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Nutritional Evaluation and Path Coefficient Analysis of Twelve Accessions of Pumpkin (Cucurbita Spp) Fruit Pulp Collected from Abia State, Nigeria

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Abstract:
Fruits pulp of twelve accessions of pumpkin collected from Abia State of Nigeria were evaluated for their proximate values, minerals, vitamin and phytochemical composition. Correlations and path coefficient analysis among the nutrients of these accessions were also determined. Results showed that proximate composition % (carbohydrate 2.79 - 4.87; crude protein 1.74 - 2.05; ether extract 0.83 - 1.06; and moisture content 90.18 - 92.49) differed significantly (p<0.01) among the accessions. Vitamins (mg/100g), minerals (mg/100g) and phytochemical composition (%) measured among the accessions differed significantly. Mean vitamin values ranged from 19.77 - 31.66 in vitamin A; 4.76 - 5.76 in vitamin C; 0.55 - 0.81 in vitamin E; 0.17 - 0.26 in thiamine; 0.57 - 0.85 in riboflavin and 0.31 - 0.51 in niacin. Lower values were obtained for alkaloid (0.46 - 0.78), hydrogen cyanide content (0.62 - 0.13), oxalate (0.33 - 0.55), saponin (0.10 - 0.95), phytate (0.67 - 0.95) and tannin (0.43 - 77). The fruit pulp contained appreciable minerals like calcium (21.54 - 30.65), iron (0.59 – 0.91), magnesium (0.17.60 – 23.77), phosphorus (23.68 – 35.61), potassium (2.82 – 134.78), and sodium (45.71 – 60.36). Path coefficient analysis for dry matter showed that traits like, ash, CHO and crude fiber had the highest positive direct effect on dry matter with 0.14, 0.01, and 0.01 respectively; HCN and its traits depicted that oxalate (0.99) had maximum direct positive influence followed by Tannin (0.30) while phytate (-0.23), alkaloid (-0.576) and Saponin (-0.24) have negative direct effects; Calcium and its traits indicated that iron had the largest direct positive influence (15.98) followed by Magnesium (0.59) while Potassium (-0.04), Sodium (-0.53) and (-0.04) had negative direct influence.

Keywords: *Pumpkin, evaluation, nutritional composition, correlation, path analysis*

1. Introduction

Despite its health and dietary benefits, the production of pumpkin (Cucurbita) in Abia State and Nigeria at large is still on a small scale with very low average yield occasioned by low knowledge on its economic importance (Abali and Okorokwo, 2017 and Aruah *et. al*, 2011). However, the cultivation of this nutrient rich food crop is most desirable for the purpose of overcoming the problems of under nourishments and food insecurity. With the current emphasis on consumption of fruits and vegetables to promote good health and life longevity, it is expected that the demand for pumpkin (Cucurbta) as a fruit vegetable may be increased in Nigeria and this increase must be matched with an increase in production and productivity (Abali and Okorokwo, 2017).

Pumpkin young leaves and vines are consumed as vegetables among the rural dwellers in South-east Nigeria. It is a cheap source of protein, vitamins, fibres, antioxidants and phytonutrients in their diet (Pandey *et. al*, 2003 and Aruah*et. al*, 2011). The vines and fruits are used as fodder for livestock, and gourds used for vast array of ornamentals, traditional and other related functional purposes (Wikipedia, 2017).

For the effective utilization of pumpkin fruit and its parts as a functional food component or medicinal herb, qualitative and quantitative information on the nutritional value is essential. Extensive research efforts have been made on nutritional composition of *Cucurbita* but the Nigerian Accessions has not been sufficiently reported as to compare with other Cucurbits like melon, Cucumber, water melon etc. (Abali and Okoronkwo, 2017). In order to establish the nutritive value of the crop species and thereby stimulate interest in its utilization beyond the traditional localities, this study was designed to evaluate proximate values, minerals, vitamin and phytochemical composition and also, determine path coefficient analysis that exists among the nutrients of these accessions of some pumpkin pulp which would aid in the improvement of this important crop as well as bridge the gap of underutilization of the crop.

