Original Research Article

Cucumber fruit nutrient quality as influenced by variety and organic fertiliser rate

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Abstract

The nutrient contents of a product can depend on the quantity of fertiliser supplied. An experiment was conducted at the Federal University of Agriculture, Abeokuta, in the tropical rainforest-savannah transitional zone of southwestern Nigeria to determine the nutrient contents of three cucumber varieties as influenced by Gateway Organic Fertiliser (GOF) rates. There were 48 plots of 3.0×2.0 m each, separated by 1.0 m pathways. The main plot was cucumber variety (Marketmore, Poinsett, and Marketer) while the sub-treatment was organic fertiliser rate at 0, 5, 10, and 15 t.ha^{-1} in a split-plot arrangement fitted into Randomised Complete Block Design (RCBD) with 4 replicates. Fruit nutrient contents differed with cucumber varieties and rates of gateway organic fertiliser. Marketmore variety fruits without application of GOF had higher moisture contents. Poinsett variety fruits cultivated with the application of 5 t.ha^{-1} GOF had higher dry matter contents. Poinsett variety fruits cultivated with either 10 or 15 t.ha^{-1} GOF had higher crude protein and carbohydrate contents when compared with other interactions. Poinsett variety cultivated with either 10 or 15 t.ha^{-1} GOF had higher vitamins A and C contents when compared with other interactions. It was concluded that cultivating the Poinsett cucumber variety with a 10 t.ha^{-1} GOF rate gave optimum nutrient contents concerning the crude protein, carbohydrate, and vitamin content. The Poinsett cucumber variety cultivated with 10 t.ha^{-1} Gateway Organic Fertiliser is recommended for optimum nutrient contents.

Keywords: Gateway organic fertiliser; *Cucumis sativus*; crude protein; vitamins.

INTRODUCTION

Increasing soil productivity is one of the major key factors, attributed to substantially increasing agricultural production to fulfill the human population's needs. Soil health is a critical factor in achieving higher yields and quality. Mineral fertilisers are considered a major source of plant nutrition. Still, excessive use of mineral fertilisers takes up the major cost in plant production and can create pollution of agroecosystems as well as deterioration of soil fertility (Singh and Ryan, 2015). There is a need to integrate organic fertiliser to boost production and improve fruit quality.

Problems associated with handling and disposing of animal wastes in Nigeria have necessitated various State Governments to set up pilot projects to evaluate the feasibility of composting them for use as commercial organic fertilisers in agriculture, as a value-added product. One such venture is the 'Gateway Organic Fertiliser'. It is a commercial brand of organic fertiliser produced in Ogun State, Nigeria, made from composted poultry waste, cow dung, and wood ash. Use of city waste in the production of vegetables has been reported by Prakash and Bhadoria (2004). Soretire et al. (2013) recommended Gateway Organic Fertiliser at 15 t.ha^{-1} application for higher growth and grain yield of soybeans. Aiyelaagbe et al. (2007) also recommended 10 t.ha^{-1} composted city refuse (Pace-setter Organic Fertiliser) as a substitute for inorganic fertiliser for cucumber production in peri-urban gardens of southwestern Nigeria.

Fertiliser application has been reported to affect produce nutrient contents (Milošević et al. 2022; Fazio et al. 2020; Doryanizadeh et al. 2017) but limited information on how GOF rates affect cucumber varieties prompted this study. Thus, this experiment was carried out to determine the nutrient contents of three cucumber varieties as influenced by GOF rates.

The hypothesis was that cucumber's nutritional contents are not affected by the rate of organic fertiliser.

MATERIALS AND METHODS

The experiment was conducted at the research farm of the Federal University of Agriculture, Abeokuta in the tropical rainforest-savannah transitional zone of southwestern Nigeria, latitude 7°15′N; longitude 3°25′E. Pre-planting soil samples were taken randomly up to 0.15 m depth from 5 locations, using a soil auger and bulked to have a composite sample that was air dried and analysed to determine soil nutrient status. The first season (Early season) field trial was conducted from April to July, while the second season (Late season) field trial was conducted from September to December 2015.

