

Identification of Amino Acids and B-Vitamins in Scotch Bonnet Pepper (*Capsicum chinense*) Using an HPLC-UV Detector

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Abstract The scotch bonnet pepper (*Capsicum chinense*), which is grown in Ado Ekiti, Nigeria, is frequently used to spice up foods and soups in addition to a variety of therapeutic benefits. They contain vitamins and amino acids and can be used to treat pain disorders including headaches, osteoarthritis, rheumatoid arthritis, and severe diabetic neuropathy. The concentration of amino acids and vitamins B₁, B₂, and B₆ in the flesh and seed of red and green scotch bonnet peppers, on the other hand, remains unknown, which prompts this inquiry. On a nearby farm in Ado Ekiti, Nigeria, red and green scotch bonnet peppers were picked, split into flesh and seed, mixed, air-dried at room temperature and then ground into powder. With the aid of an HPLC-UV detector, the samples were tested for their amino acid content and vitamin B₁, B₂, and B₆ identification. For the red scotch bonnet pepper, 17 amino acids were identified at different retention times and classified as essential and non-essential. Eighteen amino acids were discovered in the seed and eighteen in the flesh. However, serine was only found in the seed and not in the flesh. Furthermore, eighteen acids were identified in the flesh and seed of green pepper, eighteen in the flesh, and fifteen in the seed. Serine has only been detected in the flesh and in the flesh and seed.

The vitamins B₁, B₂, and B₆ were all present in the seed and flesh of the red and green peppers studied with varying heights and retention times. The abundance of serine in the green pepper seed and flesh, as well as the availability of eighteen amino acids shows that it is more nutritious than the red pepper.

Keywords Red and Green Pepper, HPLC-UV Detector, Amino Acids, B-vitamins

1. Introduction

Scotch Bonnet pepper is a *Capsicum chinense* Jacquin cultivar that belongs to the Solanaceae family. Peppers are a rich source of important vitamins, minerals, and nutrients, which makes them extremely beneficial to human health [1]. Locally in Nigeria, the vast population of people consumes red scotch pepper only, and some do remove the seed before grinding. The health benefits associated with the consumption of pepper and more importantly their therapeutic effects have been well documented [2]. Vegetables are essential for food security and nutrition [2].

Because of the vitamins, minerals, phytochemical components and dietary fibre, they contain are beneficial to human health [3]. Pepper comes in a variety of kinds in the Nigerian market. Capsicum genus has over 30 species, five of which (*C. annuum*, *C. frutescens*, *C. chinense*, *C. baccatum*, and *C. pubescens*) have been domesticated and mostly farmed for human consumption [4]. Provitamin A, vitamins E and C, carotenoids, and phenolic substances such as capsaicinoids, luteolin, and quercetin are all found in pepper. All of these chemicals have antioxidant properties, and perform other biological functions [5]. Pepper is the most widely used spice in the world, and it is prized for its spiciness and ability to enrich the flavour of a variety of dishes [5]. In addition, Pepper is an important commercial commodity that is used as vegetables, spices, and in some value-added processed foods [5]. Phytochemicals and vitamins such as vitamin A, vitamin C (ascorbic acid), iron, vitamin B, carotenoids, niacin, riboflavin, dietary fibre, flavonoids, and magnesium are abundant in Scotch bonnet peppers [6]. The nutritional composition and the number of metabolites differ between pepper types [1,6,7]. [17] found significant differences in the phytonutrient composition of 32 capsicum accessions. The number of proximate, minerals, fatty acids, and amino acids discovered in different types varied greatly [6,8]. Further, the nutritional compositions of a variety of peppers vary depending on their developmental stages, growing locales, and agricultural practices even within the same variety [9-13]. For genetic improvement of metabolic features, especially health-related chemicals, a comparative investigation of metabolite compositions has been undertaken in a broad collection of peppers [7,12,14]. However, there is little information about the amino acids and vitamin B₁, B₂, and B₆ components of *Capsicum chinense* (both green and Red) grown in Ado-Ekiti, Nigeria. The purpose of this study is to determine the amino acid and the B vitamins contents of the seed and flesh of green and red scotch bonnet pepper.

2. Materials and Methods

Sample collection: The red and green scotch bonnet

pepper (*Capsicum chinense*) were harvested, the seeds were separated from the flesh and air-dried for five days and powdered.



Plate 1. Picture of Red and Green *Capsicum chinense*

Amino Acid determination: HPLC with UV Detector, 10.00g Sample extracted with Acetonitrile, the extract stabilized with Ethyl Acetate, introduced into 25 ml standard flask, and made up to the mark. 5ul injected @ 2ml / min flow rate, the following chromatographic conditions were employed; Agilent Technologies HPLC 1200, Column: uBondapak C18, Carrier: Acetonitrile/Water 70:30.

Vitamins B₁, B₂, and B₆ determination: HPLC with UV Detector, 10.00g Sample extracted with Acetonitrile, the extract stabilized with Ethyl Acetate, introduced into 25 ml standard flask, and made up to the mark. 5ul injected @ 2ml/min flow rate, the following chromatographic conditions were employed: Agilent Technologies HPLC 1200, Column: uBondapak C18, Carrier: Acetonitrile/Water 75:25.

3. Results

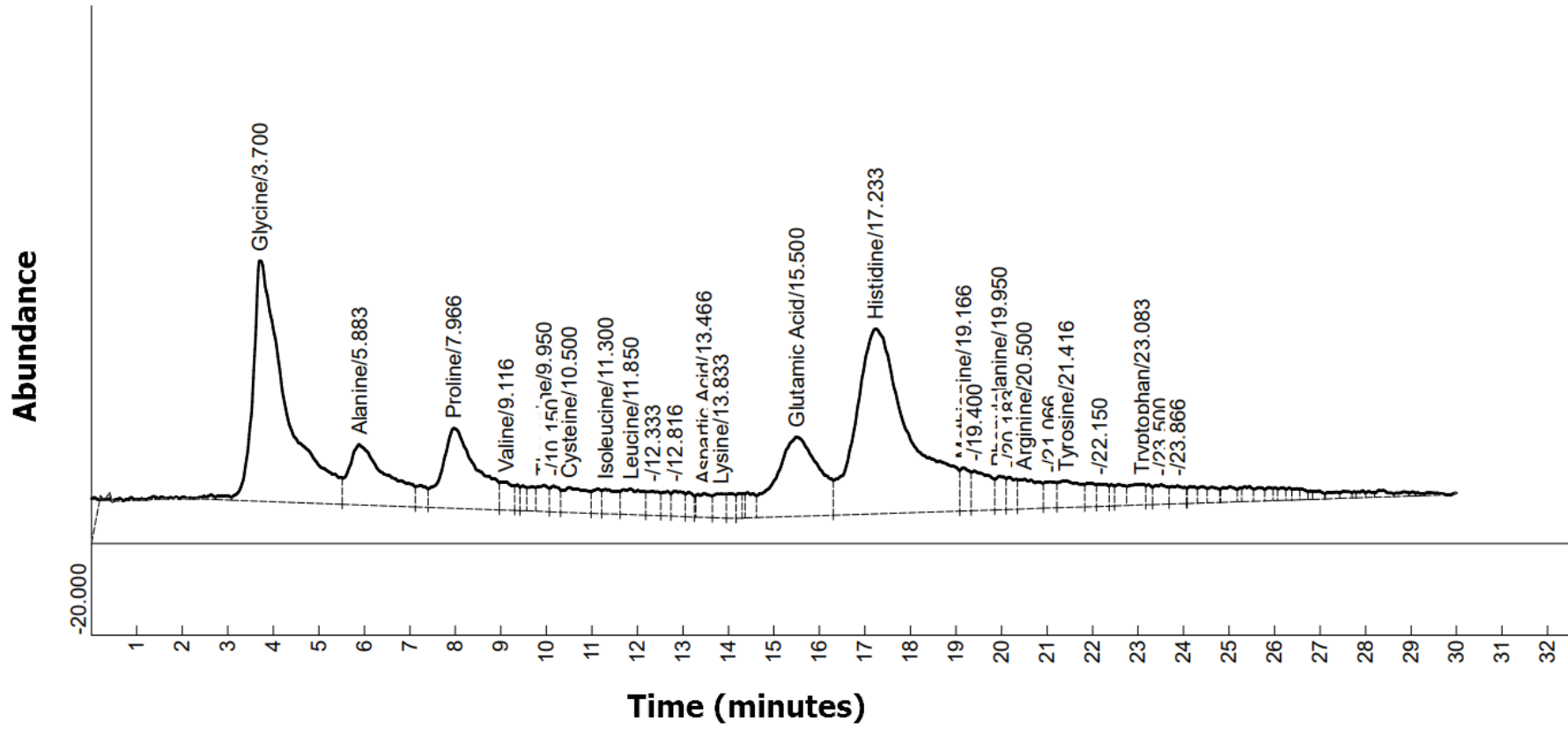


Figure 1. Chromatogram of amino acid of seed and flesh of red *Capsicum chinense*

Table 1. Identified amino acid contents in seed and flesh of red *scotch bonnet pepper*