2. Materials and Methods

2.1. Sources and Preparation of Sample

The experimental materials comprised of 12 accessions of pumpkin collected from different locations in Abia State, Nigeria (Table 1). The pods were washed with distilled water; the fruits pulp was pulverized into paste using a grinder kept in an ice box (to prevent moisture loss) and then used for analyses.

2.2. Proximate Analysis

The Moisture content, ash contents and crude fibre of the fruit pulp samples were determined by the method of Association of Official Analytical Chemist (AOAC, 2000). Dry matter was obtained by100 - % moisture contents (James, 1995). The crude protein content was determined by macro-kjeldahi (Onwunka, 2005). Nitrogen free extract (NFE) referred to as soluble carbohydrate was calculated by: NFE = 100 - (% ash + % crude fibre + % crude protein + % moisture). The solvent extraction gravimetric method was used to determine the fat content as described by Udo *et al*. (2009).

2.3. Mineral Analysis

Phosphorus content was obtained by Molybdo vanadate method, Calcium and Magnesium content by the versanate EDTA, Potassium and Sodium by the flame photometry method, all described by the Association of Official Analytical Chemist (AOAC, 2000).

2.4. Vitamin Analysis

Vitamin A, thiamin (B1), niacin (B3), and riboflavin contents were done by the spectrophotometric method described by James (1995), Vitamin C content by the methods described by Kirk and Sawyer (1998) while Vitamin E was estimated by the method described by Pearson (1976).

2.5. Photochemical Analysis

Alkaloid was determined using the alkaline precipitation gravimetric method as described by Harborne (1998). Tannin, Saponin, and Oxalate were obtained by the method described by the Association of Official Analytical Chemists (AOAC, 2000). Hydrogen Cyanide (HCN) was determined using the alkaline extraction method described by Onwunka (2005).

2.6. Experimental Design and Data Analysis

The experiment was laid out in Complete Randomize Design (CRD). All the attributes were taken in triplicates and data collected from all determinations were subjected to analysis of variance using Genstat Discovery Edition 12.1 (Genstat, 2009) software. The least significant difference test was used to identify significant differences among treatments means ($p<0.05$) as outlined by Obi (2002).

3. Results and Discussion

3.1. Proximate Composition of the Fruit Pulp of Twelve Accessions of Pumpkin from Abia State

Significant differences ($p<0.01$) were observed for carbohydrate, crude protein, dry matter, ether extract and moisture content while ash and crude fibre were not significantly different among the accessions (Table 2). The results showed that OBO (5.37%), followed by UMU 2 (4.78%) and UMU 5 (4.87%) had high content of carbohydrate when compared to the other accessions. The values obtained from these accessions were comparable to the values obtained by Loukou *et al*. (2007) for *Arachishypogaea* and Aruah*et al*. (2011) for *Cucurbitaspp*. High content of carbohydrate in *Cucurbita* fruits makes it a good food (Aruah*et al*., 2011).

Crude protein varied from 1.74% in ITEM to 2.05% in UMU 2 and UMU 5 respectively, which is very low compared to Aruah*et al*. (2011) (8.29-12.56%) for *Cucurbita*spp and Behera (2009) (7.31-9.67%) for yam. But the crude protein content values were higher than that reported by Osuagwu and Edeoga (2014) for seeds (0.30-36%) and leaves (0.30-50%) for *Cucurbita*spp.

Dry matter ranged from 7.51% (IMEREM 1) to 9.82% (OBO). The dry matter reported by Jacob *et al*. (2015) for melon seed was found to be significantly higher (92.90) than the one reported on this study.

