
KPF-4	No fertilizer	76.74	1.08	1039	1687.5	1.235	102	1105.8
	10 t/ha PM	89.8	1.59	1053	1833.8	1.26	95.45	1075.5
	20 t/ha PM	93.78	1.66	1142	2004.1	1.315	9007	1140.5
	5 t/ha PM+200 kg/ha NPK	90.17	2.4	1550	1800	1.25	91.86	1129.8
	10 t/ha PM+200 kg/ha NPK	93.8	2.45	877	1595.4	1.32	83.47	996.8
	400 kg/ha NPK	102.83	1.54	712	1567	1.275	77.99	974.6
LSD0.05		1.27	0.07	117.8	77.9	0.021	5.2	39.25

**Table 4.** Main effects of genotype and fertilizer on pH, total soluble solid, total titratable acidity, °brix, vitamins A and C of yellow passion fruit juice as influenced by organic and inorganic fertilizers

Genotype	pH (H <sub>2</sub> O)	Total soluble solid (mg/100 mL)	Total titratable acidity (mg/100 mL)	°Brix	Vitamin A (ug/100 mL)	Vitamin C (mg/100 mL)
Conventional	3.034	15.535	6.743	9.865	1.613	27.797
KPF-4	2.943	15.522	6.865	9.841	1.818	26.206
LSD 0.05	0.025	ns	ns	ns	0.021	0.896
Fertilizer						
No fertilizer	2.94	15.388	5.93	9.903	1.915	25.42
10 t/ha PM	3.158	19.73	6.137	9.868	1.778	25.435
20 t/ha PM	2.945	14.505	6.76	9.833	1.712	29.04
5 t/ha PM+200 kg/ha NPK	3.123	12.783	6.053	9.818	1.71	27.48
10 t/ha PM+200 kg/ha NPK	2.923	15.68	8.223	9.848	1.583	25.303
400 kg/ha NPK	2.843	15.128	7.722	9.85	1.597	29.33
LSD 0.05	0.029	0.6	0.154	ns	0.076	0.556

**Table 5.** Interaction effect of genotype and fertilizer on pH, total soluble solid, total titratable acidity, °brix, vitamins A and C of yellow passion fruit juice as influenced by organic and inorganic fertilizers

Genotype	Fertilizer	pH (H <sub>2</sub> O)	Total soluble solid (mg/100 mL)	Total titratable acidity (mg/100 mL)	°Brix	Vitamin A(ug/100 mL)	Vitamin C (mg/100 mL)
Conventional	No fertilizer	3.065	13.82	5.21	9.915	1.855	26.175
	10 t/ha PM	3.195	19.755	6.095	9.865	1.875	27.815
	20 t/ha PM	2.99	17.265	6.95	9.84	1.525	28.4
	5 t/ha PM+200 kg/ha NPK	3.155	12.885	6.26	9.84	1.72	28.885
	10 t/ha PM+200 kg/ha NPK	3.91	13.88	7.875	9.825	1.37	25.625
	400 kg/ha NPK	2.89	15.69	8.07	9.905	1.335	29.88
KPF-4	No fertilizer	2.815	16.955	6.65	9.89	1.975	24.665
	10 t/ha PM	3.12	19.705	6.18	9.87	1.68	23.055
	20 t/ha PM	2.9	11.745	6.57	9.825	1.9	29.68
	5 t/ha PM+200 kg/ha NPK	3.09	12.68	2.845	9.795	1.7	26.075
	10 t/ha PM+200 kg/ha NPK	2.935	17.48	8.57	9.87	1.795	24.98
	400 kg/ha NPK	2.795	14.565	7.375	9.795	1.86	28.78
LSD 0.05		0.04	0.84	0.254	Ns	0.099	0.853

**Table 6.** Main effects of genotype and fertilizer on phytochemical composition of yellow passion fruit juice as influenced by organic and inorganic fertilizers