Amino acid	Retention time (minutes)	Height	Area	Concentration (mg/g)	Concentration (mg/10g)	Concentration (mg/kg)	Class of amino acid
Glycine	3.700	52.511	2620.2190	1.190	0.119	11.90	Non-essential
Alanine	5.883	13.149	766.1790	0.347	0.035	3.50	Non-essential
Proline	7.966	17.442	925.7770	0.419	0.042	4.20	Non-essential
Valine	9.116	6.192	116.6250	0.053	0.005	0.50	Essential
Threonine	9.950	5.763	97.9270	0.044	0.004	0.40	Essential
Cysteine	10.500	5.501	200.2000	0.091	0.009	0.90	Non-essential
Isoleucine	11.300	5.337	122.0820	0.055	0.005	0.50	Essential
Leucine	11.850	5.608	179.2830	0.081	0.008	0.80	Essential
Aspartic Acid	13.466	5.238	108.4800	0.049	0.005	0.50	Non-essential
Lysine	13.833	5.269	92.5400	0.042	0.004	0.40	Essential
Glutamic Acid	15.500	17.339	1117.9450	0.506	0.051	5.10	Non-essential
Histidine	17.233	40.365	3268.3140	1.481	0.148	14.8	Essential
Methionine	19.166	9.435	135.0025	0.061	0.006	0.60	Essential
Phenylalanine	19.950	7.279	105.4400	0.048	0.005	0.50	Essential
Arginine	20.500	6.493	205.9610	0.093	0.009	0.90	Non-essential
Tyrosine	21.416	5.840	199.5070	0.090	0.009	0.90	Non-essential
Tryptophan	23.083	4.547	110.2080	0.050	0.005	0.50	Essential

Figure 1 shows the chromatogram of seed and flesh of red *Capsicum chinense* and the nineteen amino acids identified at different heights and retention times. The results of table 1 indicate the type of amino acids and their classifications. Nine essential amino acids were revealed at various heights with Histidine having the highest height of 40.365 at a retention time of 17.233 minutes and Tryptophan having the least height of 4.547 and retention

time of 23.083 minutes. For the non-essential amino acid, glycine had the highest height of 52.511 at a retention time of 3.700 minutes. It is worth noting that all of the nine essential amino acids were present while eight non-essential amino acids were identified in the seed and flesh of the red scotch bonnet pepper. Different amino acids - both essential and non-essential amino acids perform various functions in the human body system.

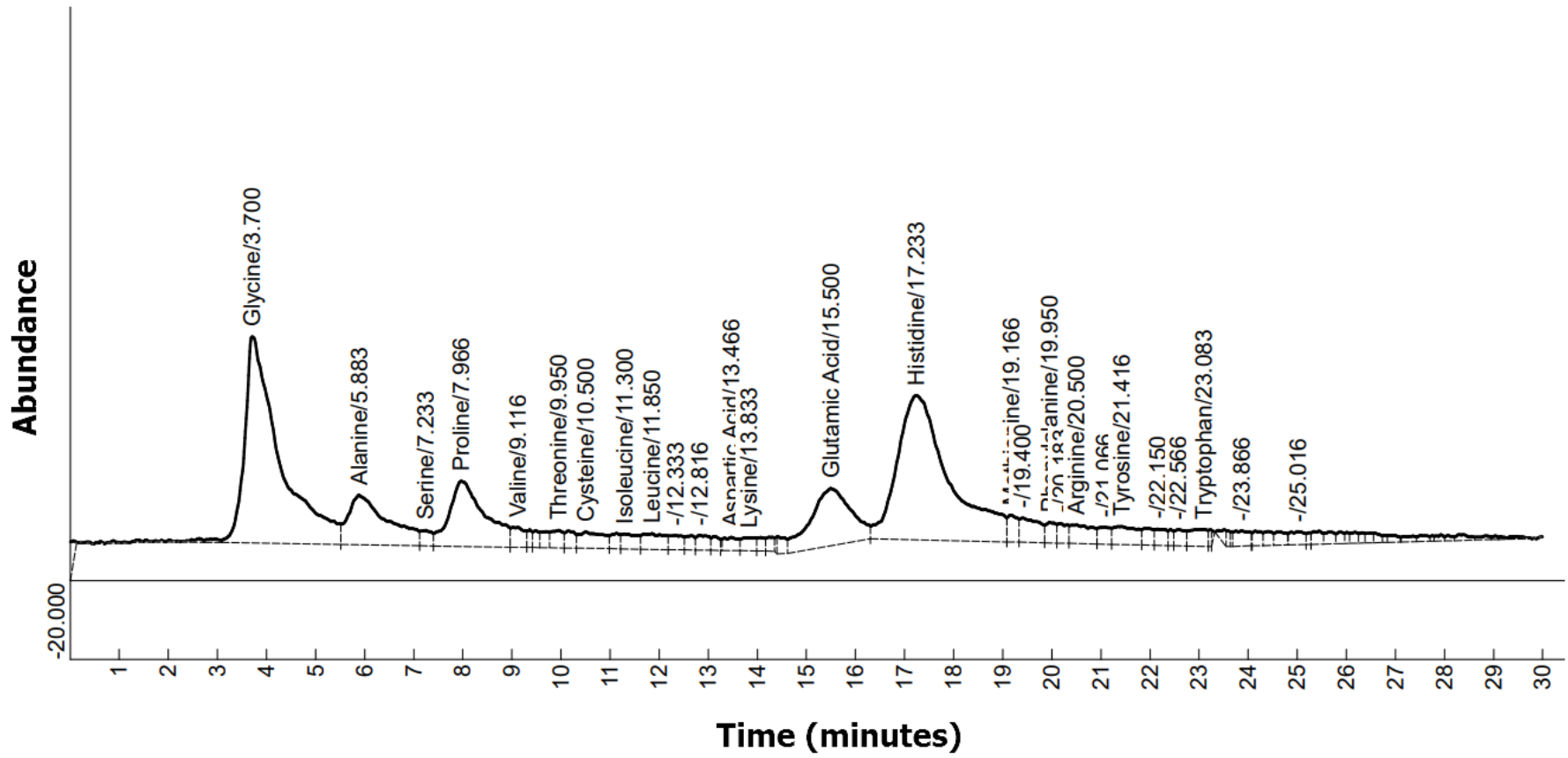


Figure 2. Chromatogram of amino acid of the seed of red *Capsicum chinense*

Table 2. Identified amino acid contents in the seed of red *Capsicum chinense*

Amino acid	Retention time (minutes)	Height	Area	Concentration (mg/g)	Concentration (mg/10g)	Concentration (mg/kg)	Class of amino acid
Glycine	3.700	52.269	2570.5060	1.164	0.1164	11.64	Non-essential
Alanine	5.883	12.548	701.5710	0.318	0.0318	3.18	Non-essential
Serine	7.233	3.901	62.0550	0.028	0.0028	0.28	Non-essential
Proline	7.966	16.497	833.6570	0.378	0.0378	0.38	Non-essential
Valine	9.116	5.058	93.8850	0.043	0.0043	0.43	Essential
Threonine	9.950	4.492	75.1300	0.034	0.0034	0.34	Essential
Cysteine	10.500	4.139	144.7200	0.066	0.0066	0.66	Non-essential
Isoleucine	11.300	3.843	85.7700	0.039	0.0039	0.39	Essential
Leucine	11.850	4.023	125.1210	0.057	0.0057	0.57	Essential
Aspartic Acid	13.466	3.387	67.7580	0.031	0.0031	0.31	Non-essential
Lysine	13.833	3.358	64.8680	0.030	0.003	0.30	Essential
Glutamic Acid	15.500	14.507	839.7910	0.380	0.038	3.80	Non-essential
Histidine	17.233	36.596	2685.2335	1.216	0.122	12.2	Essential
Methionine	19.166	6.834	96.3625	0.044	0.004	0.40	Essential
Phenylalanine	19.950	5.151	73.7525	0.033	0.003	0.30	Essential
Arginine	20.500	4.697	147.6340	0.067	0.007	0.70	Non-essential
Tyrosine	21.416	4.597	155.9395	0.071	0.007	0.7	Non-essential
Tryptophan	23.083	4.310	106.4570	0.048	0.005	0.7	Essential

Figure 2 shows a chromatogram of amino acids from the seed of a red *Capsicum chinense*, where eighteen amino acids were identified within the retention time range of 3.700 and 23.083 minutes, having varied heights of 52.269 (highest) and 4.310 (least). Table 2 presents the eighteen amino acids identified - nine essential and nine non-essential. Glycine, a non-essential amino acid, was identified at a retention time of 3.700 minutes and had the highest height of 52.269, while histidine, an essential one, was identified at a retention time of 17.233 minutes and height of 36.596. Serine was identified at a retention time of 7.233 minutes and a height of 3.901. Serine is useful for treating neurological diseases and injury. Scholars have discovered that the non-essential amino acid L-serine, as well as its metabolic metabolites, are vital not just for cell proliferation but also for neural development and specific brain functions. L-serine modulates the production of various cytokines in the brain to improve cognitive performance, improve cerebral blood flow, limit

inflammation, promote remyelination, and have other neuroprotective effects on a neurological injury, according to growing data. L-serine has been used to treat epilepsy, schizophrenia, psychosis, and other neurological disorders at various dosage concentrations [15-16]. In addition, serine is said to be physiologically required and plays a critical role in a variety of cellular functions, and is classified as a nutritionally non-essential (dispensable) amino acid, the most common source of one-carbon units for methylation processes that result in S-adenosylmethionine formation. The modulation of serine metabolism in mammalian tissues is therefore crucial for methyl group transfer control [17]. L-serine is also GRAS (generally regarded as safe), and the FDA has approved it as a standard food ingredient and dietary supplement under CFR172. 320. The serine concentration (0.28 mg/kg) was lower than the recommended daily dosage (200 mg/kg or 400 mg/kg), according to [18].