The ether extract was lowest in UMU 3 and OVI (0.83% respectively) and highest in IMEREM 2 (1.06%) and OBI (1.05%). The values were low when compared to other leafy vegetables such as *Talinumtrianguare* and *Amaranthushybridus* (Akindahunsi and Salawu, 2005). This low lipid concentration in the fruit makes it a good food for people suffering obesity. Excess fat consumption has been implicated in certain cardiovascular disorders such as atherosclerosis, cancer and aging (Antia *et al*., 2006). Therefore, diets of pumpkin fruits should be encouraged in other to reduce the risks of the above disorders in man.

The moisture content ranged from 90.18% in OBO to 92.49% in IMEREM 1. The value is very high and slightly higher than that reported by Nwofia *et al*., (2012) (78.46% - 91.97) in *Cucurbita*s pp and lower than that reported by Onimisi and Ovansa (2015) (95.10 - 95.85%) in cucumber varieties. This shows that the shelf life of the fruit pulp is very short and can be easily attacked by microbes and hence spoilage (Desai and Salunkle, 1991).

3.2. Mineral Composition of the Fruit Pulp of Twelve Accessions of Pumpkin from Abia State

The mineral composition of the fruit pulp of the twelve accessions of *Cucurbita*spp from Abia State is shown in Table 3. There were significant (p<0.001) variations among the accessions in all the minerals measured. Calcium varied from 21.54 - 30.65 mg/100g in IMEREM 2 and OVI respectively. The range of calcium can be comparable to that of Nwofia *et al*. (2012). The variation in iron content revealed that IMEREM 1 (0.91 mg/100g) was the highest followed by OBI (0.87 mg/100g) while UMU 4 (0.59 mg/100g) gave the lowest value. The value obtained was low but slightly higher when compared to values obtained by Aruah*et al*. (2011) and Onimisi and Ovansa (2015). The low values obtained is desirable due to the fact that large quantity of iron in the food have been reported to have destructive effect on the ascorbic acid (Lajide *et al*. 2008). The accessions, OBO (23.77 mg/100g) and UMU 5 (23.10 mg/100g) were highest in magnesium and the accessions UMU 3 (17.60 mg/100g) and OVI (18.66 mg/100g) were lowest. The value obtained in Nwofia *et al*. (2012) (25.43-46.77 mg/100g) were higher than the value obtained in this report. The observed phosphorus content of the fruit pulp was high in OBI (35.61 mg/100g) and IMEREM 1 (32.77 mg/100g) and low in OVI (23.68 mg/100g). The phosphorus content recorded in these *Cucurbita* accessions were less than the one reported by Nwofia *et al.* (2012). The potassium content was highest in IMEREM 1 (134.78 mg/100g) and ITEM (130.69 mg/100g) and lowest in IMEREM 2 (115.86 mg/100g) and UMU 2 (115.87 mg/100g). The sodium content of the fruit was highest in OBO (60.36 mg/100g) and lowest in UMU 4 (45.71 mg/100g). Ibanga and Okon, (2009) reported that Minerals is considered to be essential in human nutrition and these minerals are vital for the overall mental and physical well-being (Soeton *et. al*., 2010).

3.3. Vitamin Composition of the Fruit Pulp of Twelve Accessions of Pumpkin from Abia State

The vitamin compositions of the fruit pulp of twelve accessions of *Cucurbita* from Abia State are shown in Table 4. Highly significant difference (p<0.001) was observed among the twelve accessions in the vitamins measured. UMU 5 had the highest Vitamin A contents (31.66 mg/100g) followed by UMU 1 (30.66 mg/100g) while the lowest was observed in OBO (19.77 mg/100g). The highest vitamin C value was obtained in UMU 1 (5.76 mg/100g) while the lowest value was obtained in IMEREM 1 (4.76 mg/100g). Nwofia *et al*. (2012) reported higher vitamin C content compared with the one from this study. Vitamin E varied from 0.55 mg/100g in UMU 1 to 0.81 mg/100g in IMEREM 2. Thiamine ranged from 0.17 mg/100g in OBI to 0.26 mg/100g in UMU 2. Thiamine value observed in this report is higher compared to the values reported by Nwofia *et al*. (2012). The Riboflavin of the fruits ranged from 0.57 mg/100g in IMEREM 1 to 0.85 mg/100g in IMEREM 2 while Niacin ranged from 0.31 mg/100g in UMU 4 to 0.51 mg/100g in UMU 2 and UMU 5. The vitamin performs an active role in human health and welfare mostly as an oxidant. The result showed that the accessions contain moderate quantity of thiamine, riboflavin, niacin, vitamin E, vitamin C and vitamin A. Vitamin A was slightly higher in all the accession compared to other vitamin. Vitamin A exists in plant as the precursor of carotenoid family. Vitamin C is vital for body performance (Okwu and Josiah, 2006). Thiamine plays a central role in cerebral metabolism. Vitamin E has potential in providing protection from radicals and products of oxygenation. It also inhibits lipoxygenation, an enzyme responsible for the formation of proinflammatory leukotriens (Anon, 2002).

