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# Comparative evaluation of the nutritional, phytochemical and microbiological quality of three pepper varieties

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**Abstract:** The study investigated the comparative evaluation of nutritional, phytochemical, and microbiological quality of three pepper varieties (*Capsicum annum*, *Capsicum* genus, and *Capsicum frutescens*). Three pepper varieties were purchased fresh from local market in Calabar, Cross River State. The samples were washed with distilled water and thinly sliced, (diameter of 1.0±0.1cm and thickness of 3-4mm), and then treated with chlorine concentrated solution. These samples were oven dried at temperature of 60°C for 24 hours. The samples were ground with a woring blender and stored in air-tight container. The result of the analysis showed that the proximate composition of *Capsicum* genus was significantly ( $p<0.05$ ) higher than *Capsicum annum* and *Capsicum frutescens* in moisture and carbohydrate contents. *Capsicum annum* was significantly ( $p<0.05$ ) higher than *Capsicum* genus and *Capsicum frutescens* in fat, insoluble and soluble fibre contents. *Capsicum frutescens* was significantly ( $p<0.05$ ) higher than *Capsicum annum* and *Capsicum* genus in protein and ash contents. Vitamin composition showed that *Capsicum annum* was significantly ( $p<0.05$ ) higher than *Capsicum* genus and *Capsicum frutescens* in vitamin C, vitamin A, vitamin E, niacin, vitamin B<sub>6</sub>, folic acid, and vitamin K. Mineral composition showed that *Capsicum annum* was significantly ( $p<0.05$ ) higher *Capsicum frutescens* and *Capsicum* genus in calcium, sodium, magnesium, phosphorus, copper, zinc, and nickel contents. *Capsicum* genus was significantly ( $p<0.05$ ) higher than *Capsicum annum* and *Capsicum frutescens* in potassium, iron and cobalt contents. Phytochemical composition showed that *Capsicum annum* was significantly ( $p<0.05$ ) higher than *Capsicum* genus and *Capsicum frutescens* in tannins, flavonoid, saponin, terpenoid, and carotenoid contents. *Capsicum* genus was significantly ( $p<0.05$ ) higher than *Capsicum annum* and *Capsicum frutescens* in alkaloid, phenolic compound, glycoside, and limonoid contents. *Capsicum frutescens* was significantly ( $p<0.05$ ) higher than *Capsicum* genus and *Capsicum annum* in anthraquinone contents. *Aspergillus spp* and *Staphylococcus spp* in *Capsicum annum*, *Capsicum* genus, and *Capsicum frutescens* were less than 10% and 100%. *Escherichia coli* and *salmonella* in these pepper varieties were not detected or absent. The result of this analysis revealed that the three pepper varieties have high nutritive value, medicinal value and can be used to remediate diseases and sustain health.

**Keywords:** Pepper, Phytochemical, Proximate Composition, Calcium, Sodium

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## 1. Introduction

Pepper, chili, or chili belongs to the Solanaceae family genus *Capsicum* and is closely related to tomato, eggplant, potato and tobacco. The genus *Capsicum* represents a diverse plant group and includes twenty seven species; five domesticated and twenty two un-domesticated (Bosland, 1993). *Capsicum annum*, *C. frutescens*, *Capsicum* genus, *Capsicum baccatum* and *Capsicum pubescens* are considered domesticated species of peppers. Peppers are quite diverse and may be classified by the trade according to

the end use. Peppers grown for their characteristics hot flavor are of genus *Capsicum*, *Capsicum annum* principally and *Capsicum frutescens* to a lesser extent.

Red Pepper is an important agricultural crop, not only because of its economic importance, but also due to nutritional and medicinal value. These are the excellent source of natural colors and antioxidant compounds (Howard *et al.*, 2000). A wide spectrum of antioxidant vitamins, carotenoids, and phenolic compounds are present in pepper. The intake of these compounds in food is an important health-protecting factor by prevention of

widespread human diseases. As consumption continues to increase, red peppers could provide important amounts of nutritional antioxidants to the human diet (Marin *et al.*, 2004).

Nigeria like other tropical countries has abundance of pepper varieties that grow all year round. Pepper occupies an important place in the diets of Nigerians. Long chili pepper (*Capsicum* genus), Drum pepper (*Capsicum annuum*), Small chili pepper (*Capsicum frutescens*) are among the pepper varieties consumed in Nigeria. Their nutritional contribution has not been widely exploited. Nutritional information on these varieties of pepper will be useful for the nutritional education of the public as a means to improve the nutritional status of the population. In this study, we determined the nutritional, phytochemical and microbiological quality of these pepper consumed in Nigeria.