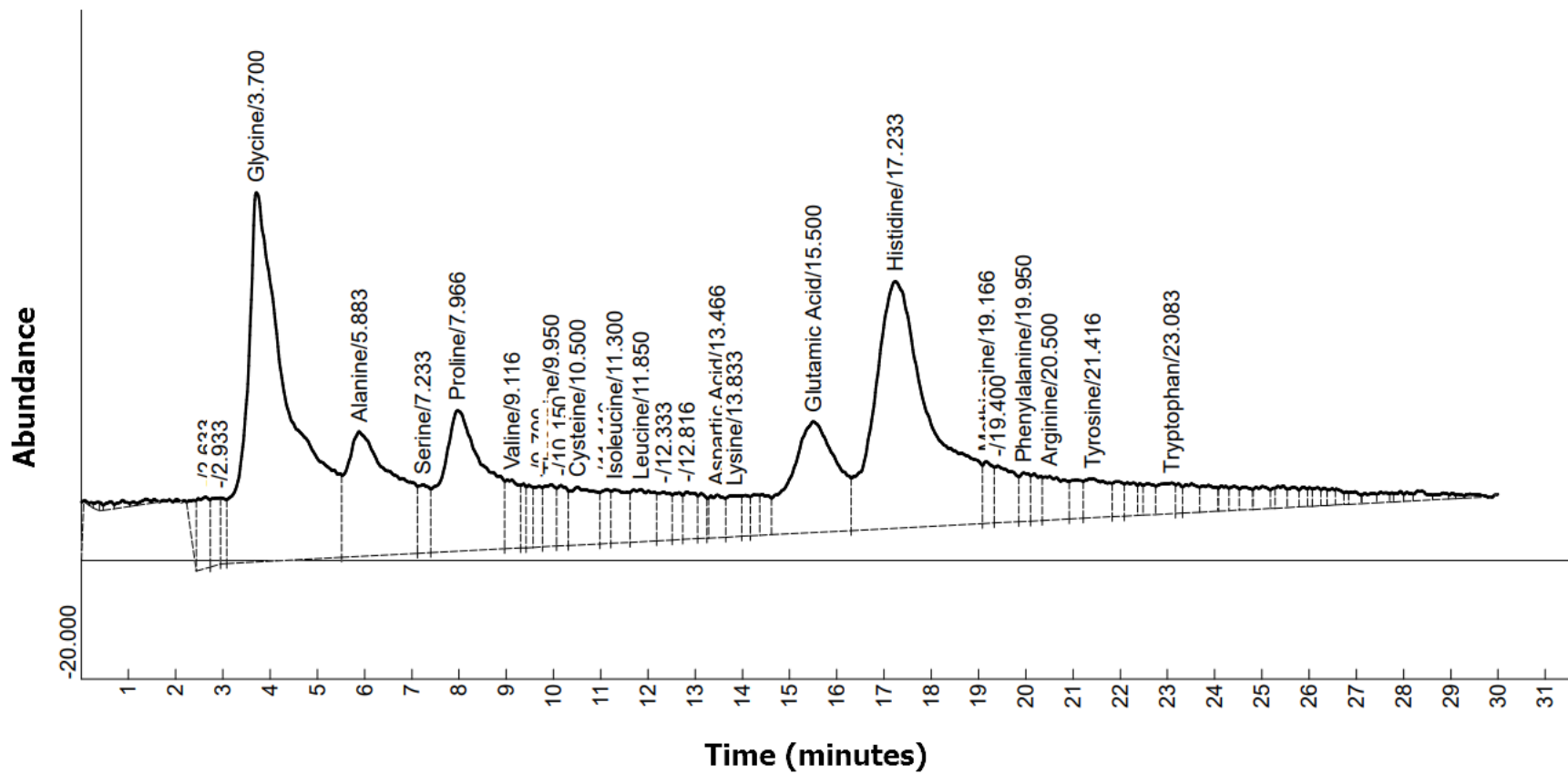


Figure 3. Chromatogram of amino acid of the flesh of red *Capsicum chinense*

Table 3. Identified amino acid contents in the flesh of red *Capsicum chinense*

Amino acid	Retention time (minutes)	Height	Area	Concentration (mg/g)	Concentration (mg/10g)	Concentration (mg/kg)	Class of amino acid
Glycine	3.700	62.076	3948.5270	1.789	0.1789	17.89	Non-essential
Alanine	5.883	21.011	1488.3870	0.674	0.0674	6.74	Non-essential
Serine	7.233	11.531	191.5185	0.087	0.0087	0.87	Non-essential
Proline	7.966	23.676	1495.9340	0.678	0.0678	6.78	Non-essential
Valine	9.116	11.528	223.0950	0.1011	0.01011	1.01	Essential
Threonine	9.950	10.449	182.7430	0.083	0.0083	0.83	Essential
Cysteine	10.500	9.757	365.7600	0.166	0.0166	1.66	Non-essential
Isoleucine	11.300	8.968	207.0540	0.094	0.0094	0.94	Essential
Leucine	11.850	8.810	286.8250	0.130	0.0130	1.3	Essential
Aspartic Acid	13.466	7.177	151.1490	0.069	0.0069	0.69	Non-essential
Lysine	13.833	6.922	136.3580	0.062	0.0062	0.62	Essential
Glutamic Acid	15.500	18.644	1250.1540	0.566	0.0566	5.66	Non-essential
Histidine	17.233	41.512	3452.8490	1.564	0.1564	15.64	Essential
Methionine	19.166	10.405	149.4925	0.067	0.0067	0.67	Essential
Phenylalanine	19.950	8.177	118.8875	0.054	0.0054	0.57	Essential
Arginine	20.500	7.341	234.3850	0.106	0.0106	1.06	Non-essential
Tyrosine	21.416	6.603	227.3865	0.103	0.0103	1.03	Non-essential
Tryptophan	23.083	5.158	125.7830	0.057	0.0057	0.57	Essential

Figure 3 presents the chromatogram of the flesh of red *Capsicum chinense*, with amino acids eluting at different retention times and having various heights. Eighteen amino acids were identified as shown in table 2, nine essential and non-essential amino acids. Histidine was identified at 17.233 minutes and had a height of 41.512, the least non-essential was tyrosine having a height of 6.603. Moreover, serine was identified at a retention time of 7.233 minutes and had a height of 11.531. Serine is a non-essential amino acid that is indispensable as its numerous roles in the human body system cannot be over-emphasized. D- and L-serine are used by the body to create proteins. In the brain, D-serine also conveys

chemical messages [19]. As a result, it could aid in the treatment of schizophrenia and other mental illnesses. [20-21] stated that L-serine, which has long been thought to be a non-essential amino acid, may have a more crucial role in neurological development than previously thought, and that dietary reliance on endogenous L-serine is becoming more popular. From primary protein construction to cell signaling, L-serine plays a range of roles and activities, the latter predominantly through post-translational phosphorylation. L-serine deficiency can have serious consequences for your health, from the fetus to the elderly [19].

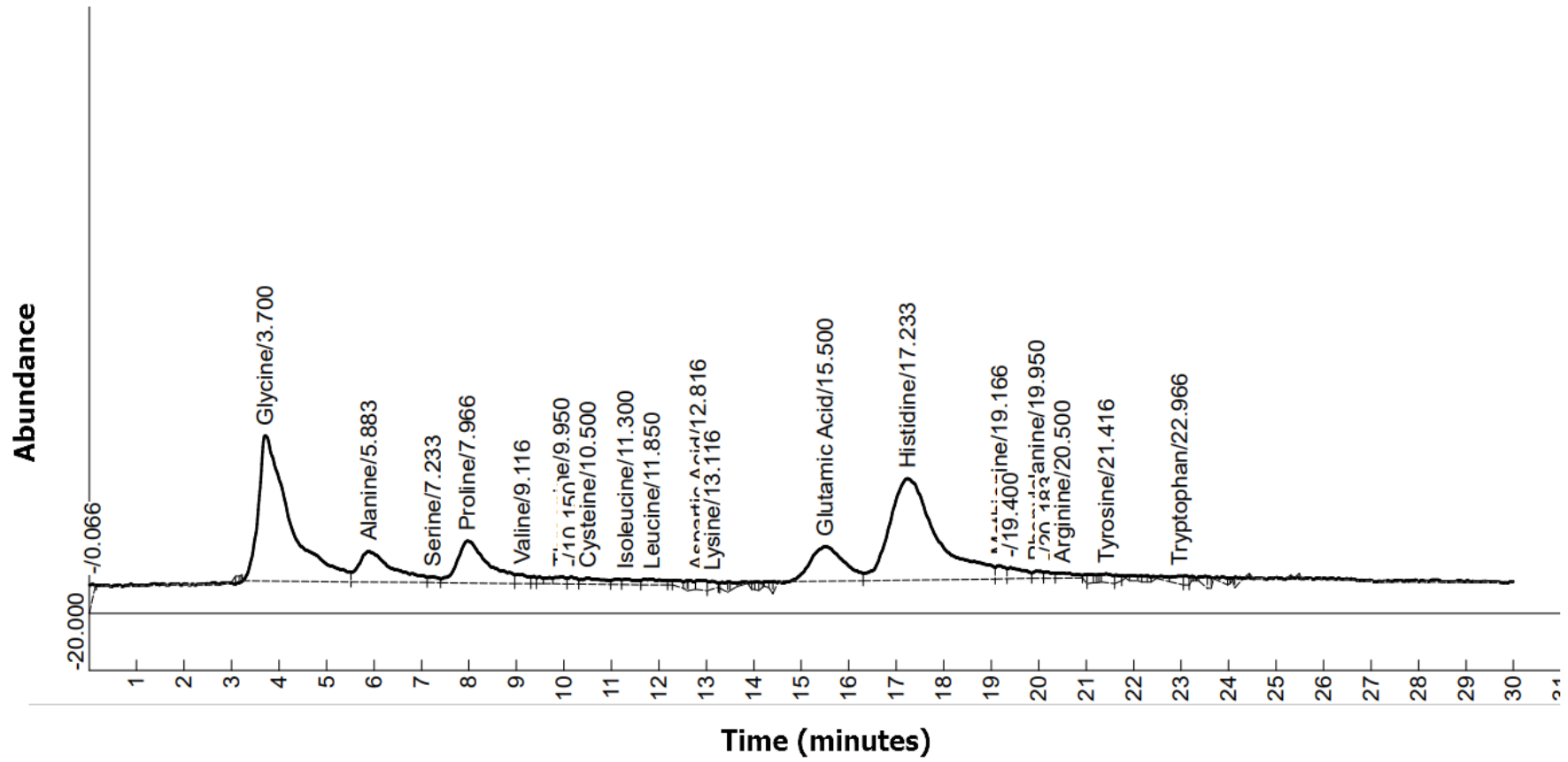


Figure 4. Chromatogram of amino acid of flesh and seed of *Capsicum chinense*

Table 4. Identified amino acid contents in flesh and seed of green *Capsicum chinense*