3.4. Phytochemical (Anti nutritional) Composition of the Fruit Pulp of Twelve Accessions of Pumpkin

The result (Table 5) obtained showed that the *Cucurbita* accessions had low values of phytochemicals which were significantly different from one another. The Alkaloid contents varied from 0.46% in UMU 4 to 0.078% in UMU 1 and UMU 2. The HCN content ranged from 0.062% in UMU 4 to 0.127% in OVI. The oxalate content varied from 0.033% in OBI to 0.055% in IMEREM 1. The Phytate was lowest (0.067%) in ITEM and highest 0.095% in OHIFA. While the Saponin content ranged from 0.010% in UMU 1 to 0.095% in IMEREM 1 and UMU 4 respectively. The Tannin content ranged from 0.043% in UMU 5 to 0.077% in OBO. The value reported in Alkaloid, HCN and Tannin is lower than that reported by Nwofia *et al.,* (2012) but the values reported for phytate and tannin were higher than that reported by Aruah*et al.,* (2011). Tannins are useful in the treatment of intestinal disorders such as diarrhea, dysentery and urinary tract infections (Fahey 2005, Akimpelu and Onakoya 2006). This explains the use of the plant in the treatment of gastrointestinal disorders.

3.5. Path Coefficient Analysis

Path coefficient analysis allows the researcher to measure which of the possible relationships is most important and the ones that are not important at all. The direct and indirect effects of some traits on dry matter are presented in Figure 1. Path coefficient analysis for dry matter showed that traits like, ash, CHO and crude fibre showed highest positive direct effect on dry matter with 0.14, 0.01, and 0.01 respectively. This means that a slight increase in one of the above traits may directly increase the dry matter. These traits are therefore, very important components of dry matter and should be given high weightage in any selection process aimed at improving dry matter in this crop. Similar results were reported by Mohanty *et al.* (2016). On the other hand, the maximum negative direct effect was exhibited by moisture content (-0.99) followed by ether extract (-0.24).

Path coefficient analysis of HCN and its traits depicted that oxalate (0.99) had maximum direct positive influence followed by Tannin (0.30) while Alkaloid (-0.576), Saponin (-0.24) and phytate (-0.23) have negative direct effects to the HCN (Fig. 2). Oxalate had most direct effect and closely related to HCN revealing that cucurbits accession with high value of oxalate produced the highest proportion of HCN. When breeding crop for low HCN, crops that have negligible or barest minimum of oxalate and tannin should be considered as important traits for selection. Residual factor effect was negligible showing that no other HCN and its traits components were captured which revealed appropriateness of trait chosen.

Path coefficient of analysis of calcium and its traits (Figure 3) indicated that iron had the largest direct positive influence (15.98). Magnesium had a positive and low effect (0.59) compared to iron. Potassium (-0.04), Sodium (-0.53) and

(-0.04) had negative direct influence on Calcium. This means that any slight increase on any of the above minerals will result to decrease in Calcium. Magnesium had low direct influence on Calcium (0.59) but its indirect relationship through Phosphorus (0.95) is greater. Although, Potassium had a negative direct relationship with Calcium but had high positive indirection relationship through Phosphorus (8.85).

