Original Research Article

Physico-chemical and Fourier Transform Infrared Spectra Analysis of Sweet Italian (*Capsicum annuum*) and Habanero (*Capsicum annuum*) Peppers Consumed in Benue State, Nigeria

ABSTRACT

This study investigates the physico-chemical and Fourier transform infrared spectra of Sweet Italian (*Capsicum annum*) and Habanero (*Capsicum chinense*) pepper varieties. The two varieties of pepper were harvested fresh and dried using local drying equipment and ground into powder using a laboratory blender. The proximate composition results showed that the Sweet Italian pepper (SIP) possessed higher moisture (8.89%), crude fat (5.33%), crude protein (9.32%) and carbohydrate (51.5%) contents than the Habanero pepper (HNP). SIP showed higher content of the major (Na, K, Mg, Ca & P) and trace (Fe, Zn, Cu and Mn) minerals when compared to the HNP. The results of the infrared spectrum analysis of the two varieties of SIP and HNP showed that these pepper varieties had similar infrared spectra lines that are dominated by alcohol/phenol groups, alkanes, alkenes and amine groups, corresponding to the frequencies in the range 3435.44-675.11 cm^{-1} for the phenols, 1037, 1379-1458 $cm^{-1}$for the alkanes group, 1637.62-920.08$cm^{-1}$for the alkenes and 719.47-817.57 $cm^{-1}$for amine groups. The result indicated that the two varieties of peppers SIP and HNP having similar spectra lines, may also possess similar structural properties.

Keywords: Proximate Composition, Mineral, FTIR, Sweet, Italian, Habanero, and pepper.

INTRODUCTION

Proximate composition evaluates the content of the six macronutrients in foods including moisture, protein, fats, fibre, ash and carbohydrates. The significance of determining the moisture content of food products helps a lot of people to know about the food product characteristics, including its physical appearance, texture, taste and weight, in addition to the food product shelf-life/stability, freshness and resistance to bacterial contamination [1]. Moisture content in dried foods should be ≤ 12 % for prolong shelf-life and storage stability [2]. Protein is very essential for body building and repair of worn out body tissues, in addition, its presence in peppered food product will help reduce the problem of protein-energy malnutrition for all ages in a population suffering this challenge [3].

The advantage of having low fat content in pepper is that its keeping quality will be enhanced as lipid peroxidation will minimally occur. In contrast, high amount of fats in pepper could provide energy for physical and physiological activities but could result in rancidity. Excess fats could also be extracted for use as essential oil for treatment of skin diseases and provide relieve from swollen body parts [4]. Crude fibres are broadly defined as non-starch polysaccharides and possess varying physicochemical properties depending on their chemical composition. Fibre has been reported to have an attenuating effect on appetite by increasing satiety thus reducing the amount of food consumed by individuals [5]. The diets rich in fibre such as fruits and vegetables have been reported to have a positive effect on health improvement since regular consumption has been linked to decreased incidences of several diseases such diabetes and cardiovascular events [6]. Fibre is an important nutrient in the body useful for colon nutrition for ease of feacal passage

through gastrointestinal tract for egestion [7]. Ash is a measure of mineral content in food material [8]. Most of the energy in a diet comes from carbohydrates. Carbohydrates provide the major source of the most easily available energy in the diet. The Institute of Medicine recommends that we should consume between 45–65% of total calories which should come from carbohydrates [9].

Mineral content *of food are the essential macronutrient that* plays a central role in the normal regulation of blood pressure [10] and to regulate the body homeostasis via the Na^+/K^+ pump which also promotes the proper functioning of the brain [11]. It is also involved in the regulation of the fluid balance of the body and hence, influences the cardiac output.(sodium and potassium), Calcium is one of the important macronutrients relevant in the building of strong bones and teeth [12]. Calcium is also very essential in muscle contraction, oocyte activation, blood clotting, nerve impulse, transmission and in regulation of heart beat [13]. It is also important in circulatory system, extracellular fluid, muscle and other tissues is critical for mediating vascular contraction and vasodilatation, muscle function, nerve transmission, intracellular signaling and hormonal secretion and the body to obtains calcium from the bone tissues which serves as a reservoir for source for these critical metabolic needs through the process of bone remodeling [14].

