RESPONSE OF TEN WINGED BEAN ACCESSIONSON NUTRITIONAL QUALITY AND NUTRIENT UPTAKE IN THE GUINEA SAVANNAH ZONE OF NORTH CENTRAL,NIGERIA

Abstract

~~E~~ The current experiment was conducted at the Biotechnology Advanced Research CentreFarm,Garki-Abuja during 2018 and 2019 seasons to study the nutritional quality and nutrient uptake of ten accessions of winged bean. The experiment was laid out using Randomized Complete Block Design (RCBD), replicated three times, respectively. Data collected on nutritional qualities were ~~P~~protein, ~~M~~magnesium, ~~C~~carotene, ~~I~~iron, ~~P~~phosphorus, ~~C~~calcium and ~~V~~vitamin C.~~and~~Nutrient uptake elements were:~~N~~nitrogen, ~~P~~phosphorus, ~~C~~calcium, ~~P~~potassium and ~~M~~magnesiumrespectively. The mineral contents were subjected to analysis of variance (ANOVA) and significant means compared using Duncan Multiple Range Test (DMRT). Results revealed that among the nutritional quality of mineral content evaluated, Phosphorus recorded the highest content which was obtained from TPT 9 (236.28 mg/100 g). Morealso, the highest nutrient uptake was obtained from ~~C~~calcium in accession TPT 6with mean value (354.33 mg kg).In the overall, both nutritional qualities and nutrient uptake mineral contents recorded level of significance ($p \leq 0.05$) from the study.Based on the result from this study, it could be stated that for better nutritional quality and nutrient uptake TPT 9 and TPT 6 can be grown particularly by farmers within this ecological zone.

Key words: winged bean, accessions, nutritional qualities, nutrient uptake

Introduction

Winged bean [*Psophocarpus tetragonolobus* (L.) DC] is an herbaceous perennial plant but can be grown as an annual crop [1]. It is an underutilized plant which has a wide genetical potential to be utilized as a source of quality food and forage [2].Winged bean seeds are generating unique research and commercial interest mainly due to their nutritional quality,~~-~~ high proteins and fatty oil content [3].It is also a protein rich multipurpose legume and is listed as one of the under exploited plant in the tropics [4] with huge potential as a food source [5, 6]. It is consumed as pods, seeds, flowers and also tuberous roots because of their great nutritional values. The tubers, young pods, seeds, leaves, flowers and shoot are rich in protein, amino acids oils, vitamins and minerals [7, 8]. Winged bean has been regarded as “one species supermarket” because practically all of the plant parts are edible [9, 10, 11]. At maturity, the pods are 6-9 inches long and 1½ inches broad, with four angled leaflike wings running lengthwise to the pods. Seeds are round and green when mature, similar to soybeans. In tropical regions, winged bean is a crop with vigorous production of new foliage, high protein, and tolerance of soil acidity and salinity [12].Root and seed are high in protein. Much publicity has been given to this because of its high protein content and the edibility of so many parts. The leaf and stem petiole of winged bean and

velvet bean mainly serve as ground cover, but the pod is used as food and medicine in regions of Southern Asia[13, 14].Winged bean plants grow best under hot, wet conditions and grow best with 1000 to 1250 mm of rainfall per annum. This research was conducted to ascertain various mineral contents that can be consumed by farmersfor body metabolism and nutrient uptake utilized by plants for their growth.