## 2. Materials and Methods

### 2.1. Preparation of Sample

Three pepper varieties (*Capsicum annuum*, *Capsicum* genus, and *Capsicum frutescens*) were purchased fresh from the local market in Calabar, Cross River State. The samples were washed with distilled water and thinly sliced, and then treated with chlorine concentrated solution. These samples were oven dried at temperature of 60°C for 24 hours. The samples were ground with a blender (Model No. 205) and stored in air-tight container. Each sample (100g) was weighed and extracted with methanol which was used for the analysis.

### 2.2. Determination of Proximate Analyses

Moisture, protein, fat, ash and crude fiber contents were determined by AOAC method (1990) while carbohydrate content was determined by difference: 100- (%Moisture + %Ash + %Protein + %Fat + %Crude fiber). The moisture content was determined by hot air oven method at 105°C. The Macro Kjeldahl method was used for the determination of protein content. The fat content was determined by extracting 2g of sample with petroleum ether (boiling point of 40°C to 60°C) using soxhlet extraction method. Ash content was determined by weighing 2g of dry sample into a tarred porcelain crucible which was incinerated at 550°C in an ash muffle furnace until ash was obtained. The crude fiber was determined by exhaustive extraction of soluble substances in sample using 1.25% H<sub>2</sub>SO<sub>4</sub> acid and 1.25% NAOH solution after the residue was ashed and the loss in weight was recorded as crude fiber.

### 2.3. Determination of Mineral and Vitamin Elements

The method of AOAC (1990) was used to determine minerals. The samples were wet digested with concentrated nitric and perchloric acids. The minerals calcium (Ca) and magnesium (Mg) were determined by atomic absorption spectrophotometer (Model 3030 Perkin Elmer, Nortwalk, USA). Potassium (K) and Sodium (Na) were determined

with the aid of corning 400 flame photometer according to the method of Oyeleke (1984). Phosphorus was determined using spectrophotometer (JASCO V-630) followed by the method as described by Pearson (1976). The concentration of phosphorus was determined through the measurement of the yellow phosphor vanado-molybdate complex using Cecil Digital Spectrophotometer series. Vitamin A was determined spectrophotometrically using the method adopted from IVACG (1992). Vitamin C and other trace vitamins (Folic acid, Vitamin B<sub>6</sub>, Niacin) were determined using AOAC 1990 method.

### 2.4. Determination of Phytochemicals

Alkaloid was determined using the method described by Maxwell *et al.* (1995). Saponin was determined spectrophotometrically using the method described by Makkar and Becker (1996). The method of Trease and Evans (1983) was used for the determination of flavonoids, anthraquinones, and polyphenols. The method by Bohn and Kocapai-Abyazan (1994) was used for the determination of tannin.

### 2.5. Determination of Microbes and Aspergillus Counts

The method of Abramson and Clear (1996) was used for *aspergillus* counts. Ten (10) gram samples were ground and thoroughly mixed with 90 ml of sterile distilled water. Spore counting was performed by plate count technique on a selective medium for *Aspergillus flavus* after incubation for 7 days at 25°C using each suspension in a serial dilution from 10<sup>-1</sup> up to 10<sup>-6</sup> according to method. The count of *Escherichia coli* was performed on Violet Red Bile Agar (VRBA) incubated at 37°C for 48hrs. Enumeration of *Salmonella* was performed on Salmonella Shigella Agar (SSA) incubated at 37°C for 48hrs.

### 2.6. Statistical Analysis

Mean and Standard Deviation (SD) of the samples were determined using the statistical package for social sciences (SPSS) version 12 software package. Significance was accepted at 5% probability level. All the data reported in the tables are average values of triplicate determinations.

## 3. Results

The results of the proximate analysis as shown in Table 1 shows *Capsicum* genus to have the highest moisture content (11.16± 0.06%) which was significantly (p<0.05) higher than the moisture contents of all the other pepper. There was significant difference (p<0.05) between *Capsicum frutescens* (10.14±0.04%) and *Capsicum annuum* (9.43±0.02%) with the former significantly higher than the later. *Capsicum frutescens* have the highest ash contents (16.77±0.04%) which was significantly higher (p<0.05) when compared to *Capsicum* genus (10.78±0.04%) and *Capsicum annuum* (9.78±0.04%). Ash contents of *Capsicum* genus was also significantly higher (p<0.05) than