Magnesium is very important in the body because of its involvement in the respiratory process in the body [15]. Literature has provided extensive evidence of widespread magnesium deficiency the need for magnesium replenishing its content in diverse medical conditions. Magnesium is an essential element required as a cofactor for over 300 enzymatic reactions and thus important in the biochemical functioning of numerous metabolic pathways. Iron is an essential component of hemoglobin and myoglobin and thereby facilitates the transport, transitional tissue storage and cellular use of oxygen. It also has important roles in cytochromes within mitochondria, mediating the transfer of electrons in the electron transport chain [16-18]. Zinc is very important in the body and helps the immune system fight off the invading bacteria and viruses. During pregnancy, infancy and childhood, the body needs zinc for proper growth and development. Zinc also helps wounds heal and is important for proper senses of taste and smell [12]. Copper is very important in the absorption of iron and therefore has a very important role in preventing anemia. This trace element helps in the use of iron for the transport of hemoglobin. Copper helps to form collagen and melanin and is indispensable in diets for skin and hair care [19]. Manganese also helps the body to utilize a number of vitamins such as choline, thiamine and vitamin C and E and ensures proper liver function [19].

FT–IR spectra is used recently in research for fast detection of the natural active compounds in plants and animals tissues. The utilization of Fourier transform-infrared spectroscopy (FTIR) as an essential technique has been widely employed [20] and becomes handy for research into medicinal plants, [21, 22] human disease [23-28] also forensic science [29-31] and food characterization due to its nondestructive nature as well as allowance for easy identification [32, 33]. The present study sought to encourage the detection components and other relative compounds in the two pepper varieties in short time at minimal cost using FT-IR detection.

2.0 MATERIALS AND METHODS

2.1 Source of Materials

The two varieties of pepper, Sweet Italian (*Capsicum annum*) and Habanero (*Capsicum annum*) were harvested fresh from local farms in Makurdi metropolis in their ripened stage and dried using local drying equipment and milled into powder using a laboratory blender.

2.2 Processing of Pepper Powder

The modified method of [34] was used for pepper powder production as shown in Figure 1. The red pepper were selected to uniform sizes, shapes, and without any defect on visual inspection and thoroughly cleaned before manually sorting. The sorted red peppers were washed in cold water to remove soil and dust particles. The thoroughly cleaned samples were manually graded on the basis of their size. Washed red peppers were sliced with knives as approximate sizes of 15 mm x 15 mm of uniform slices with thickness of 2–4 mm. After slicing, the slices were blanched with hot water at 95 °C for 3-5 min. The method of blanching is similar to that of [35, 36].The blanched slices were dried using locally fabricated electric dryer, where the red pepper slices were spread on the shelves of the drying bin and the hot air was passing through these dryer upward from the electric air collectors at the temperatures between 65-70 ºC. Drying time and final moisture content for product was controlled. Also, the red pepper slices were shifted alternatively inside the electric bin in order to give the same chance for the red pepper slices to have the same drying conditions. The red pepper was ground and kept until used.

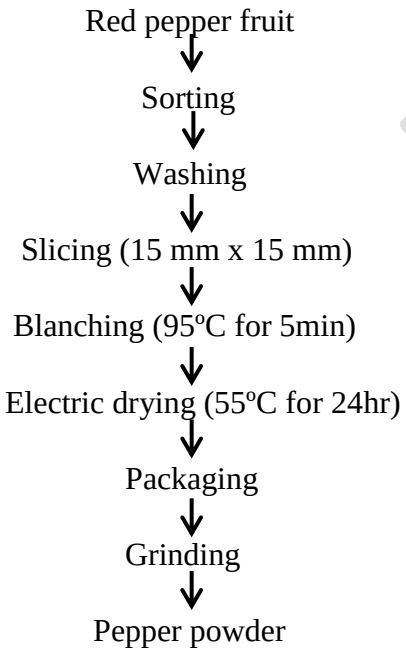

Fig. 1: Flow chart for pepper powder preparation.
Source: [34]