4. Conclusion

Pumpkin fruit pulp contains protein, carbohydrate and minerals good for human and animal health. Interestingly, the anti-nutritional contents of the fruits were low, much lower than is obtainable in most other Nigerian vegetables.
It has low lip concentration which makes it a good source of food for people suffering from obesity. OBO, Umu2 and Umu 5 had high content of carbohydrate compared to other accessions.

The pumpkin fruit pulp has high moisture content that result in low shelf life.
The fruit pulp of the accessions had appreciable vitamins (especially vitamin A). UMU 5, UMU 1 and IMEREM 2 had high vitamin A content and could be selected in the improvement of vitamin A in pumpkin.

The accessions had high phosphorus, potassium, magnesium, and calcium. Imerem 1 had high amount of calcium, iron, phosphorus and potassium while OBO had high amount of calcium, iron, magnesium and sodium. The accessions that had high phosphorus, had high potassium; those that had high sodium content, had high iron and magnesium content, those that had high phosphorus also had high iron content and vice versa.

Increase in ash, carbohydrate, and crude fibre resulted direct increase in dry matter and should be considered when improving dry matter in pumpkin. Crop with low hydrogen cyanide requires pumpkin that has negligible or barest minimum of oxalate. Calcium content in fruit pulp decreases with increase in potassium and sodium.

Accession	Location	L.G. A	Latitude	Longitude	Altitude (m)
OBI	Obikabia	Aba North	5.136934°	7.402019°	197 m
IMEREM 1	Ntigha	Isialangwa North	5.350770°	7.375206°	177 m
IMEREM 2	Umuekaa	Isialangwa South	5.3271°	7.3923°	111 m
OBO	Obohia	Aba South	5.63634°	7.356204°	180 m
UMU 1	Worldbank	Umuahia North	5.53745°	7.49729°	146 m
UMU 2	Umudike	Ikwuano	5.47648°	7.54908°	151 m
UMU 3	Ossiah	Umuahia South	5.46234°	7.43997°	159 m
UMU 4	Umugasi	Osisioma	5.9939°	7.33079°	77 m
UMU 5	Umuoha	Obingwa	5.15059°	7.33049°	190 m
OVI	Ovim	Isuikwato	5.53333°	7.48333°	151 m
ITEM	Item	Bende	5.55718°	7.63676°	140 m
OHA	Elu	Ohafia	5.63444°	7.8229°	153 m

Table 1: Twelve Accessions of Pumpkin and Their Collection Sites

Accessions	Moisture Content	Ash	CCarbo-hydrate	Crude Fibre	Crude Protein	Ether Extract	Dry Matter Content
OBI	2.1	1.38	3.21	0.	1.85	1.05	7.73
IMEREM 1	92.49	0.95	2.79	0.82	1.93	1.03	7.51
IMEREM 2	92.49	1.15	3.97	0.72	1.74	1.06	8.65
OBO	90.18	0.81	5.37	0.62	1.88	1.01	9.82
UMU 1	92.34	1.41	2.76	0.75	2.03	0.94	7.66
UMU 2	900.37	0.92	4.78	0.76	2.05	1.02	9.62
UMU 3	91.63	1.23	3.65	0.66	1.83	0.83	8.43
UMU 4	92.22	0.95	3.25	0.76	1.91	0.90	7.81
UMU 5	90.37	1.08	4.87	0.62	2.05	1.04	9.61
OVI	91.62	1.06	3.83	0.78	1.82	0.83	8.37
ITEM	91.44	1.05	3.67	0.83	1.74	1.03	8.56
OHA	90.39	1.13	4.77	0.71	1.93	0.90	9.61
Mean	91.362	1.06	3.954	0.726	1.967	0.9728	8.617
$LSD_{(0.05)}$	0.1593	NS	0.1762	NS	0.5839	0.03036	0.1608
CV (%)	0.1	16.6	2.6	3.2	17.6	1.9	1.1