The Oxic Paleudulf soil was mechanically ploughed and harrowed after 2 weeks. The entire field was demarcated into 48 plots of 3.0×2.0 m each, separated by 1.0 m pathways. The main plot was cucumber variety (Marketmore, Poinsett and Marketer) while the sub-treatment was organic fertiliser rate at 0, 5, 10, and 15 t.ha^{-1} in a split-plot arrangement fitted into Randomised Complete Block Design (RCBD) with 4 replicates.

Gateway Organic Fertiliser was used. It is a commercial brand of organic fertiliser produced by Gateway Fertilizer Company, Kotopo, Ogun State, Nigeria, composed of cured cow dung fortified with with wood ash, and with a C:N ratio of 1:3.4. It was applied in a single dose at 2 weeks before planting at the rate of 5, 10, and 15 t.ha^{-1} while unfertilised plots served as control. Three cultivars of cucumber used for the experiment were: Marketmore, (an open-pollinated variety that is resistant to cucumber scab and cucumber mosaic virus); Poinsett (an open-pollinated variety that is resistant to angular leaf spot, anthracnose, downy mildew, and powdery mildew) and Marketer (an open-pollinated variety that is resistant to downy and powdery mildew) variety. The planting was done two weeks after the organic fertiliser application. Two cucumber seeds were planted on flat beds at a 1.0×0.5 m spacing. Manual weeding was done at 3-week intervals before flowering and fruiting. Pest control was done organically using a bio-pesticide formulation composed of 200 g neem (*Azadiracter indica* A. Juss) shoot biomass, 100 g pawpaw (*Carica papaya* L.) leaves, 100 g jatropha (*Jatropha curcas* L.) leaves, and 100 g lemon (*Cymboponon citratus* L. Spreng) grass, boiled in 10 litres of water. The extract was allowed to cool and foliar application was done using a hand sprayer at 2 and 4 weeks after planting.

Healthy, mature fruits were harvested, beginning 10 weeks after planting (WAP). After harvest, fruit samples were analysed for moisture content, ash, fat, crude fibre, crude protein, and carbohydrate, using established methods (AOAC, 2005).

Vitamin A was analysed using high-performance liquid chromatography (HPLC) with UV/VIS detection. Vitamin C was extracted using metaphosphoric acid (MPA) and the pH was adjusted to 1.2. The extract was thereafter titrated against 2,6 dichlorophenolindophenol (DCIP) to a pink endpoint colour.

Data were subjected to analysis of variance using GENSTAT discovery (12th ed., VSN International, Hemel Hempstead, UK), with cucumber variety and organic fertiliser rates as factors. The interactions were majorly significant and were used to explain results, separated using DMRT at $p \leq 0.05$.

RESULTS

Soil characteristics varied between seasons. The soil pH in both seasons was near neutral. Organic matter and nitrogen contents were higher in the early season

Table 1. Pre-cropping soil and organic fertiliser analysis

Parameter Chemical Composition	Early Season	Late Season	Organic fertiliser
pH	7.20	7.30	6.50
O.M. (%)	4.32	1.55	12.32
Total N (%)	0.15	0.08	2.14
Avail. P (mg.kg^{-1})	12.58	18.2	43.12
C:N			1:3.4
Exch. Bases			
Mg (mg.kg^{-1})	8.99	61.02	69.53
K (mg.kg^{-1})	23.85	19.55	58.65
Na (mg.kg^{-1})	11.96	8.97	34.04
Ca (mg.kg^{-1})	8.42	25.26	244.61
Zn (mg.kg^{-1})	0.10	0.11	2.11
Fe (mg.kg^{-1})	0.41	0.32	2.02
Physical			
Sand %	52.67	70.2	
Silt %	31.00	14.00	
Clay %	16.00	15.8	
Soil Textural Class	sandy loam	sandy loam	