Amino acid	Retention time (minutes)	Height	Area	Concentration (mg/g)	Concentration (mg/10g)	Concentration (mg/kg)	Class of amino acid
Glycine	3.700	50.554	2323.5475	1.053	0.1053	10.53	Non-essential
Alanine	5.883	10.762	528.7710	0.240	0.024	2.4	Non-essential
Serine	7.233	2.071	30.9365	0.014	0.0014	0.14	Non-essential
Proline	7.966	14.644	658.7700	0.298	0.0298	2.98	Non-essential
Valine	9.116	3.167	56.0650	0.025	0.0025	0.25	Essential
Threonine	9.950	2.574	40.6420	0.018	0.0018	0.18	Essential
Cysteine	10.500	2.203	67.1000	0.030	0.0030	0.30	Non-essential
Isoleucine	11.300	1.882	38.6220	0.018	0.0018	0.18	Essential
Leucine	11.850	2.045	57.8010	0.026	0.0026	0.26	Essential
Aspartic Acid	12.816	3.291	48.8755	0.022	0.0022	0.22	Non-essential
Lysine	13.116	2.879	35.1770	0.016	0.0016	0.16	Essential
Glutamic Acid	15.500	12.133	593.2480	0.268	0.0268	2.68	Non-essential
Histidine	17.233	35.351	2439.4930	1.105	0.1105	11.05	Essential
Methionine	19.166	4.635	63.0700	0.029	0.0029	0.29	Essential
Phenylalanine	19.950	2.566	34.7900	0.015	0.0015	0.15	Essential
Arginine	20.500	1.840	48.2690	0.022	0.0022	0.22	Non-essential
Tyrosine	21.416	3.088	49.7325	0.023	0.0023	0.23	Non-essential
Tryptophan	22.966	2.740	42.1500	0.019	0.0019	0.19	Essential

From the chromatogram in figure 4, eighteen amino acids were identified at varied retention periods, with serine, a non-essential amino acid, being found with a retention time of 7.233 minutes and a height of 2.071. The retention durations for essential amino acids ranged from 9.116 minutes to 22.966 minutes, whereas non-essential

amino acids were retained for 3.700 minutes to 21.416 minutes. Among the other nine necessary amino acids, glutamic acid had the highest height of 12.133, while histidine had the highest height of 35.351 among the non-essential amino acids.

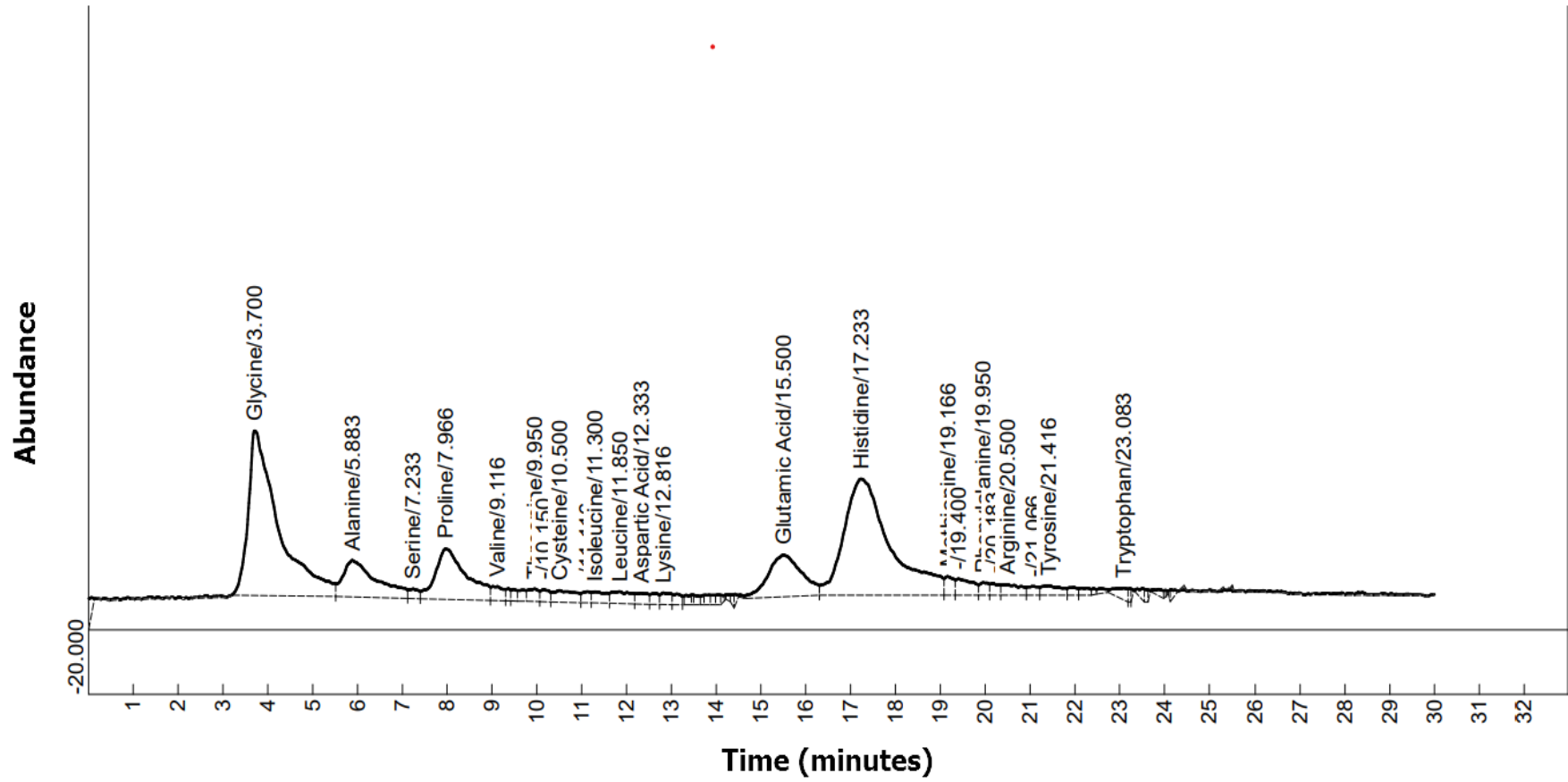


Figure 5. Chromatogram of amino acid of flesh green *Capsicum chinense*

Table 5. Identified amino acid contents in the flesh of green *Capsicum chinense*

Amino acid	Retention time (minutes)	Height	Area	Concentration (mg/g)	Concentration (mg/10g)	Concentration (mg/kg)	Class of amino acid
Glycine	3.700	51.057	2396.2990	1.085	0.0108	1.08	Non-essential
Alanine	5.883	11.399	597.2670	0.270	0.0270	2.70	Non-essential
Serine	7.233	2.946	45.8965	0.021	0.0021	0.21	Non-essential
Proline	7.966	15.649	756.8590	0.343	0.0343	3.43	Non-essential
Valine	9.116	4.376	80.2950	0.036	0.0036	0.36	Essential
Threonine	9.950	3.930	64.9330	0.029	0.0029	0.29	Essential
Cysteine	10.500	3.656	126.2800	0.057	0.0057	0.57	Non-essential
Isoleucine	11.300	3.476	77.3580	0.035	0.0035	0.35	Essential
Leucine	11.850	3.735	115.5840	0.052	0.0052	0.52	Essential
Aspartic Acid	12.333	3.396	65.3140	0.030	0.0030	0.3	Non-essential
Lysine	12.816	3.628	58.1110	0.026	0.0026	0.26	Essential
Glutamic Acid	15.500	12.969	675.6140	0.306	0.0306	3.06	Non-essential
Histidine	17.233	36.072	2576.4330	1.167	0.1167	11.67	Essential
Methionine	19.166	5.773	80.2750	0.036	0.0036	0.36	Essential
Phenylalanine	19.950	3.872	54.4625	0.025	0.0025	0.25	Essential
Arginine	20.500	3.265	97.7050	0.044	0.0044	0.44	Non-essential
Tyrosine	21.416	2.911	92.4475	0.042	0.0042	0.42	Non-essential
Tryptophan	23.083	3.632	68.2760	0.031	0.0031	0.31	Essential

From the result of figure 5, eighteen amino acids were revealed and presented in table 5. Glycine, a non-essential amino acid had the highest height of 51.057 while histidine, an essential, had a height of 36.072. It is worth noting that tyrosine had the least height, 2.911 and the role of tyrosine has been found to have a link with phenylalanine and they both play significant roles in body metabolism.