Table 2: Proximate Composition (%) of the Fruit Pulp of Twelve Accessions of Pumpkin from Abia State LSD (Less Significant Difference 0.05%), NS (Not Significant)

Accessions	Calcium	Iron	Magnesium	Phosphorus	Potassium	Sodium
OBI	24.77	0.87	21.74	35.61	123.77	54.80
IMEREM 1	27.86	0.91	19.49	32.77	134.78	49.28
IMEREM 2	21.54	0.62	20.66	29.61	115.86	56.49
OBO	29.44	0.85	23.77	27.11	120.77	60.36
UMU 1	23.66	0.76	21.66	26.78	118.68	54.80
UMU 2	27.12	0.63	20.83	25.86	115.87	53.49
UMU 3	24.77	0.73	17.60	25.67	121.54	49.04
UMU 4	26.78	0.59	19.54	28.44	123.72	45.71
UMU 5	25.77	0.82	23.10	27.54	125.76	51.72
OVI	30.65	0.76	18.66	23.68	116.79	48.27
ITEM	29.34	0.73	20.71	28.52	130.69	46.27
OHA	21.59	0.66	22.23	27.70	125.82	54.70
MEAN	26.109	0.7619	20.833	28.275	122.839	52.079
$LSD_{(0.05)}$	0.1224	0.0349	0.3960	0.5101	0.4825	0.4273
CV	0.3	2.7	1.1	1.1	0.2	0.5

Table 3: Mineral Composition (Mg/100g) of the Fruit Pulp of Twelve Accessions of Pumpkin LSD (Less Significant Difference 0.05%)

Accessions	Vita A	Vit C	VitE	Thiamin	Riboflavin	Niacin
OBI	25.63	4.88	0.78	0.17	0.74	0.36
IMEREM 1	21.66	4.76	0.73	0.24	0.57	0.38
IMEREM 2	28.75	5.17	0.81	0.21	0.85	0.32
OBO	19.77	5.41	0.62	0.18	0.62	0.44
UMU 1	30.66	5.76	0.55	0.25	0.76	0.38
UMU 2	26.62	5.32	0.68	0.26	0.63	0.51
UMU 3	23.37	4.87	0.75	0.23	0.76	0.43
UMU 4	23.57	5.51	0.67	0.23	0.66	0.31
UMU 5	31.66	4.83	0.71	0.23	0.72	0.51
OVI	25.54	5.38	0.63	0.23	0.83	0.42
ITEM	24.72	4.78	0.76	0.19	0.72	0.39
OHA	22.84	5.19	0.61	0.24	0.66	0.38
MEAN	25.4	5.1567	0.6914	0.2231	0.7125	0.4044
LSD (0.05)	0.2454	0.0681	0.0456	0.0262	0.0354	0.0382
CV (%)	0.6	0.8	3.9	7	2.9	5.6

Table 4: Vitamin Composition (Mg/100g) of the Fruit Pulp of Twelve Accessions of Pumpkin LSD (Less Significant Difference 0.05%), Vit (Vitamin)

Accessions	Alkaloid	HCN	Oxalate	Phytate	Saponin	Tannin
OBI	0.072	0.078	0.033	0.082	0.012	0.073
IMEREM 1	0.062	0.083	0.055	0.091	0.095	0.066
IMEREM 2	0.055	0.09	0.045	0.086	0.092	0.075
OBO	0.065	0.075	0.042	0.079	0.017	0.077
UMU 1	0.078	0.066	0.035	0.074	0.01	0.056
UMU 2	0.078	0.067	0.046	0.069	0.013	0.052
UMU 3	0.055	0.067	0.037	0.073	0.077	0.058
UMU 4	0.046	0.062	0.044	0.075	0.095	0.049
UMU 5	0.054	0.096	0.051	0.083	0.012	0.043
OVI	0.064	0.127	0.044	0.074	0.014	0.053
ITEM	0.062	0.086	0.054	0.067	0.084	0.046
OHA	0.062	0.076	0.053	0.095	0.015	0.053
MEAN	0.06175	0.08164	0.04531	0.07917	0.044	0.05872
$LSD_{(0.05)}$	0.002480	0.001291	0.003335	0.097697	0.00335	0.006411
CV (%)	2.4	1.9	4.4	5.8	4.5	6.5