2.3 Functional Properties of Sweet Italian and Habanero peppers

2.3.1 Determination of bulk density (BD) of the pepper powders

The method of [37] was used to determine the bulk density of the pepper powders. A 10ml capacity graduated measuring cylinder was gently filled with the sample and the bottom of the cylinder was tapped on the laboratory bench several times until there no further diminution of the sample level after filling to the 10ml mark. Bulk density was calculated by using the formula,

$$\text{Bulk density (g/ml)} = \frac{Weight\ of\ sample\ \ (g)}{Volume\ \ of\ sample\ \ (ml)} \quad \text{.....[1]}$$

2.3.2 Determination of water absorption capacity of the pepper powders

Water absorption capacity was determined using the procedure of [38]. One gram of the sample was mixed with 10 ml distilled water for 5 min on a magnetic stirrer. The mixture was centrifuged at 3500 rpm for 30 min and the volume of the supernatant noted. WAC was calculated using as thus;

Water absorption capacity= volume of distilled water×100/weight of sample used

2.3.3 Determination of oil absorption capacity of the pepper powders

One gram of sample was weighed, 10 ml of vegetable oil of a known density (0.99 mg/ml) was added to the sample and the mixture stirred on a magnetic stirrer at 1000 rpm for 5 min. The mixture was centrifuged at 3500 rpm for 30 min and the supernatant removed and measured with 10 ml measuring cylinder [38]. The OAC was calculated

Oil absorption capacity = volume of oil absorbed ×density×100/weight of sample used

2.3.4 Determination of the foaming capacity of the pepper powders

Foaming capacity (FC) was determined by the method of [39]. One gram flour sample was added to 50ml distilled water at ambient temperature in a graduated cylinder. The suspension were mixed and shaken for 5min to foam. The volume of foam at 30secs after whipping was expressed as foam capacity using the formula:

Where AW = after whipping, BW = before whipping.

2.3. 5 Determination of swelling index of the pepper powders

The method of [40] was used to determine the swelling power of the experimental flours in duplicate. One gram of flour samples was mixed in a varl-whirl mixer with 10ml of distilled water for 30 seconds and allowed to stand for 30 minutes at ambient room temperature (29^0C) before being centrifuged at 5,000 rpm for 30 minutes. Measuring out thevolumes of the supernatants was used to find the volumes of the remaining absorbed liquids. Multiplication of the respective absorbed volumes by the respective liquid density (mass/volume) was used to get the expression in g liquid/g sample.

2.3. 6 Determination of gelation temperature of the pepper powders

The water absorption capacity was done according to the method described by [38].A suspension of 10% of the sample in a test tube was prepared and the aqueous suspension in a boiling water bath, with continuous stirring was heated. The temperature 30secs after gelatinization was visually noticed as the gelatinization temperature was recorded.

2.3.7 Reconstitution index

Reconstitution Index was done following the method described by [38]. 5g of pepper powder each was dissolved in 40Ml of boiling water. The mixture was agitated for 90 seconds and transferred into a 50 ml of the cylinder and the volume of the sediment recorded after settling for 30 min.

2.3.8 Wettability

Wettability was determined according to the method described by [38]. 10g of pepper was weighed into a clean, dried measuring cylinder (10Ml). The cylinder was inverted and clamped at height of 10cm from the surface of a 600Ml beaker containing 500Ml distilled water. The flour in the cylinder was gradually spread on the surface of water at a moderate speed. The time taken for the sample to completely wet was noted as wettability.

2.4 Determination of Proximate Composition of Pepper Powders

2.4.1 Determination of moisture content of pepper powders

The moisture content was determined by hot air oven method as described by [37]. Empty crucible was weighed and 2g of the sample was transferred into the crucible. This was taken into the hot air oven and dried for 24 hours at 100^0C. The loss in weight was regarded as moisture content and expressed as:

$$\%\ Moisture\ \frac{W2-W1}{W}\ X\ 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [2]$$

Where:

W_2=Weight of the crucible and dry sample;

W_1=Weight of empty crucible

W=Weight of the sample

2.4.2 Determination of crude protein of pepper powders.

The micro Kjedahl method described by [37] was used to determine crude protein. Two grams of the sample was put into the digestion flask. A gram of copper sulphate and sodium sulphate (catalyst) in the ratio 5:1 respectively and 25ml concentrated sulphuric acid was added to the digestion flask. The flask was placed into the digestion block in the fume cupboard and was heated until frothing ceased giving clear and light blue green colouration. The mixture was then allowed to cool and diluted with distilled water until it reaches 250ml of volumetric flask. Distillation apparatus was connected and 10ml of the mixture was poured into the receiver of the distillation apparatus, also 10ml of 40% sodium hydroxide was added. The released ammonia by boric acid was then treated with 0.2M of hydrochloric acid until the green colour changed to purple. Percentage of nitrogen in the sample was calculated using the formula:

Crude protein = % Total Nitrogen = (Titre blank) x Normality x N_2.