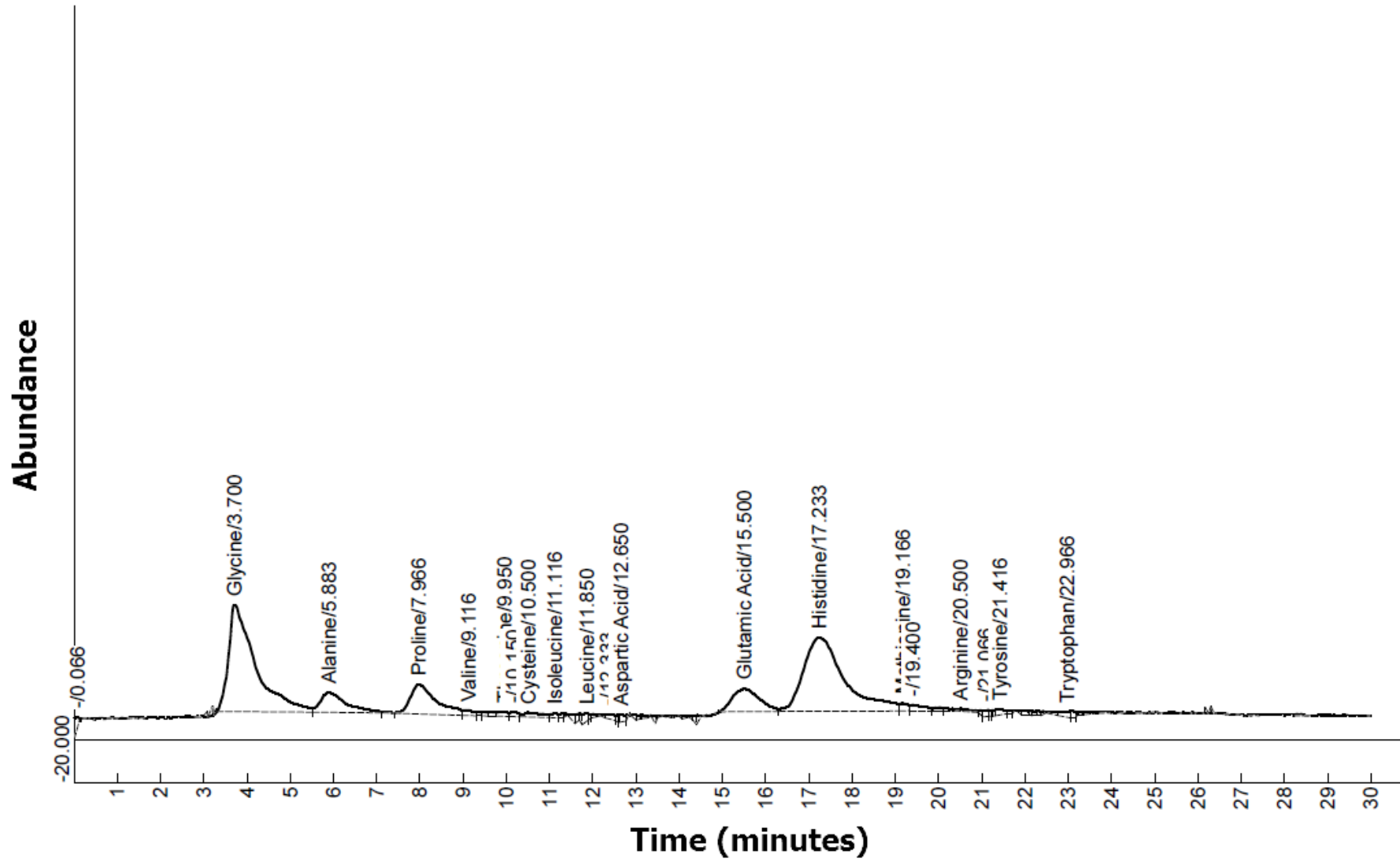


Figure 6. Chromatogram of amino acid of the seed of green *Capsicum chinense*

In the chromatogram of a green scotch bonnet pepper seed as shown in Figure 6, fifteen amino acids were detected at various retention times ranging from 3.700 minutes to 22.966 minutes as shown in Table 6. It was discovered that there are seven essential and eight

non-essential amino acids. At a retention time of 20.500 minutes, arginine, and a non-essential acid was identified and had the lowest height of 1.144 minutes, isoleucine, and an essential amino acid, had the lowest height of 2.020 among the essential amino acids present.

Table 6. Identified amino acid contents in the seed of green *Capsicum chinense*

Amino acid	Retention time (minutes)	Height	Area	Concentration (mg/g)	Concentration (mg/10g)	Concentration (mg/kg)	Class of amino acid
Glycine	3.700	49.020	2117.6495	0.959	0.0959	9.59	Non-essential
Alanine	5.883	9.229	381.6990	0.173	0.0173	1.73	Non-essential
Proline	7.966	13.547	563.3600	0.255	0.0255	2.53	Non-essential
Valine	9.116	2.502	42.8950	0.019	0.0019	0.19	Essential
Threonine	9.950	2.221	34.0630	0.015	0.0015	0.15	Essential
Cysteine	10.500	2.056	63.5000	0.029	0.0029	0.29	Non-essential
Isoleucine	11.116	2.020	24.7260	0.011	0.0011	0.11	Essential
Leucine	11.850	3.746	32.4900	0.014	0.0014	0.14	Essential
Aspartic Acid	12.650	3.417	27.7785	0.013	0.0013	0.13	Non-essential
Glutamic Acid	15.500	10.566	458.9600	0.208	0.0208	2.08	Non-essential
Histidine	17.233	34.006	2224.6475	1.008	0.1008	10.08	Essential
Methionine	19.166	3.537	46.6750	0.021	0.0021	0.21	Essential
Arginine	20.500	1.144	32.1700	0.015	0.0015	0.15	Non-essential
Tyrosine	21.416	2.553	36.8635	0.017	0.0017	0.17	Non-essential
Tryptophan	22.966	2.740	42.1500	0.019	0.0019	0.19	Essential

Table 7. Estimates of amino acid requirement ^a

Amino Acid	Requirements (mg/kg/day by age group)			
	Infants, age 3-4 months ^b	Children, Age 2 years ^c	Children, Age 10-12 years ^d	Adults ^e
Histidine	28	?	?	8-12
Isoleucine	70	31	28	10
Leucine	161	73	42	14
Lysine	103	64	44	12
Methionine plus cystine	58	27	22	13
Phenylalanine plus tyrosine	125	69	22	14
Threonine	87	37	28	7
Tryptophan	17	12.5	3.3	3.5
Valine	93	38	25	10
Total without histidine	714	352	214	84

Source: [22]

^a From WHO (1985).

^b Based on amounts of amino acids in human milk or cow's milk formulas fed at levels that supported good growth. Data from Fomon and Filer (1967).

^c Based on achievement of nitrogen balance sufficient to support adequate lean tissue gain (16 mg N/kg per day). Data from Pineda et al. (1981).

^d Based on upper range of requirement for positive nitrogen balance. Recalculated by Williams et al. (1974) from data of Nakagawa et al. (1964).

^e Based on the highest estimate of requirement to achieve nitrogen balance. Data from several investigators (reviewed in FAO/WHO, 1973).

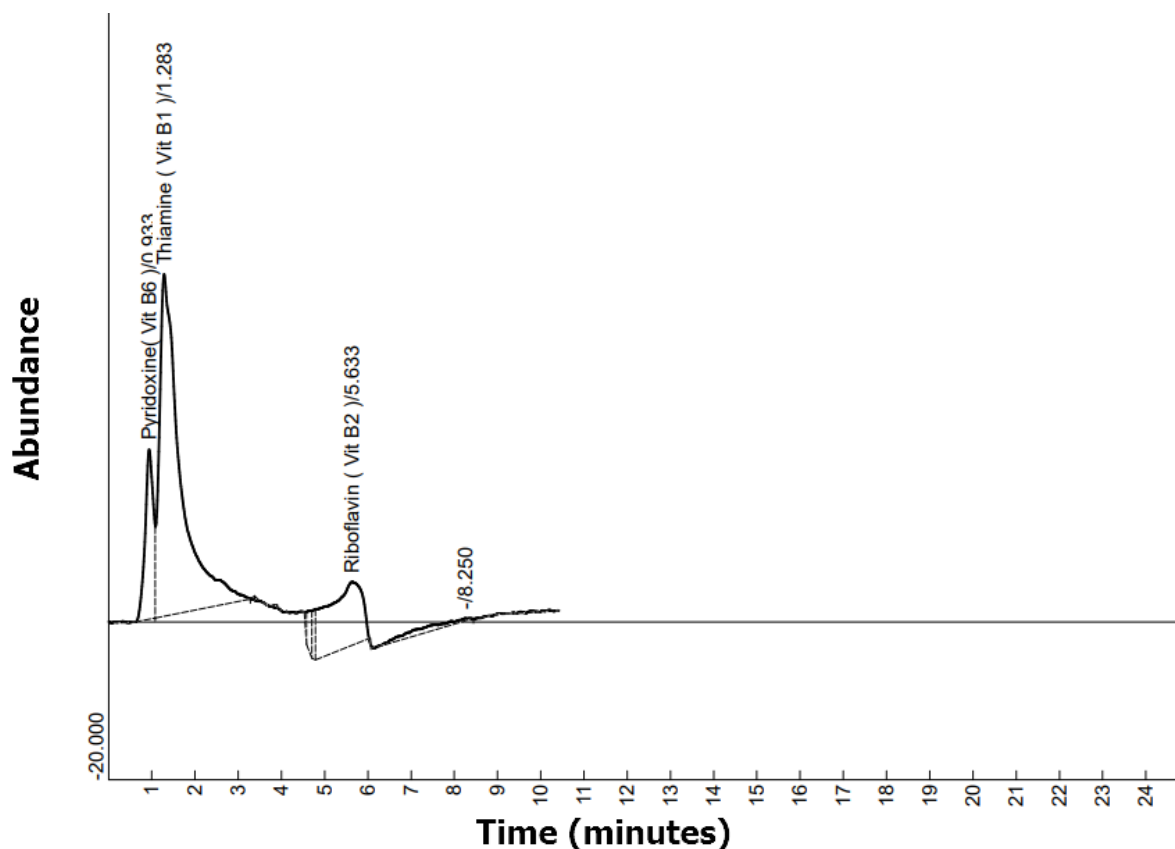


Figure 7. Chromatogram of Vitamins B₁, B₂, and B₆ of seed and flesh of red *Capsicum chinense*