Materials and methods

~~E~~ This experiment was conducted at the Biotechnology Advanced Research Centre Farm, Sheda Science and Technology Complex Garki-Abuja, FCT, Nigeria in 2018 and 2019 cropping seasons. Abuja is located at 8^{O}10'N and 7^{O} 10'N and the climate is cold and dry from November to March and then warm and moist from April to October. The maximum and minimum temperature is 35 and 27^{O}C, respectively. The humidity of this area is high (74%) all the year round except in January when dry wind blows from the north. The average annual rainfall is over 1250 mm. Ten winged bean accessions were planted to obtained nutritional quality and nutrient uptake viz: TPT 3, TPT 6, TPT 9, TPT19, TPT 30, TPT 32, TPT 33, TPT 42, TPT 48 and TPT 153. Standard laboratory methods were used to analyze the seeds and leaves that were processed into powder form for proximate analysis. The determination of grain phytochemical contents was at full maturity, 10 grain samples were randomly selected per plot and analyzed for nutritional qualities such as ~~P~~protein, ~~M~~magnesium, ~~C~~carotene, ~~I~~iron, ~~P~~phosphorus, ~~C~~calcium and v~~V~~itamin C. To assess these contents the grain samples were oven at 75^{O}C for 72 hours. The dried grain samples were separately ground with a Wiley mill, and pass through a 0.5 mm sieve for tissue analysis. Total P was determined by the Vanadomolybdate method, K and Ca was determined by the flame photometry and Mg and Fe were determined by atomic absorption spectrophotometer [15]. Total N was analyzed by the micro-Kjeldahl procedure as described by [15] and crude protein was obtained by multiplying the total N by a factor of 6.25.The same method was used to determine the nutrient uptake. The determination of leaf phytochemical contents of 5 leaves were randomly selected per plot and analyzed for nutrient uptake such as ~~N~~nitrogen, ~~P~~phosphorus, ~~C~~calcium, ~~P~~potassium and ~~M~~magnesium. The proximate and nutrient uptake analyses were conducted at the Central Services Laboratory of NCRI Badeggi, Niger State. Data were subjected to analysis of variance (ANOVA) using Crop STAT package and significant means were separated by Duncan Multiple Range Test (DMRT) at 5% probability level.

Table 1: The mean~~P~~protein, ~~M~~magnesium and ~~C~~arotene nutritional qualities ofwinged bean

accessions in 2018 and 2019 cropping seasons

Accessions	Nutritional qualities (mg/100g)					
	Protein		Magnesium		Carotene	
	2018	2019	2018	2019	2018	2019
TPT3	12.78	31.75	151.67	72.67	24.56	16.04
TPT6	20.21	27.31	96.18	64.33	21.90	22.54
TPT9	30.19	31.58	190.67	61.67	24.54	24.01
TPT19	18.96	24.85	163.51	83.88	25.39	30.08
TPT30	23.91	25.19	213.99	77.41	24.86	26.93
TPT32	29.65	24.34	201.57	68.67	22.80	27.88
TPT33	23.75	31.05	175.09	79.00	28.06	28.83
TPT42	25.39	25.80	221.49	72.00	27.37	32.07
TPT48	33.50	32.60	180.03	82.63	27.09	29.43
TPT153	32.74	25.15	205.11	65.33	28.76	29.83

Means with the same letter are not significantly different at 5% probability (DMRT)

Results

Nutritional qualities of ten winged bean accessions:

Protein, magnesium and carotene minerals contents obtained from winged bean were not significantly ($p \geq 0.05$) different in 2018 and 2019 cropping seasons.

Iron mineral content of the ten winged bean plants evaluated was not significantly ($p \geq 0.05$) influenced in 2018 and 2019 cropping seasons. Phosphorus mineral content was not significant ($p \geq 0.05$) in 2018 cropping season, but the mineral content derived from the winged bean accessions were significantly ($p \leq 0.05$) different from each other in 2019 season. TPT9 (236.28mg/100g) recorded the highest mineral content which was followed by TPT48 (204.63mg/100g) and the least mean values were obtained from TPT153 (144.93mg/100g) and TPT3 (143.17mg/100g) respectively.

Table 2: **The mean ~~I~~ iron and ~~P~~p hosphorus nutritional qualities of winged bean accessions in 2018 and 2019 cropping seasons**

Accessions	Nutritional qualities (mg/100g)			
	Iron~~P~~phosphorus			
	2018	2019	2018	2019
TPT3	9.28	1.73	240.25	143.17c
TPT6	8.96	2.13	172.97	166.99bc
TPT9	8.77	2.76	229.24	236.28a
TPT19	9.75	2.70	169.03	151.53c
TPT30	9.11	4.54	219.84	164.33bc
TPT32	9.66	3.55	213.35	164.33bc
TPT33	9.78	2.51	163.34	165.44bc
TPT42	9.37	3.84	229.42	164.47bc
TPT48	10.66	3.52	141.40	204.63ab
TPT153	11.58	3.23	192.72	144.93c

Means with the same letter are not significantly different at 5% probability (DMRT)