Nitrogen factor = 6.25

Crude protein= % total Nitrogen X 6.25

2.4.3 Determination of crude fat of pepper powders

The Soxhlet extraction method described by [37] was used in determining the crude fat content of the samples. Two grams of the sample was weighed and the weight of the flat bottom flask

taken with the extractor. Mounted on it, the thimble was held half way into the extractor and the weight of sample. Extraction was carried out using boiling point 60^0C. The thimble was plugged with cotton wool. At completion of extraction which lasted for 8 hours, the solvent was removed by evapouration on a water bath and remaining part in the flask was dried at 80^0C for 30 minutes in the air oven to dry the fat then cooled in a desiccator. The flask was reweighed and percentage fat was calculated as thus:

$$\% \text{ fat} \frac{Weight\ of\ extracted\ \ fat}{Weight\ of\ sample} X\ 100 \ldots\ldots\ldots\ldots\ldots [3]$$

2.4.4 Determination of ash content of pepper powders

The [37] method for determining ash content was used. Two (2) grams of sample was weighed into an ashing dish which had been pre-heated, cooled in a desiccator and weighed soon after reaching room temperature. The crucible and content was then heated in a muffle furnace at 550°C for 6-7 h. The dish was cooled in a desiccator and weighed soon after reaching room temperature. The total ash was calculated as percentage of the original sample weight.

$$\% \ Ash = \frac{(W3-W1)}{(W2-W1)}\ x\ 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (4)$$

Where: W1 = Weight of empty crucible, W_2 = Weight of crucible + sample before ashing,

W_3 = Weight of crucible + content after ashing.

2.4. 5 Determination of crude fiber of pepper powders

The method described by [37] was used for fibre determination. Two (2) grams of the sample was extracted using Diethyl ether. This was digested and filtered through the California Buchner system. The resulting residue was dried at 130 ± 2^oC for 2 h, cooled in a desiccator and weighed. The residue was then transferred in to a muffle furnace (Shanghai box type resistance furnace, No.:SX2-4-10N) and ignited at 550^oC for 30 min, cooled and weighed. The percentage crude fibre content was calculated as:

$$\% \ Crude\ fibre\ \ = \frac{Loss\ in\ weight\ after\ \ incineration}{Weight\ of\ \ original\ \ food} \times 100 \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (5)$$

2.4. 6 Determination of carbohydrate content of pepper powders

Carbohydrate content was determined by difference according to [41] as follows: $\% \ Carbohydrate = 100\ - (\%moisture + \%Protein + \%Fat + \%Ash\ + \%Fibre) \ldots\ldots$ [6]

2. 5 Determination of mineral content of pepper powders

Mineral content of pepper was determined using the method of [37]. Five hundred milligram (500 mg) of sample was weighed in a digesting flask and 10 ml of each of HCl and HNO_3 was added. The mixture was digested for 10 minutes on a Bunsen burner and allowed to cool. The mixture was then filtered using filter paper and the filtrate was made up-to mL with distilled water and injected into the atomic absorption spectroscopy for quantification of the mineral elements except for sodium and potassium which were determined using flame photometer.