Table 8. Identified Vitamins B₁, B₂, and B₆ contents of seed and flesh of red *Capsicum chinense*

Class of vitamin	Name of vitamin	Retention time (minutes)	Height	Area	Concentration (mg/g)	RDA (mg/g) (Men, 50 yrs old)	RDA (mg/g) (Women, 50 yrs old)
Vit B ₆	Pyridoxine	0.933	21.519	279.5770	0.315	1.7	1.5
Vit B ₁	Thiamine	1.283	43.285	1468.4340	1.655	1.2	1.1
Vit B ₂	Riboflavin	5.633	7.995	467.5300	0.527	1.3	1.1

The glycine content of red scotch pepper flesh is the greatest (17.89 mg/kg), followed by the flesh and seed (11.90 mg/kg), and the seed (11.64 mg/kg), as shown in Tables 1, 2, and 3. The Histidine concentration in the seed and meat of red scotch pepper was higher than adult requirements (mg/kg/day) (8-12 mg/kg) [22], as indicated in table 7. Both the seed and the flesh had 14.8 mg/kg, with the seed having 12.2 mg/kg and the flesh 15.64 mg/kg. Other amino acids in the red scotch pepper were significantly below adult requirements. Tables 4, 5, and 6 showed that the histidine content of seed and flesh, flesh

and seed of green scotch pepper was lower than that required when compared to table 7.

The chromatograms of vitamins B₁, B₂, and B₆ were exhibited in Figure 7, and their varying retention times (minutes), heights, and vitamin names were listed in Table 8. The vitamins were eluted at various retention times ranging from 0.933 to 5.633 minutes, with heights varying from 21.519 to 7.995. The vitamin B₁ concentration in the seed and meat of red scotch pepper is, however, more than the RDA for both men and women aged 50 and over.

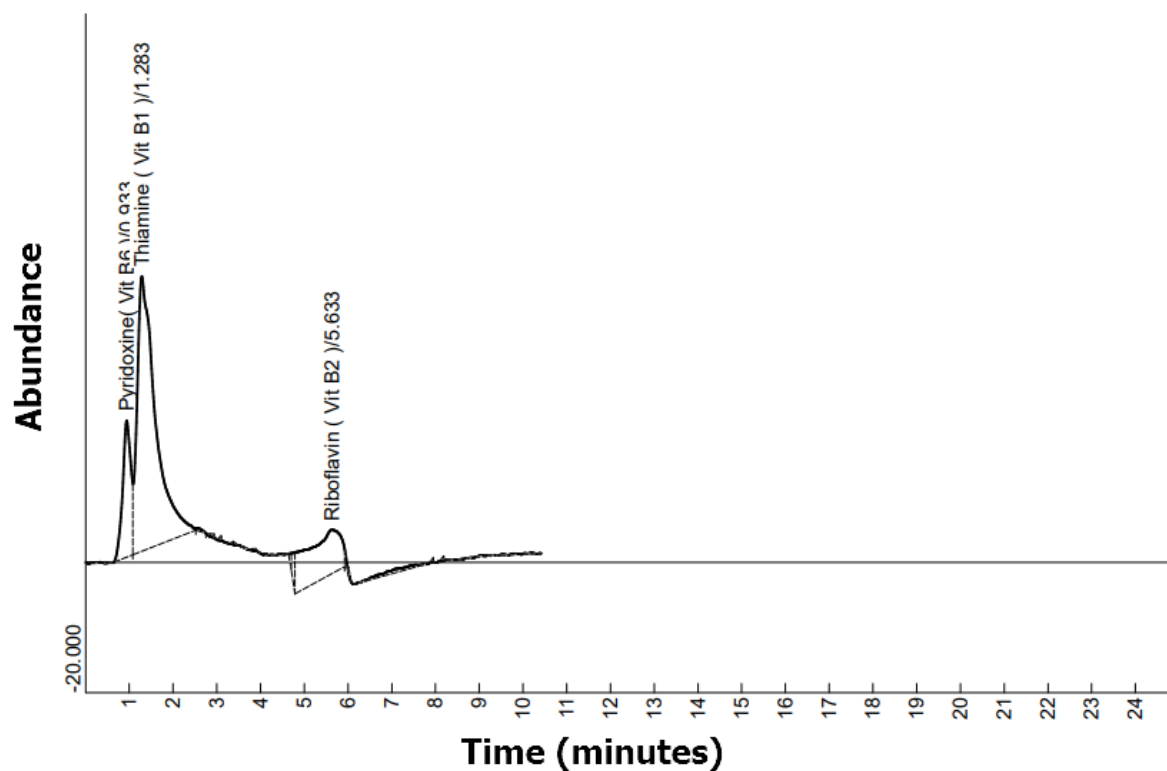


Figure 8. Chromatogram of Vitamins B₁, B₂, and B₆ of the seed of red *Capsicum chinense*

Table 8. Identified Vitamins B₁, B₂, and B₆ contents in the seed of red *Capsicum chinense*

Class of vitamin	Name of vitamin	Retention time (minutes)	Height	Area	Concentration (mg/g)	RDA (mg/g) (Men, 50 yrs old)	RDA (mg/g) (Women, 50 yrs old)
Vit B ₆	Pyridoxine	0.933	21.053	270.1110	0.3046	1.7	1.5
Vit B ₁	Thiamine	1.283	42.282	1242.7780	1.400	1.2	1.1
Vit B ₂	Riboflavin	5.633	6.728	394.5710	0.445	1.3	1.1

Figure 8 depicts the chromatogram of the seed of red scotch bonnet pepper, and B vitamins, with their identities provided in table 9. At various retention times and heights, the three vitamins B₁, B₂, and B₆ were detected. The RDA of vitamin B₁ is less than that of the seed of the red *Capsicum chinense*.

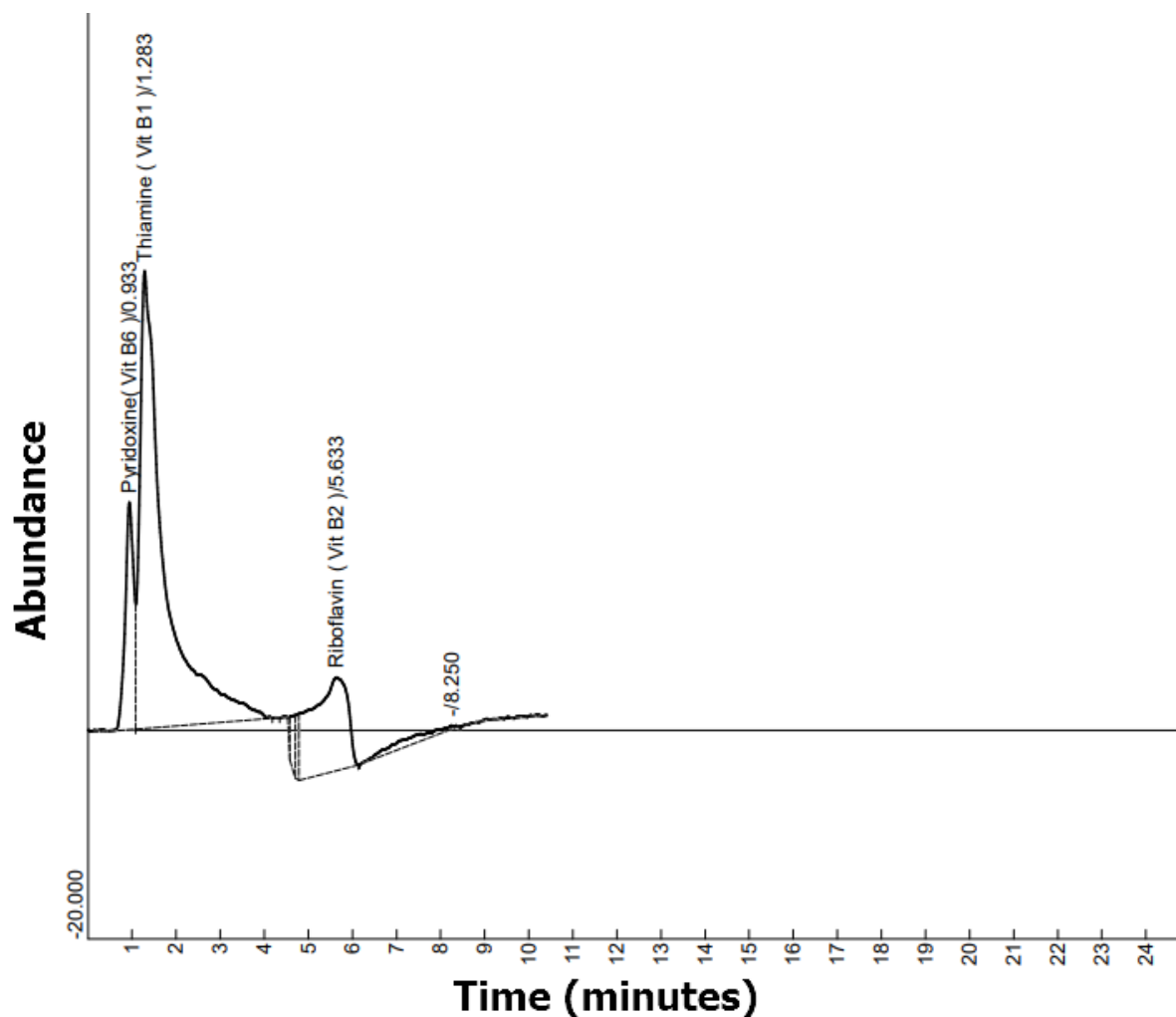


Figure 9. Chromatogram of B Vitamins of the flesh of red *Capsicum chinense*

Table 10. Identified Vitamins B₁, B₂, and B₆ contents in the flesh of red *Capsicum chinense*

Class of vitamin	Name of vitamin	Retention time (minutes)	Height	Area	Concentration (mg/g)	RDA (mg/g) (Men, 50 yrs old)	RDA (mg/g) (Women, 50 yrs old)
Vit B ₆	Pyridoxine	0.933	21.800	286.0365	0.323	1.7	1.5
Vit B ₁	Thiamine	1.283	43.829	1686.2190	1.901	1.2	1.1
Vit B ₂	Riboflavin	5.633	8.924	521.5775	0.587	1.3	1.1

Figure 9 depicts the B vitamin spectrum of flesh red scotch bonnet pepper, whereas table 10 lists the names, retention time, and height of the vitamins. With a retention time of 1.283 minutes, Vitamin B₁ has a maximum height of 43.829. The vitamin B₁ of the flesh is higher than that of the RDA for both men and women of 50 years and above.