Genotype	Tannin (mg/100 mL)	Saponin (mg/100 mL)	Phytate (mg/100 mL)	Oxalate (mg/100 mL)	Phenol (mg/100 mL)
Conventional	0.042	1.018	0.29	0.188	0.094
KPF-4	0.041	0.982	0.293	0.202	0.095
LSD0.05	ns	ns	Ns	ns	ns
<b>Fertilizer</b>					
No fertilizer	0.044	0.96	0.273	0.175	0.09
10 t/ha PM	0.039	1.06	0.258	0.178	0.098
20 t/ha PM	0.041	1.064	0.345	0.218	0.092
5 t/ha PM+200 kg/ha NPK	0.041	0.994	0.283	0.193	0.098
10 t/ha PM+200 kg/ha NPK	0.044	0.908	0.308	0.205	0.094
400 kg/ha NPK	0.039	1.016	0.283	0.2	0.095
LS D0.05	0.001	0.023	0.018	0.01	0.006

**Table 7:** Interaction effect of genotype and fertilizer on phytochemical composition of yellow passion fruit juice as influenced by organic and inorganic fertilizers

Genotype	Fertilizer	Tannin (mg/100 mL)	Saponin (mg/100 mL)	Phytate (mg/100 mL)	Oxalate (mg/100 mL)	Phenol (mg/100 mL)
Conventional	No fertilizer	0.05	0.91	0.265	0.205	0.081
	10 t/ha PM	0.033	1.029	0.235	0.165	0.098
	20 t/ha PM	0.04	1.099	0.37	0.2	0.086
	5 t/ha PM+200 kg/ha NPK	0.036	1.058	0.23	0.15	0.105
	10 t/ha PM+200 kg/ha NPK	0.05	0.966	0.315	0.19	0.1
	400 kg/ha NPK	0.042	1.049	0.325	0.215	0.092
KPF-4	No fertilizer	0.039	1.01	0.28	0.145	0.099
	10 t/ha PM	0.045	1.092	0.28	0.19	0.097
	20 t/ha PM	0.043	1.03	0.32	0.235	0.098
	5 t/ha PM+200 kg/ha NPK	0.045	0.851	0.335	0.22	0.105
	10 t/ha PM+200 kg/ha NPK	0.039	0.93	0.3	0.235	0.1
	400 kg/ha NPK	0.037	0.984	0.24	0.185	0.097
LSD0.05		0.001	0.049	0.023	0.024	0.008

different between the genotypes (Table 6). Fertilizer, however, had significant influence on all the phytochemical compositions of the juice (Table 6). The juice tannin (0.044 mg/100 mL) was significantly highest when either 10 t/ha PM+200 kg/ha NPK was applied or when no fertilizer was applied. The lowest tannin content was observed when either 10 t/ha poultry manure or 400 kg/ha NPK were applied. The application of 20 t/ha PM resulted in highest

juice concentration of saponin (1.064 mg/100 mL), phytate (0.345 mg/100 mL) and oxalate (0.218 mg/100 mL). However, phenol composition was highest with either 10 t/ha PM or 5 t/ha PM+200 kg/ha NPK.

Genotype and fertilizer interaction showed that the application of 10 t/ha PM+200 kg/ha NPK gave highest juice tannin concentration in the Conventional (0.05 mg/100 mL) (Table 7). The phenol concentration was

highest also in the Conventional with either 5 t/ha PM+200 kg/ha NPK (0.105 mg/100 mL) or 10 t/ha PM+200 kg/ha NPK (0.100 mg/100 mL) application. The fruit juice of Conventional genotype that received 20 t/ha PM had highest concentration of saponin (1.099 mg/100 mL) and phytate (0.37 mg/100 mL). On the other hand, highest oxalate composition was observed in KPF-4 juices when their fruits received either 20 t/ha PM or 10 t/ha PM+200 kg/ha NPK.

## DISCUSSION

The proximate compositions of the two genotypes were relatively similar except the crude fat and fibre contents. Earlier reports (Ndukwe and Baiyeri, 2016a,b) on the growth, fruit yield and juice biochemical qualities of the two genotypes in the same study area indicated that the genotypes could be genetically related. It will be pertinent to characterize the Conventional genotype so that genetic comparisons with the hybrid, KPF-4 could be elucidated.