Table 2. Meteorological data of the experimental site in 2015

	Rainfall (mm)	Sunshine (hr)	Maximum temperature (°C)	Minimum temperature (°C)
January	0.00	6.10	35.40	20.50
February	17.10	2.10	33.10	24.60
March	149.00	5.60	35.30	25.10
April	87.20	6.10	33.80	24.10
May	113.80	6.70	33.10	23.80
June	116.50	4.20	31.00	22.80
July	90.70	3.60	23.50	28.30
August	92.70	2.40	22.90	22.90
September	160.00	2.80	30.40	22.50
October	205.90	5.90	31.60	23.00
November	17.60	6.30	33.50	23.80
December	0.00	5.90	33.50	19.30

cropping whereas available phosphorus, magnesium, calcium, and zinc were lower (Table 1).

Total rainfall in the early cropping season was greater than in the late cropping season. Total rainfall and rainfall during the vegetative phase were higher in the late season than in the early season. However, the reproductive phase received more rainfall in the early season than in the late season. Mean temperatures were higher during the vegetative phase but lower during the reproductive phase in the early cropping season while in the late cropping season, mean temperatures were lower during the vegetative phase but higher during the reproductive phase (Table 2).

In the early season, there were significant differences in the interaction of variety and organic fertiliser rates on the proximate composition of cucumber fruits (Table 3). The Marketmore variety fruits without the application of GOF had higher moisture contents, compared with the Poinsett variety cultivated with 5, 10, and 15 t.ha^{-1} GOF and the Marketer variety cultivated with 10 and 15 t.ha^{-1} GOF but similar with other interactions (Table 3).

The Poinsett variety fruits cultivated with the application of 5 t.ha^{-1} GOF had higher dry matter contents than the Marketmore, Poinsett, and Marketer without fertiliser application but similar to other interactions (Table 3).

Table 3. Interaction effects of variety and organic fertiliser rates on proximate composition of Cucumber Fruit in the early cropping season

Variety (V)		Moisture Content	Dry Matter	Fat content	Crude fibre	Ash Content	Crude protein	Carbo Hydrate
Variety × fertiliser rate					g/100 g			
Marketmore	0	96.14a	3.86cd	0.38a	0.60a	0.78a	0.55c	3.72fg
	5	95.52abc	4.48a	0.14cd	0.47bc	0.31de	0.61bc	4.77def
	10	95.34abc	4.66ab	0.14cd	0.48bc	0.32cd	0.68bc	6.20bc
	15	95.46abc	4.54abc	0.15c	0.4cd	0.31de	0.70b	6.33bc
Poinsett	0	95.76ab	4.24cd	0.26b	0.5bc	0.76b	0.58bc	4.02fg
	5	94.21c	5.79a	0.10g	0.37cde	0.27h	0.62bc	6.21bc
	10	94.26c	5.74ab	0.11fg	0.30de	0.28gh	0.91a	6.94ab
	15	94.46c	5.54abc	0.12ef	0.25e	0.29fg	0.84a	7.89a
Marketer	0	95.62ab	4.38d	0.25b	0.58ab	0.79a	0.61bc	3.18g
	5	94.92abc	5.08abcd	0.14cd	0.40cd	0.33c	0.64bc	4.47ef
	10	94.55bc	5.45abc	0.13de	0.45c	0.30ef	0.71b	5.93bcd
	15	94.52bc	5.48abc	0.13de	0.3de	0.30ef	0.71b	5.51cde

Means with the same letter(s) under the same column are not significantly different ($p < 0.05$) using the Duncan Multiple Range Test (DMRT).

Table 4. Interaction effects of variety and organic fertiliser rates on Vitamin A and C contents of cucumber fruit in the early cropping season

Variety × fertiliser rate		Vitamin C mg/100 g	Vitamin A ug/100 g
Marketmore	0	2.61i	58.75e
	5	2.71d	66.73c
	10	2.78a	69.74ab
	15	2.64a	69.04abc
Poinsett	0	2.60j	59.00e
	5	2.75c	67.93bc
	10	2.77b	70.24ab
	15	2.68f	70.82a
Marketer	0	2.58k	56.25f
	5	2.70e	64.35d
	10	2.68f	69.04abc
	15	2.65g	69.07abc

Means with the same letter(s) under the same column are not significantly different ($p < 0.05$) using the Duncan Multiple Range Test (DMRT).