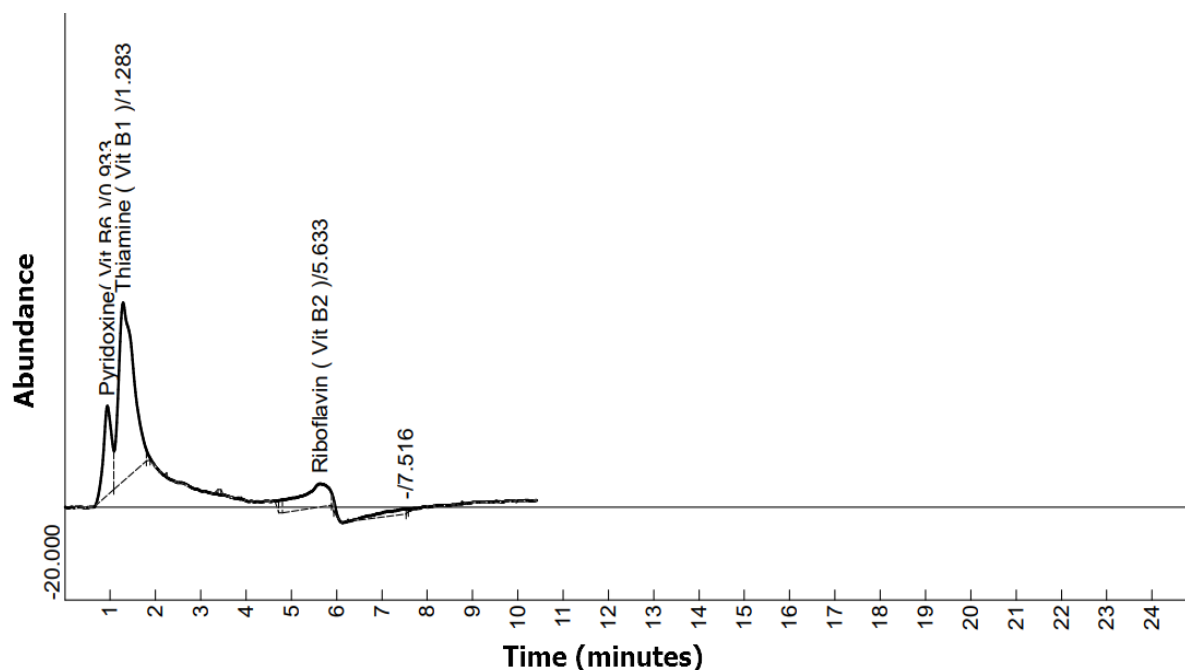


Figure 10. Chromatogram of Vitamins B₁, B₂, and B₆ of flesh and seed of green *Capsicum chinense*

Table 11. Identified B Vitamins contents in flesh and seed of green *Capsicum chinense*

Class of vitamin	Name of vitamin	Retention time (minutes)	Height	Area	Concentration (mg/g)	RDA (mg/g) (Men, 50 yrs old)	RDA (mg/g) (Women, 50 yrs old)
Vit B ₆	Pyridoxine	0.933	19.322	235.4840	0.265	1.7	1.5
Vit B ₁	Thiamine	1.283	38.460	880.5575	0.993	1.2	1.1
Vit B ₂	Riboflavin	5.633	4.955	225.3595	0.254	1.3	1.1

Figure 10 shows a chromatogram of the flesh and seed of a green *Capsicum chinense*, and table 11 shows the characteristics of discovered B vitamins at various retention times and heights. Vitamin B₂ is the shortest, with a height of 4.955. B vitamins are required for the efficient functioning of the methylation cycle, according to [23] and a decrease in methylation function leads to persistent neurological problems. Anti-inflammatory

qualities are found in thiamine, riboflavin, and pyridoxine, and their lack results in a variety of immunological diseases. The vitamin contents of the flesh and seed of green *Capsicum chinense* are lower than that of the RDA, an indication that the flesh and seed is safe for consumption. Scientists can isolate thiamine from the flesh and seed based on the foregoing findings for the treatment of patients who are in desperate need of it.

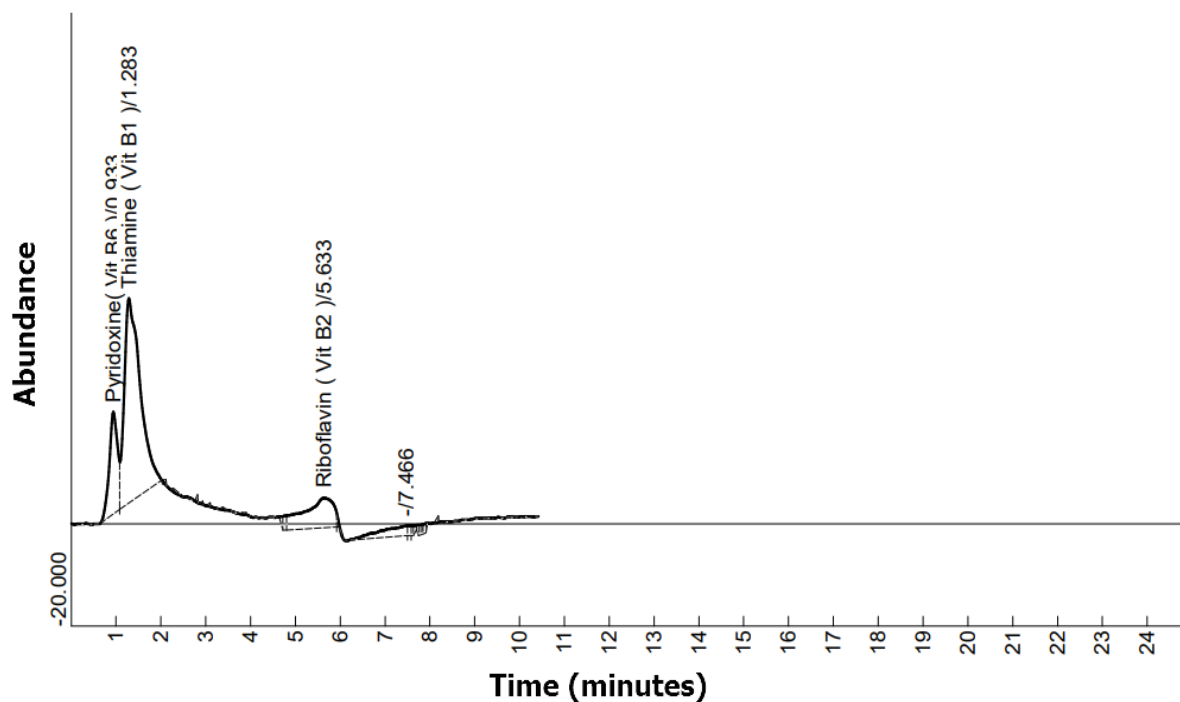


Figure 11. Chromatogram of Vitamins B₁, B₂, and B₆ of the flesh of green *Capsicum chinense*

Table 12. Identified Vitamins B₁, B₂, and B₆ contents in the flesh of green *Capsicum chinense*

Class of vitamin	Name of vitamin	Retention time (minutes)	Height	Area	Concentration (mg/g)	RDA (mg/g) (Men, 50 yrs old)	RDA (mg/g) (Women, 50 yrs old)
Vit B ₆	Pyridoxine	0.933	20.003	248.8485	0.281	1.7	1.5
Vit B ₁	Thiamine	1.283	40.007	995.8725	1.122	1.2	1.1
Vit B ₂	Riboflavin	5.633	5.827	269.3545	0.304	1.3	1.1

Table 12 lists the features of the identified B vitamins, including the spectrum (see figure 11), as well as the qualities of the revealed vitamins, such as retention period, vitamin name, and height. Vitamin B₂ has the shortest height of 5.827 and the shortest retention duration of 5.633 minutes. The concentration of the vitamins (mg/g) when

compared to the RDA, they were lower and this implies that the flesh of green pepper is safe for consumption at that concentration. It's worth noting that thiamine can be extracted from the flesh of green *Capsicum chinense* and used to treat people who are deficient in the vitamin.