The juice moisture contents of both genotypes (78.29% and 77.34% for Conventional and KPF-4, respectively) were comparatively high. The passion fruit is reported to be rich in water (Orjuela et al., 2011) with range of about 55.7% to 90% moisture contents (Rodríguez and García, 2010). The fruits could serve as good sources of rehydrating the body and quenching thirst. The moisture contents (85.57 to 86.33%) reported by Ani and Baiyeri (2008) as well as Ogbonna et al. (2013) in orange (85.85%), pineapple (83.99%) and pawpaw (82.74%) juices are comparable to the values obtained in this study.

The concentrations of the minerals in the juice from both passion fruit genotypes indicated that the fruit juice possessed considerable amount of minerals which falls within the recommended rates required by humans per day. For instance, the Adequate Intake (AI) for Ca ranges from 500 to 1200 mg day<sup>-1</sup> while the Recommended Dietary Allowance (RDA) for P ranges from 460 to 700 mg/day (National Academy of Sciences, 2005).

The pH range (2.94 and 3.03) agreed with the standards of identity and quality for passion fruit pulp, given between 2.7 and 3.8 (Brasil, 2000). The value of total soluble solid reported in this work (12.78 to 19.73 mg/100 mL), titratable acidity (5.93 to 8.22 mg/100 mL), vitamins A (1.58 to 1.92 µg/100 mL) and vitamin C (25.30 to 27.79 mg/100 mL) were consistent with the results reported by Ani and Baiyeri (2008) on passion fruit juice. Vitamin C contents of 11.76, 26.55 and 35 mg/100 g was reported by Uchoa et al. (2008), da Silva et al. (2015) and Farias et al. (2007), respectively.

The phytochemical compositions of the juice also did not vary between the genotypes. This could further suggest that the two yellow passion fruit genotypes have genetic

relationship. The values for the tannin (0.041 to 0.042 mg/100 mL), saponin (0.982 to 1.018 mg/100 mL), phytate (0.290 to 0.293 mg/100 mL), oxalate (0.188 to 0.202 mg/100 mL) and phenol 0.094 to 0.095 mg/100 mL compositions were low such that the juice can be consumed without deleterious effect on human health. Similar trends were reported by Ndukwe and Baiyeri (2016a) in the juice of Conventional and KPF-4 passion fruit genotypes previously grown with varying PM rates. Results from the study revealed low oxalate composition in the Conventional (0.177 mg/100 mL) and KPF-4 (0.183 mg/100 mL) genotypes which implied that their level in their juices are not lethal. Earlier report of Munro and Bassir (1969) noted that the lethal level of oxalate in man is 2-5 g. The range of phytate compositions (0.258-0.345 mg/100 mL) obtained in this study were lower than the range (9.22–5.72 mg L<sup>-1</sup>) obtained by Okon and Akpanyung (2005) while working on Nigerian brands of malt. The reported range was rated as a low level and cannot result in a toxicity problem. The phytate level in this study, been lower than the previous report therefore indicates that the juice from the passion fruit genotypes are safe for consumption. The juice concentrations of tannin (0.024 and 0.028 mg/100 mL for Conventional and KPF-4, respectively) obtained in this study were very low compared to the concentrations reported for banana fruit (3.4 mg/100 g dry weight) and apple fruit (8.5 mg/100 g dry weight) juices, hence the juices will not pose health hazards. The compositions of saponin (0.908 to 1.016 mg/100 mL) and phenol (0.09 to 0.098 mg/100 mL) will also not pose any health problem.

Fertilizer application significantly influenced all the proximate compositions of the yellow passion fruits. Highest juice crude protein with the application of 400 kg/ha NPK and 5 t/ha PM+200 kg/ha NPK could be attributed to higher accumulation and absorption of soil nitrogen aided by the addition of these fertilizers. Highest value of nitrogen (22,800 mg/100 mL) was recorded in this study. The application of fertilizer significantly reduced the juice crude fat implying that growing yellow passion fruit with appropriate fertilizer will further present the juice as a low cholesterol fruit juice. Passion fruit juice possess low saturated fat, cholesterol (total fat=1% dietary value) (Condé Nast, 2018). The highest concentrations of crude fibre and total ash with the addition of 10 t/ha PM+200 kg/ha NPK could be due to more supply of nutrients, availability of such minerals and higher absorption by the plants. Crude fibre aids digestion, making sure food is better absorbed while ash content is a good predictor of mineral concentration in the juice (Adeyeye and Aremu, 2017). This indicates that the combined fertilizer application provided more minerals which might have accumulated in the fruit juice. This combined fertilizer

application, 10 t/ha PM+200 kg/ha NPK enhanced the accumulation of highest juice moisture which may have resulted in the dilution per given volume of juice, hence the lowest percentage juice dry matter accumulation observed with 10 t/ha PM+200 kg/ha NPK addition.