2. 6 Fourier transform infrared spectra analysis of SIP and HNP pepper powders

The Fourier transform infrared spectra analysis of capsicum pepper samples was determine using validation of analytical methods of methamphetamine described by [42]. A total of 1 g; 0.9 g; 0.8 g; 0.7 g; 0.6 g; 0.5 g; 0.4 g; 0.3 g; 0.2 g; 0.1 g of standard methamphetamine pure powders and

pepper powders (CC and CA) were put in a each cup that has been labeled. Each coupled with alum-weight to 1 g and shaken until homogeneous. It is a standard methamphetamine with a concentration of 100%, 90%, 80%, 70%, 60%, 50%, 40%,30%, 20%, and 10% were used for the preparation of calibration curve and determination of methamphetamine. The values for the precession of the system (RSD % ≤ 2.0, n = 7) show that the system is precise and method validation. The linear range of the method was studied by analyzing in duplicate ten concentrations of each compound ranging from 10.0 to 100.0 %. The obtained linear ranges for each of the methamphetamine with corresponding correlation coefficients (R2) are given in paper. Limit of detection (LOD) and limit of quantification (LOQ) by an empirical method that consisted of analyzing a series of standard solutions containing decreasing amounts of methamphetamine were determined.

The limit of detection was calculated by LOD = (3Sy/x)/a.

Where Sy/xis the standard deviation of the response of the blank and a is the slope of the calibration curve.

The limit of quantification was calculated by LOQ = (10Sy/x)/a. The limits were validated by analyzing standards prepared at the concentrations of the LOQs for each standard and their precision and accuracy were assessed.

2.5 Statistical Analyses of the Samples

Data was subjected to Analysis of Variance (ANOVA) followed by T-Test and means were separated by Duncan multiple range test; significant levels were obtain at 95% (P>0.05). SPSS version 17 software was used.

3.0 RESULTS AND DISCUSSION

3.1 Proximate Composition of Pepper Powders

Table 1 shows the proximate composition of Sweet Italian (SIP) and Habanero (HNP) peppers. The moisture content of the samples were 8.89 and 8.54 % for the SIP and HNP, respectively. The moisture content of SIP was significantly ($p<0.05$) higher than that of HNP pepper variety. Since the moisture content of the pepper varieties is less than 10 %, it suggests that the samples may have longer shelf-life and inhibit microbial growth [43, 2]. Similarly, the crude protein, crude fat and carbohydrate contents of SIP sample (9.32, 5.33 and 51.5%) were significantly ($p<0.05$) higher than that of the HNP sample (8.77, 4.87 and 50.9, respectively). In contrast, the HNP sample had significantly ($p<0.05$) higher crude fibre and ash contents (21.8 and 5.21%) than was exhibited by the SIP sample with lower values of 20.3 and 4.63%, respectively. Protein presence in peppered food product will help reduce the problem of protein-energy malnutrition for all ages in a population suffering this challenge [3]. The fat values reported in the present study were lower than those obtained for dried pepper (12.5-15.8%) harvested at different times of the year by [44]. The advantage of having low fat content in pepper is that its keeping quality will be enhanced as lipid peroxidation will minimally occur. The fibre content of the pepper varieties in this study were higher than 2.10 and 3.25 % reported for garlic and ginger powders [19], suggesting that these pepper varieties had better fibre contents compared to other spices as reported by [45]. Including these pepper samples in product development could confer on such functional food products physiological and health benefits that will ameliorate morbidities and manage chronic disease conditions. The Ash results suggest that HNP and SIP are better mineral source [8]. The

carbohydrate content of SIP and HNP samples obtained in this study are within recommended (45–65%) threshold levels [9].

Table 1: Proximate Composition of Sweet Italian and Habanero peppers (dry wt basis)

Parameter	Sweet Italian pepper	Habanero pepper
Moisture content (%)	8.89^{a}±0.85	8.54^{b}±0.23
Crude protein content (%)	9.32^{a}±0.93	8.77^{b}±0.65
Crude fat content (%)	5.33^{a}±0.84	4.87^{b}±0.41
Crude fibre content (%)	20.3^{b}±1.04	21.8^{a}±0.74
Ash content (%)	4.63^{b}±0.09	5.21^{a}±0.34
Carbohydrate (%)	51.5^{a}±2.0	50.9^{b}±1.43

Values are mean±standard deviation of triplicate determinations. Mean values with same superscript letter(s) along each row are not significantly (p>0.05) different.