Table 5: Phytochemical Composition (%) of the Fruit Pulp of twelve Accessions of Pumpkin LSD (Less Significant Difference 0.05%), HCN (Hydrogen Cyanide Content)

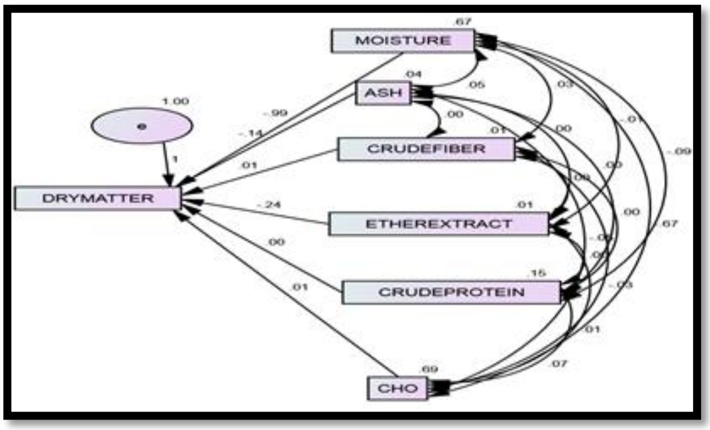

Figure 1: Path Coefficient of Analysis of Dry Matter and Its Traits

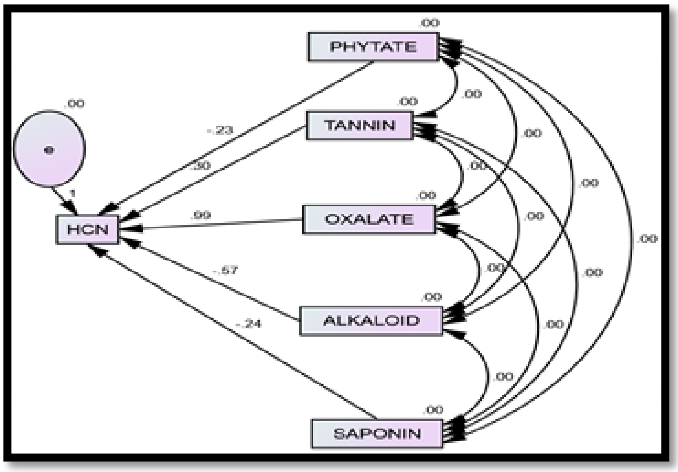

Figure 2: Path Coefficient of Analysis of Hydrogen Cyanide and Its Traits

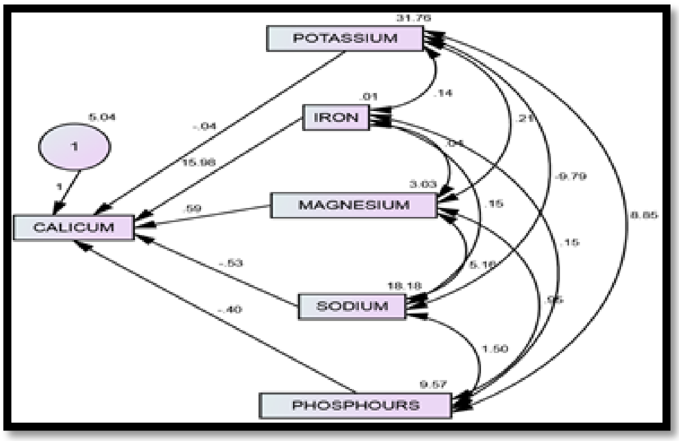

Figure 3: Path Coefficient of Analysis of Calcium and Its Traits

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