Table 3: **The mean ~~C~~calcium and ~~V~~vitamin C nutritional qualities of winged bean accessions in 2018 and 2019 cropping seasons**

Accessions	Nutritional qualities (mg100/g)			
	Calcium		Vitamin C	
	2018	2019	2018	2019
TPT3	85.89	339.00a	15.29ab	11.52c
TPT6	132.26	154.00c	13.14abc	13.85bc
TPT9	125.28	156.67c	7.94bc	13.00bc
TPT19	127.31	353.33a	5.83c	21.40a
TPT30	134.85	285.67ab	13.13abc	14.33bc
TPT32	134.08	277.67ab	12.50abc	15.67abc
TPT33	102.27	248.67abc	7.06c	17.74ab
TPT42	103.30	242.00abc	16.44a	17.00abc
TPT48	105.30	283.33ab	8.11bc	17.48abc
TPT53	103.60	195.00bc	10.39abc	18.67ab

Means with the same letter are not significantly different at 5% probability (DMRT)

Calcium mineral element content had no significant effect ($p \geq 0.05$)in 2018, but there was significant ($p \leq 0.05$) difference in 2019 cropping season. The highest mineral content was received from TPT19 (353.33mg/100g) but was not significantly different from the mineral content obtained from TPT3 (339.00mg/100 g). This was followed by TPT30, TPT48 and TPT32 (285.69mg100/g, 283.33mg/100g, 277.67mg/100g) while the least mean values were observed from TPT9 (156.67mg/100g) and TPT6 (154mg/100g)

Vitamin C mineral content of winged bean accessions had significant ($p \leq 0.05$) effect in both cropping seasons. In 2018, TPT42 accession recorded the highest mean value (16.44mg/100g) followed by TPT3 (15.29mg/100g) and the least mean values were obtained from TPT33

(7.06mg/100g) and TPT9 (5.83mg/100g). In 2019, the accessions had higher values than the values recorded in 2018 season. TPT19 gave the highest mean value (21.40mg/100g) followed by TPT153 (18.67mg/100g) while the least mean value was obtained from TPT3 (11.52mg/100g).

Table 4: **The mean ~~N~~nitrogen, ~~P~~phosphorus and~~C~~calcium nutrient uptake of ten winged bean accessions in 2018 and 2019 cropping seasons.**

Accessions	Nutrient uptake (mg kg)					
	Nitrogen		Phosphorus		Calcium	
	2018	2019	2018	2019	2018	2019
TPT3	2.66	2.21	56.61	79.33b	7.83c	316.74ab
TPT6	3.88	2.33	53.83	65.33b	9.11bc	354.33a
TPT9	3.16	2.25	48.05	162.67a	8.96c	336.18ab
TPT19	4.41	2.38	54.52	67.67b	10.37bc	308.26abc
TPT30	3.20	2.68	57.57	63.33b	9.03bc	319.04ab
TPT32	3.05	3.07	42.00	78.33b	10.70abc	250.23abcd
TPT33	3.34	2.80	42.72	88.00b	12.06ab	208.72bcd
TPT42	3.30	2.55	55.46	81.33b	13.54a	118.74d
TPT48	2.81	2.12	53.15	59.00b	10.78abc	177.00cd
TPT153	2.73	3.19	57.68	46.67b	13.68a	226.00abcd

Means with the same letter are not significantly different at 5% probability (DMRT)

Nutrient uptake of ten winged bean accessions:

Nitrogen nutrient uptake of the ten winged bean accessions were not significantly ($p \geq ?$ 0.05) different in both years of evaluation.Phosphorus nutrient uptake of winged bean accessions had significant ($p \leq 0.05$) difference only 2019 cropping season with the highest mean value obtained from TPT9 (162.67mg kg). This accession proved its superiority over others while the remaining accessions were at par with each other.

Calcium nutrient uptake of the ten winged bean accessions was significant ($p \leq 0.05$) in the two cropping seasons. In 2018 cropping season, the highest mean values were recorded from TPT153 (13.68mg kg) and TPT42 (13.54mg kg) respectively. These were followed by mean value

obtained from TPT33 (12.06mg kg) while the least values were gotten from TPT9 (8.96mg kg) and TPT3 (7.83mg kg). In 2019 cropping season, TPT6 accession recorded the highest mean value (354.33mg kg). This was followed by TPT9 (336.18mg kg), TPT30 (319.04 mg kg) and TPT3 (316 mg kg). The least mean value was gotten from TPT42 (118.74 mg kg). In the overall,

the ten winged bean accessions planted in 2019 cropping season proved their superiority over 2018 cropping season (Table 4).