3.2 Functional Properties of Pepper Powders

Table 2 presents the functional properties of Sweet Italian (*Capsicum annuum*) and Habanero (*Capsicum chinese*) powders. The bulk density results for the samples were 0.49 and 0.54 g/ml for SIP and HNP respectively This showed that the pepper samples in this study are low in calories [46]. Results in this study are in line with [47] who reported a value of 0.71 for green pepper and 0.54 for red pepper for SIP and HNP respectively. The water absorption capacity for the sample were 1.36 and 1.97 g/ml for SIP and HNP respectively with HNP significantly (p>0.05) higher as compared to SIP. This results is in line with 1.0g/ml for Negro pepper reported by [48]. Results of oil absorption capacity for peppers in this study were 3.18 and 2.17 g/ml for SIP and HNP respectively with SIP significantly (p>0.05) higher than HNP. The results of the wettability showed sample SIP had higher wettability of 71.00 as compared to HNP with wettability of 57.0. The results of foaming capacity in this study were 9.10 and 6.30 for SIP and HNP respectively with SIP been significantly (p>0.05) higher as compared to HNP. Swelling index results revealed that SIP had higher swelling index of 2.89 as compared to HNP 2.86 but were not significantly (p>0.05) difference. The results of reconstitution index showed 5.87 and 6.53% for SIP and HNP respectively with SIP having higher vales than HNP There were significant (p>0.05) differences observed in the functional properties of the two varieties of peppers except in the swelling index.

Table 2: Functional Properties of *Capsicum* Varieties

Parameters	Sweet Italian Pepper	Habanero Pepper
Water Absorption Capacity(ml/g)	1.36^{b}±0.03	1.97^{a}±0.32
Oil Absorption Capacity(ml/g)	3.18^{a}±0.64	2.17^{b}±0.58
Bulk Density(g/ml)	0.49^{b}±0.03	0.54^{a}±0.06

Foaming Capacity	9.10^{a}±0.81	6.30^{b}±0.26
Swelling Index	2.89^{a}±0.02	2.86^{a}±0.01
Reconstitution Index	5.87^{b}±0.12	6.53^{a}±0.12
Wettability	71.00^{a}±1.00	57.00^{b}±1.00

Values are mean±standard deviation of triplicate determinations. Mean values with same superscript letter(s) along each row are not significantly (p>0.05) different.

3.3 Mineral Content of Pepper Powders

Table 3 shows the results of the mineral content of Sweet Italian and Habanero peppers. For both the macro and trace elements content of the studied samples, the SIP sample showed significantly ($p<0.05$) higher values than HNP sample except for magnesium in which no statistical significant difference between the SIP and HNP samples was observed (8.82 & 8.52 mg/100g). The mineral results showed that the content of the following macro-elements Na (15.3 mg/100g), K (273mg/100g), Ca (38.6mg/100g) and P (0.05mg/100g) were significantly ($p<0.05$) in SIP than in HNP which recorded 12.4mg/100g (Na), 122mg/100g (K), 25.1mg/100g (Ca) and 0.03mg/100g for Phosphorus. The trace elements (Fe, Zn, Cu and Mn) measured in this study showed that SIP variety contained denser quantities than their HNP counterparts. HNP variety contained 5.76 mg/100g of Fe, 3.21mg/100g of Zn, 0.31mg/100g of Cu and 0.83mg/100g of Mn. Correspondingly, SIP contained higher values of same trace elements as follows: 8.63, 4.39, 0.63 and 1.27, respectively. The results microelement in SIP and HNP varieties has revealed the potential diversity of elements in the two samples which could impact several physiological benefits [12, 14].

Table 3. Mineral composition (mg/100g) of Sweet Italian and Habanero pepper powders

Minerals	Sweet Italian peppers	Habanero peppers
Sodium	15.3^{a}±0.05	12.4^{b}±0.04
Potassium	273^{a}±0.09	122^{b}±0.03
Calcium	38.6^{a}±0.02	25.1^{b}±0.05
Magnesium	8.82^{a}±0.07	8.52^{a}±0.08
Phosphorus	0.05^{a}±0.07	0.03^{b}±0.01
Iron	8.63^{a}±0.05	5.76^{b}±0.11
Zinc	4.39^{a}±0.07	3.21^{b}±0.04
Copper	0.63^{a}±0.04	0.31^{b}±0.07
Manganese	1.27^{a}±0.08	0.83^{b}±0.03

Values are mean±standard deviation of triplicate determinations. Mean values with same superscript letter(s) along each row are not significantly (p>0.05) different.