The combined application of organic and inorganic fertilizers significantly produced highest juice K and Ca concentrations. Earlier report by Ani and Baiyeri (2008) revealed that potassium concentration of passion fruit juice increased with increase in poultry manure rate. Magnesium concentration. Juice Mg content was significantly reduced with the application of 10 t/ha PM+200 kg/ha NPK probably due to the antagonistic relationship between K and Mg, especially with high K concentration. Similar report on the antagonistic relationship of K and Mg on biochemical constituents of black tea had been documented by Jayaganesh et al. (2011). In this study, juice produced with 10 t/ha PM+200 kg/ha NPK were found to possess highest concentration of potassium. The combination of 10 and 5 t/ha PM each with 200 kg/ha NPK also produced highest concentrations of Na and Fe, respectively. However, the single addition of 20 t/ha PM resulted in highest Zn content in the juice.

The juice pH ranged from 2.84 to 3.16. These pH values are within the desirable juice pH value ideal to maintain juice quality during storage, according to Folegatti and Mastuura (2002). On the other hand, industrialization processes of juice are not also limited with pH values up to 4.2 since it gives allows greater flexibility in sugar addition. These values were in agreement with the juice pH value of 2.72 to 3.11 obtained by Ani and Baiyeri (2008) in the same study area. A pH value of 2.6 for fresh yellow passion fruit pulp had also been reported by Janzanti et al. (2012). Freire et al. (2014) recorded juice pH of 3.6 to 3.8 when grown with bovine bio-fertilizer. Yellow passion fruit juice, being the third most produced juice in Brazil, is widely consumed because of its high aroma and acidity (Fernandes et al., 2011). However, juice obtained from fruits produced with 400 kg/ha NPK were most acidic. This can be attributed to inorganic fertilizer application which is promotes soil acidity.

Percentage Total Titratable Acidity (TTA) was highest (8.22) and lowest (5.93) in fruits produced with 10 t/ha PM +200 kg/ha NPK and without fertilizer, respectively. The highest percentage TTA could be attributed to the humic substances and organic acids content of the applied poultry manure which may have been translocated to the fruits (Nardi et al., 2002). It has been reported that fruits with high titratable acidity are preferred by the processing industry because the artificial acidification of juice during processing are reduced (Andrade and Andrade, 2004),

hence the reduction in production cost. Report by Ani and Baiyeri (2008) also revealed increased %TTA as poultry manure rate increased.

Values of vitamin C recorded in this study (25.30 to 29.04 mg/100 mL) were higher than 21.43, 15.00 and 4.30 mg/100 mL of fresh yellow passion fruit pulp as reported by Silva et al. (2015), Janzanti et al. (2012) and Genovese et al. (2008). Highest juice vitamin C concentration was produced with the application of 20 t/ha PM. This is attributable to the organic acids and sugars present in the applied poultry manure Dias et al. (2011) which were available to the plants. Dias et al. (2011) reported increased vitamin C content of passion fruit juice with the application of bovine bio-fertilizer. On the other hand, °Brix values (9.82 to 9.30) in this study were higher than the values (1.0 to 3.0) recorded by Kaddumukasa (2017) but lower than the value of 12.0 documented by Codex Alimentarius (2005).

Reduced tannin, saponin and phytate compositions with the application of 10 t/ha PM or 400 kg/ha, 10 t/ha PM+200 kg/ha NPK and 10 t/ha, respectively indicated that fertilization could further reduce anti-nutrients in the passion fruit juice.

## CONCLUSIONS

The combined application of poultry manure and NPK fertilizers, especially 10 t/ha PM + 200 kg/ha NPK improved most of the juice biochemical characteristics of the two yellow passion fruit genotypes. Further studies on the combinations of other forms of organic and inorganic fertilizers are recommended.

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