Table 5: **The mean ~~P~~potassium and ~~M~~magnesium nutrient uptake of ten winged bean accessions in 2018 and 2019 cropping seasons**

Accessions	Nutrient uptake (mg kg)			
	Potassium		Magnesium	
	2018	2019	2018	2019
TPT3	16.47	322.52a	14.18abcd	88.22a
TPT6	15.60	283.18abc	11.06bcd	89.03a
TPT9	15.15	308.85ab	10.78cd	88.82a
TPT19	14.91	262.49abc	10.04cd	85.19ab
TPT30	16.18	313.08ab	9.52d	76.30abc
TPT32	16.58	235.18bc	14.19abcd	79.74abc
TPT33	16.29	278.85abc	13.52abcd	58.77bc
TPT42	16.56	209.30c	15.04abc	55.13c
TPT48	16.64	252.89abc	16.07ab	54.30c
TPT153	17.21	206.74c	16.68a	67.63abc

Means with the same letter are not significantly different at 5% probability (DMRT)

Potassium nutrient uptake of winged bean accession had significant ($p \leq ?$ 0.05) influence only in 2019 cropping season in which TPT3 recorded the highest mean value (322.52 mg kg). This was followed by TPT30 (313.08 mg kg) and TPT9 (308.85 mg kg) while the least mean values were found in TPT42 (209.30 mg kg) and TPT153 (206.74 mg kg).

Magnesium nutrient uptake of winged bean accessions was significantly ($p \leq ?$ 0.05) affected in both cropping seasons. In 2018 cropping season, the highest mean value was recorded from TPT153 (16.68 mg kg) which was significantly better than other accessions while the least mean value was obtained from TPT30 (9.52 mg kg). In 2019, the trend changed with the highest mean values observed from TPT6 (89.03 mg kg), TPT9 (88.82 mg kg), TPT3 (88.22 mg kg) while the least mean values were obtained from TPT48 (54.30 mg kg) and TPT42 (55.13 mg kg).

Discussion

Result from this study revealed that the accessions evaluated had the potentials to improve human health if properly utilized. Phosphorus, calcium and Vitamin C contents of winged bean seeds showed significant differences among the accessions evaluated. The result obtained from this study is in line with [16] who stated that there was significant difference in the mineral contents of okra varieties used in their trial. From this study it was observed that there was no significant difference in Protein, Magnesium, Carotene and Iron contents. This was not in consonants with [17] who narrated that these mineral contents recorded a high level of significance in their experiment. The trend of inconsistence observed in the nutritional values obtained from this study supported the observations made by [18, 19]. Generally, results from this study proved that TPT 3, TPT 9 and TPT 48 showed highest nutritional values more than other accessions. The result from this study proved that winged bean had a source of special nutrient needed in the diet as indicated by the nutritional values. This is in conformity with the findings of [20].Findings from this study corroborates with[7, 8] who revealed that the tubers, young pods, seeds, leaves, flowers and shoot are rich in protein, amino acids oils, vitamins and minerals that can improve human health. The ten winged bean accessions evaluated in this study are good sources of quality and mineral elements. The variation in the nutritive values of different accessions of winged bean from this study might be as a result of environmental effect in which they were grown. Also, distribution of minerals needed for human health in the edible portions of plants can be affected by cultural production methods as indicated by [21, 22].In the present study, the nutrient uptake mineral elements were significant except Nitrogen. Findings from this study showed that the highest nutrient uptake was found in accessions TPT 6. The result from the study is similar to the findings reported by [23, 24] in their trial conducted on the nutrient uptake of tomato at different occasions.

Conclusion

Based on this study, winged bean accessions TPT 9 gave the highest mineral contents for nutritional qualities and TPT 6 for nutrient uptake. The nutrients absorbed served as morale boaster to the plants. Therefore, these accessions can be recommended for farmers for planting within this ecological zone of Nigeria.

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