3.4 Fourier Transform Infrared Spectra Analysis of SIP and HNP Varieties

The results of the infrared spectrum analysis of the two pepper varieties are shown in table 4, Fig. 2 . The results showed that the pepper varieties (SIP and HNP) had similar infrared spectra that are dominated by the presence of alcohol/phenol, alkanes, alkenes and amine groups, corresponding to the frequencies in the range 3435.44-675.11 cm^{-1} for the phenols, 1037, 1379-1458 $cm^{-1}$for the alkanes, 1637.62-920.08$cm^{-1}$for the alkenes and 719.47-817.57 $cm^{-1}$for amine groups. The result indicated that the two varieties of peppers (SIP and HNP) had similar spectra lines, suggesting that they may possess similar structural, functional and bioactive properties [22, 29, 31].

Table 4: Infrared spectrum analysis of SIP and HNP pepper powders

Frequencies	Functional group	Assignment	Assignment
3435.44	Alcohols and Phenols	O-H (H-bonded)	O-H (H-bonded)
2928.04	Aliphatic/Methylene	C-H (asymmetry)	C-H (asymmetry)
2854.74	Aliphatic/methylene	C-H (symmetry stretch)	C-H (symmetry stretch)
1637.62	Aliphatic/Alkenyl	C=C (Stretch)	C=C (Stretch)
1458.23	Aliphatic/methyl	C-H (asymmetry)	C-H (asymmetry)
1379.25	Aliphatic/methyl	C-H (symmetry bend)	C-H (symmetry bend)
1319.35	Aliphatic/Methyne	C-H (bend)	C-H (bend)
1242.20	Aliphatic/vibrations	C-C (vibrations)	C-C (vibrations)
1157.33	Aliphatic/vibrations	C-C (vibrations)	C-C (vibrations)
1101.39	Aliphatic	Cyclohexane ring vibrations	Cyclohexane ring vibrations
1062.81	Alcohol	C-O (Broad)	C-O (Broad)
1037.64	Aliphatic	Cyclohexane ring vibrations	Cyclohexane ring vibrations
920.08	Olefinic (Alkene)	Vinyl CH out-of-plane bend	Vinyl CH out-of-plane bend
817.57	Amines	NH2 and N-H wagging (shifts on H-bonding)	NH2 and N-H wagging (shifts on H-bonding)
779.27	Amines	NH2 and N-H wagging (shifts on H-bonding)	NH2 and N-H wagging (shifts on H-bonding)
719.47	Amines	NH2 and N-H wagging (shifts on H-bonding)	NH2 and N-H wagging (shifts on H-bonding)
675.11	Alcohols and phenols	O-H bend (out-of-plane)	O-H bend (out-of-plane)