The Marketmore variety fruits without applying GOF had higher fat content when compared with other interactions (Table 3).

The Marketmore and Marketer variety fruits without applying GOF had higher crude fibre and ash contents than other interactions (Table 3).

The Poinsett variety fruits cultivated with 10 and 15 t.ha^{-1} GOF had higher crude protein and carbohydrate contents than other interactions (Table 3).

There were significant differences in the interaction of variety, GOF rates, and the vitamin A and C contents of cucumber fruits (Table 4).

The Marketmore variety cultivated with either 10 or 15 t.ha^{-1} GOF had higher vitamin C contents than other interactions (Table 4).

The Poinsett variety cultivated with 15 t.ha^{-1} GOF had higher vitamin A content than the Marketmore, Poinsett, and Marketer varieties cultivated with no fertiliser application and 5 t.ha^{-1} GOF but similar when compared with other interactions (Table 4).

In the late season, there were significant interactions in the proximate composition of cucumber as influenced by the variety and GOF rates (Table 5).

The Marketer variety cultivated without application of GOF had higher moisture contents than the Marketmore and Marketer varieties cultivated with 10 and 15 t.ha^{-1} GOF and the Poinsett cultivated with 5, 10, and 15 t.ha^{-1} GOF but similar to other interactions (Table 5).

The Poinsett variety cultivated with 10 t.ha^{-1} GOF had higher dry matter content than other interactions (Table 5).

The Marketmore variety cultivated with 10 t/ha GOF had higher fat and ash contents than other interactions (Table 5).

The Marketmore variety cultivated with 5 t.ha^{-1} GOF had higher crude fibre content than the Marketer variety cultivated with 15 t.ha^{-1} GOF but similar to other interactions (Table 5).

Table 5. Interaction effects of variety and organic fertiliser rates on the proximate composition of cucumber fruits in the late cropping season

		Moisture Content	Dry Matter	Fat Content	Crude fibre	Ash content	Crude Protein	Carbo Hydrate
					g/100 g			
Marketmore	0	95.44a	4.56k	0.22c	0.50a	0.64a	0.56bc	2.69i
	5	94.66abcd	5.34h	0.30b	0.50a	0.58bc	1.16b	2.77h
	10	93.18ef	6.82c	0.32a	0.48ab	0.63a	1.21ab	4.16d
	15	93.19ef	6.94b	0.20d	0.46ab	0.40g	1.23ab	4.66b
Poinsett	0	94.88abc	5.12i	0.19de	0.45ab	0.53e	0.46d	3.48g
	5	93.41cdef	6.59d	0.23c	0.43ab	0.45f	1.18ab	4.23c
	10	92.46f	7.59a	0.20d	0.42ab	0.44f	1.26ab	5.23a
	15	93.40def	6.40f	0.17f	0.48ab	0.33j	1.25ab	4.17d
Marketer	0	95.60a	4.40l	0.18ef	0.50a	0.59b	0.61c	2.52k
	5	95.02ab	4.98j	0.22c	0.49ab	0.57c	1.27ab	2.54j
	10	93.48def	6.52e	0.17f	0.46ab	0.55d	1.30a	4.11e
	15	94.05bcde	5.95g	0.18ef	0.36b	0.32h	1.26ab	3.79f

Means with the same letter(s) under the same column are not significantly different ($p < 0.05$) using the Duncan Multiple Range Test (DMRT).