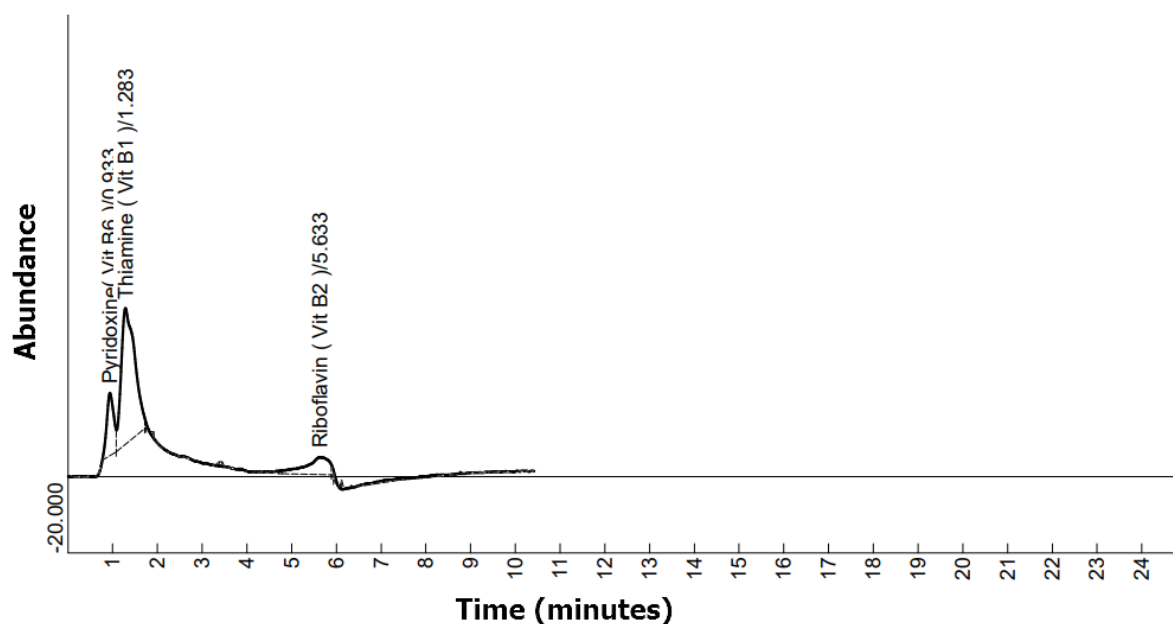


Figure 12. Chromatogram of Vitamins B₁, B₂, and B₆ of the seed of green *Capsicum chinense*

Table 13. Identified Vitamins B₁, B₂, and B₆ contents in the seed of green *Capsicum chinense*

Class of vitamin	Name of vitamin	Retention time (minutes)	Height	Area	Concentration (mg/g)	RDA (mg/g) (Men, 50 yrs old)	RDA (mg/g) (Women, 50 yrs old)
Vit B ₆	Pyridoxine	0.933	16.429	174.0100	0.196	1.7	1.5
Vit B ₁	Thiamine	1.283	35.609	747.2020	0.842	1.2	1.1
Vit B ₂	Riboflavin	5.633	4.505	162.7630	0.184	1.3	1.1

Figure 12 depicts the B vitamin spectrum, with the kind, name, retention time, and height listed in table 13. The retention duration ranged from 0.933 to 5.633 minutes, with vitamin B₁ having the maximum height of 35.609. The vitamin B₁, B₂, and B₆ concentration of the green scotch pepper seed was below the RDA, indicating that the seed is safe to eat.

4. Discussion

The pharmacological importance of amino acids in the human body system has severally been presented by scholars. Proteins are made up of amino acids, which play a crucial part in biological functioning. When the flesh and seed of red and green scotch bonnet peppers were compared, it was discovered that when submitted to HPLC with a UV detector, seventeen amino acids were found in the red counterpart (see table 1), whereas eighteen amino acids were identified in the green counterpart (see table 4). Serine was not found in the red of seed and flesh, but it was found in the green. Green *Capsicum chinense* have nine essential and non-essential amino acids each in their seed

and flesh, whereas red scotch bonnet peppers have only nine essential and eight non-essential amino acids.

Further comparisons reveal that the seed of red scotch bonnet pepper contain varying amounts of amino acids. The seed of the red *Capsicum chinense* contains eighteen amino acids, nine of which were essential and nine non-essential as shown in table 2, whereas the seed of the green scotch bonnet pepper contained only fifteen acids, seven of which were essential and eight of which were non-essential, as shown in table 6. The seed of the green *Capsicum chinense* is devoid of serine, lysine, and phenylalanine (see table 6). When compared to the seed of red, this indicates that the red seed has more pharmacological benefits.

Furthermore, both red (Table 3) and green (table 5) flesh contain the same quantity of acids, namely eighteen amino acids. There are nine essential and non-essential items in all. Although both essential and non-essential acids contain serine, the heights of the essential and non-essential acids differ.

The role of amino acids has been well discussed by researchers. In all the investigated parts, glycine is present and its numerous roles have been enumerated. All the nine

essential acids identified have been found to possess various health benefits, among these is leucine, which according to [23] is said to be an activator of rapamycin's mammalian target (mTOR), and the possibility of leucine as a dietary supplement for treating obesity and diabetes mellitus has been examined and found to be promising [23]. Other essential acids with various health benefits include isoleucine, which serves a variety of functions in the body. It has some similarities to leucine in terms of blood glucose regulation and wound healing, but it also has some distinct roles. Isoleucine aids in the detoxification of nitrogenous wastes such as ammonia, which are then expelled by the kidneys [24]. The critical significance of tryptophan in various metabolic activities has been reported by [25]. Clinicians can utilize tryptophan levels to diagnose a variety of metabolic problems and the symptoms that go along with them [26]. Its importance in the proper functioning of the brain-gut axis and immunology is firmly suggested by the literature [26]. According to [27], circulating valine levels could be a new biomarker for T2D, and restoring valine levels could be a viable diabetic treatment method. According to [28], threonine protects the digestive system by forming a mucus gel layer that covers it and acts as a barrier against harmful digestive enzymes. This vital amino acid also promotes the protective effects of the gut mucus barrier, which helps to maintain a healthy gut function. L-histidine (HIS) is an important amino acid that plays a function in proton buffering, metal ion chelation, reactive oxygen and nitrogen species scavenging, erythropoiesis, and histaminergic system, among other things.

Several decades of experience have proven the efficacy of HIS as a component part of cardiac surgical treatments for organ preservation and myocardial protection [29], the histidine contents of seed and flesh, flesh and seed of green scotch pepper were all lower than that of requirements for adults (8-12 mg/kg/day). However, the flesh of green scotch pepper was the highest (11.67 mg/kg) while the seed had 10.08 mg/kg and the histidine content of the green *Capsicum chinense* is an indication that the compound can be isolated from either the seed, flesh or both for the treatment of ailments associated with histidine therapy. The availability of different forms of non-essential amino acids in the investigated samples has shown that both the seed and flesh of red and green *Capsicum chinense* are rich and can serve varying purposes for the general well-being of humans. [30] had reported that glycine is a precursor for various low-molecular-weight metabolites, including creatine, glutathione, haem, purines, and porphyrins. Glycine is an amino acid that improves human and animal health and promotes growth and well-being. Numerous studies attest to the function of supplemental glycine in the prevention of a variety of diseases and disorders, including cancer [31]. Treatment of metabolic abnormalities in individuals with cardiovascular disease, numerous inflammatory illnesses, obesity, malignancies, and diabetes with dietary supplementation of a correct amount

of glycine is effective. Glycine can improve sleep quality and neurological processes [32]. It is worth mentioning that the identified essential amino acids can be replaced in human system by the consumption of the seed and flesh *Capsicum chinense*, the concentrations of the amino acids were all below the requirements for the adults as presented in table 7.

Further investigation of the *Capsicum chinense* for its B vitamins content showed the presence of vitamins B₁, B₂, and B₆ in both the flesh, seed, and seed and flesh of red and green *Capsicum chinense*. Functions of B vitamins have been enumerated. Vitamin B₁ (thiamine) is required by the body for proper carbohydrate digestion. Thiamine is an immune system stimulant that may help prevent type 2 diabetes, cardiovascular disease, aging-related disorders, visual problems (such as cataracts and glaucoma), renal disease, cancer, neurological diseases (such as Alzheimer's disease), as well as mental disorders (depression) [33-36]. Vitamin B₂ (riboflavin) is a potent antioxidant that helps to maintain healthy blood cells, stimulates metabolism, and increases energy levels. Riboflavin deficiency causes stomatitis, migraines, poor cognitive outcomes, depression, and personality issues [35]. It can be found in dairy products, vegetables, eggs, cereals and meat. Riboflavin contains anti-inflammatory effects and has a role in oxidative metabolism [35]. Pyridoxine, pyridoxal (three forms in tissues), pyridoxamine, pyridoxal-5-phosphate (the primary active form), 4-pyridoxic acid (the main excretory form), and pyridoxine hydrochloride are the six chemicals that make up vitamin B₆ (the main form in supplements). Pyridoxine is required for haemoglobin synthesis, as well as the generation of neurotransmitters like serotonin, dopamine, and melatonin [36-39].

5. Conclusions

From the results of the amino acids, it can be inferred that the seed and flesh of green pepper are richer than that of its red counterpart. This may not be unconnected to the presence of serine and the availability of eighteen amino acids in the seed and flesh of the green pepper compared to seventeen available in the red of seed and flesh. B vitamins are abundant in all of the classes studied, with vitamins B₁, B₂, and B₆ being particularly abundant.

Recommendation

The positive results of amino acids and vitamin B₁, B₂, and B₆ in the flesh of green *Capsicum chinense* indicate that the flesh is the most nutritious part of peppers. The concentrations of histidine and glutamic acid were higher than others, as were the contents of flesh B- vitamins, which compare favourably to the RDA for both men and women over 50.

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