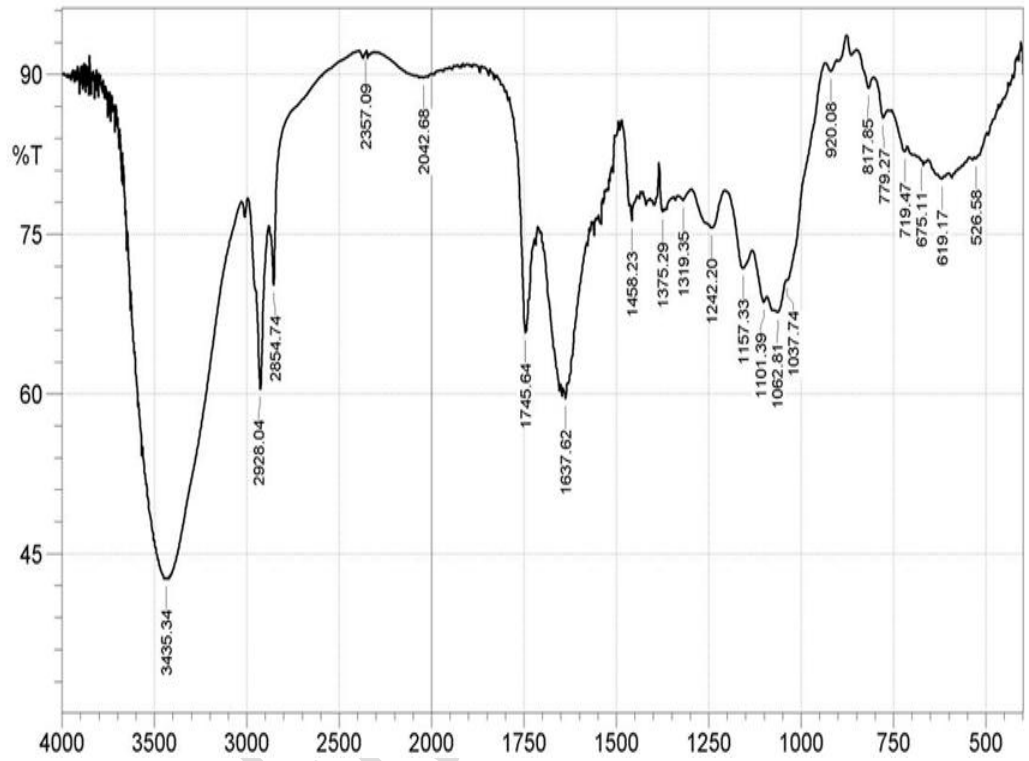

Fig. 2 (A): Infrared spectrum analysis of Sweet Italian pepper

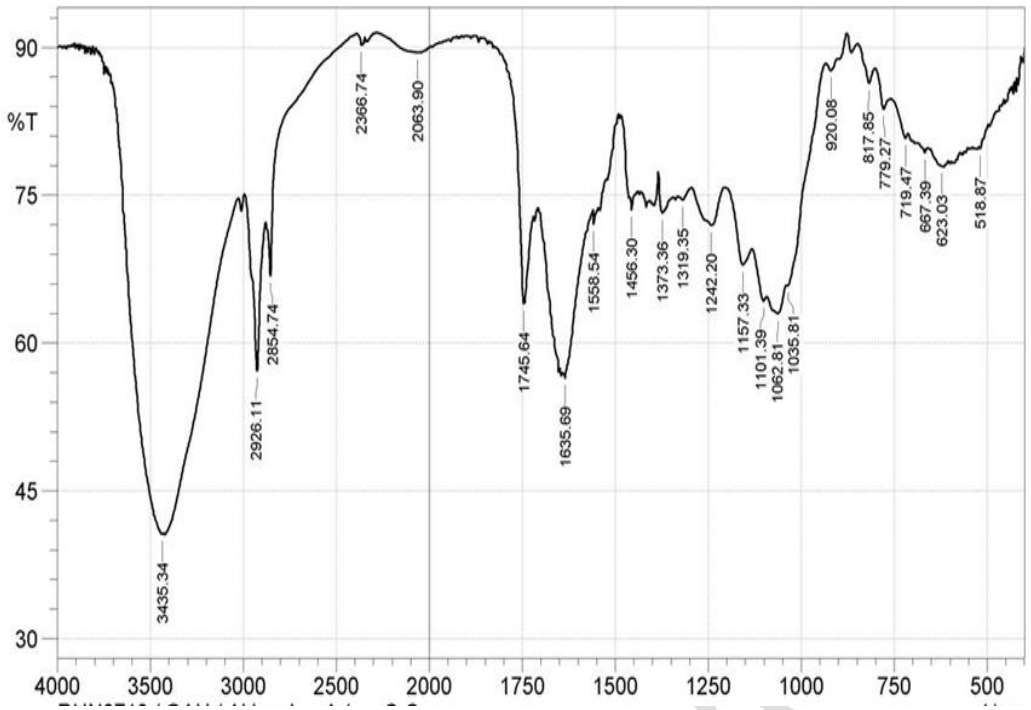

Fig. 2 (B): Infrared spectrum analysis of Habanero peppers

CONCLUSION.

Including these pepper samples in product development could confer on such functional food products physiological and health benefits that will ameliorate morbidities and manage chronic disease conditions. The SIP and HNP pepper samples could potentially contribute to energy provision in diet when used in product development or added to foods as spice. The two varieties of peppers, SIP and HNP having similar spectra lines may also possess similar structural properties. Presence of amine group in the samples indicated that they may have some quantities of Nitrogen. However, the samples also possessed broad C-O groups, indicating that the samples are richer in phenols/alcohol groups compared to other groups.

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