Table 6. Interaction effects of variety and organic fertiliser rates on the vitamin A and C composition of cucumber fruits in the late cropping season

		Vitamin C mg/100 g	Vitamin A ug/100 g
Marketmore	0	2.73f	52.00e
	5	2.75e	67.50c
	10	2.81d	70.98b
	15	2.84b	71.03b
Poinsett	0	2.70g	54.00d
	5	2.75e	70.32b
	10	2.83c	73.60a
	15	2.85a	74.15a
Marketer	0	2.69h	52.60ed
	5	2.75e	67.30c
	10	2.84b	71.43b
	15	2.85a	71.49a

Means with the same letter(s) under the same column are not significantly different ($p < 0.05$) using the Duncan Multiple Range Test (DMRT).

The Marketer variety cultivated with 10 t.ha^{-1} GOF had higher crude protein content when compared with the Marketmore variety cultivated with no fertiliser and 5 t.ha^{-1} GOF, the Poinsett and Marketer varieties without fertiliser application but similar to other interactions (Table 5).

The Poinsett variety cultivated with 10 t.ha^{-1} GOF had higher carbohydrate content than other interactions (Table 5).

Significant interactions were observed in the vitamins A and C compositions of cucumber as influenced by the variety and GOF rates (Table 6).

The Poinsett variety cultivated with 15 t.ha^{-1} GOF had higher vitamin A content than other interactions (Table 6).

The Poinsett variety cultivated with 10 or 15 t.ha^{-1} GOF had higher vitamin C contents than other interactions (Table 6).

DISCUSSION

The sandy loam soil used in this experiment had low fertility which could affect the performance and productivity of the plant and in turn, affect the fruit quality in terms of proximate and vitamin composition. According to Kuhlein (2000), the food nutrient composition depends on the natural sources of variation with the crop species, soil types, genetic diversity, seasonality, and the maturation stage. The significant differences in the nutrient composition relative to the GOF rates confirm the findings of Greer and Diver (2000) who reported that plants improve and perform better when treated with an adequate amount of organic manure, helping in the production of more fruits with adequate nutrient contents needed by animal and man that utilises them. Also, Ikeh et al. (2012) noted that crop response to fertiliser application is affected by a nutrient reserve in the soil which translates into assimilates in the form of proximate composition.

The results of this study have shown that increasing the rate of GOF increases the fruit dry matter content. This supports the findings of Naz et al. (2011) that increasing fertiliser rates increased the dry matter

content of plants. Naikwade (2014) also reported the same results with compost application.

Moisture content was observed to decrease as the GOF rate increased while the dry matter content increased with increasing GOF rates with different cucumber varieties implying that more nutrients were available to the plants for uptake at higher GOF rates, leading to higher substrate build-up in the fruits in form of dry matter composition.

Fats are important in maintaining human fertility and for the functioning of the nervous system. They can also act as a lubricant in the human digestive tract but too much intake can be harmful. It is thus suggested that cucumber fruits are suitable for the regular diet following their low fat content (Naz et al., 2011) when cultivated with GOF.

Enhanced crude fibre and ash contents at higher GOF could be associated with the nitrogen, phosphorus, and potassium contents of the GOF that were required to form substrates in the form of ash and fibre. It corroborates the finding of Massri and Labban (2014) who reported increased seed percentage, ash percentage, and total soluble solid content with manure application in watermelon production.

The increase in crude protein contents with GOF rate can be due to the enhancement in amino acid formation through fertiliser application. Higher vitamin A and C contents at higher GOF rates imply that the GOF application at higher rates increased the vitamin A and C contents of cucumber fruits. This is due to the ability of the fertiliser (C:N less than 10) to release nutrients translating into high assimilates in the form of vitamins A and C.

CONCLUSION

It can be concluded that cultivating the Poinsett cucumber variety with 10 $t.ha^{-1}$ GOF rate gives optimum nutrient contents concerning the crude protein, carbohydrate, and vitamin content. Therefore, the Poinsett cucumber variety cultivated with 10 $t.ha^{-1}$ Gateway Organic Fertiliser is recommended for optimum nutrient contents.

CONFLICT OF INTEREST

The authors declared no conflicts of interest concerning the research, authorship, and publication of this article.

ETHICAL COMPLIANCE

The authors have followed ethical standards in conducting the research and preparing the manuscript.

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