Capsicum annum when compared. Capsicum genus has the lowest crude protein value ( $9.62 \pm 0.03\%$ ) which was significantly ( $p < 0.05$ ) lower than those of Capsicum frutescens ( $11.97 \pm 0.05\%$ ) and Capsicum annum ( $11.67 \pm 0.03\%$ ). Also, Capsicum frutescens was significantly higher ( $p < 0.05$ ) than Capsicum annum. The fat contents of Capsicum frutescens ( $1.75 \pm 0.02\%$ ) was significantly higher ( $p < 0.05$ ) than the fat contents of Capsicum genus ( $0.41 \pm 0.02\%$ ) and Capsicum annum ( $0.35 \pm 0.03\%$ ). Also, Capsicum genus shows higher fat contents which was significantly ( $p < 0.05$ ) higher than the Capsicum annum. The insoluble fibre contents of the Capsicum annum ( $13.22 \pm 0.04\%$ ) was the highest which was significantly ( $p < 0.05$ ) higher than the Capsicum genus ( $8.71 \pm 0.02\%$ ) and Capsicum frutescens ( $1.02 \pm 0.04\%$ ). There was significant difference ( $p < 0.05$ ) of Capsicum genus when compared to Capsicum frutescens. Capsicum frutescens has the lowest soluble fibre contents ( $0.76 \pm 0.02\%$ ) which was significantly ( $p < 0.05$ ) lower than those of Capsicum annum ( $9.44 \pm 0.02\%$ ) and Capsicum genus ( $6.44 \pm 0.02\%$ ). Capsicum annum have the highest soluble fibre contents which was significantly ( $p < 0.05$ ) higher than Capsicum genus. The carbohydrate content of Capsicum annum ( $66.98 \pm 0.05$ ) was significantly ( $p < 0.05$ ) higher than those of the other two pepper with Capsicum frutescens having the lowest carbohydrate contents ( $58.81 \pm 0.04\%$ ).

The results of vitamin composition of Capsicum annum, Capsicum genus, and Capsicum frutescens as shown in Table 2 shows that Capsicum annum have the highest vitamin C content ( $41.55 \pm 0.04\%$ ) which was significantly ( $p < 0.05$ ) higher than those of Capsicum genus ( $27.13 \pm 0.05\%$ ) and Capsicum frutescens ( $22.21 \pm 0.03\%$ ) with Capsicum frutescens having the lowest vitamin C content. Capsicum annum shows the highest vitamin A content ( $1.55 \pm 0.03\%$ ) which was significantly ( $p < 0.05$ ) higher than that of all the other pepper. Capsicum annum also has the highest vitamin E contents ( $0.71 \pm 0.05\%$ ) which was significantly ( $p < 0.05$ ) higher than that of Capsicum genus ( $0.41 \pm 0.02\%$ ) and Capsicum frutescens ( $0.35 \pm 0.03\%$ ) when compared. Also, Capsicum genus was significantly ( $p < 0.05$ ) different from Capsicum frutescens when compared. Capsicum annum has the highest Niacin content which was significantly ( $p < 0.05$ ) higher than those of the Capsicum genus and Capsicum frutescens. However, there was no significant difference ( $p > 0.05$ ) between the Niacin content of Capsicum genus and Capsicum frutescens. There was no significant difference ( $p > 0.05$ ) of Capsicum annum, Capsicum genus and Capsicum frutescens when compared. Capsicum annum has the highest Folic acid value ( $8.14 \pm 0.02\%$ ) which was significantly ( $p < 0.05$ ) higher than Capsicum genus ( $6.49 \pm 0.02\%$ ) and Capsicum frutescens ( $7.16 \pm 0.02\%$ ). Also, Capsicum frutescens was significantly ( $p < 0.05$ ) higher than Capsicum genus when compared. The vitamin K content of Capsicum annum ( $6.68 \pm 0.05\%$ ) has the highest value which was significantly ( $p < 0.05$ ) different from Capsicum

genus ( $6.28 \pm 0.11\%$ ) and Capsicum frutescens ( $5.81 \pm 0.04\%$ ) when compared.

The results of mineral composition of Capsicum annum, Capsicum genus, and Capsicum frutescens as shown in Table 3 shows that Capsicum annum has the highest calcium value ( $134.35 \pm 1.24\%$ ) which was significantly ( $p < 0.05$ ) higher than that of other pepper varieties, followed by Capsicum frutescens and Capsicum genus having the lowest calcium value ( $104.18 \pm 0.15\%$ ) in this order. Capsicum annum has the highest sodium content ( $1.66 \pm 0.01\%$ ) which was significantly ( $p < 0.05$ ) higher than Capsicum frutescens ( $1.17 \pm 0.02\%$ ) and Capsicum genus ( $1.12 \pm 0.02\%$ ). However, there was no significant difference ( $p > 0.05$ ) between Capsicum frutescens and Capsicum genus. Capsicum genus has the highest potassium content ( $349.42 \pm 0.04\%$ ) which was significantly ( $p < 0.05$ ) higher than Capsicum annum ( $324.21 \pm 0.03\%$ ) and Capsicum frutescens ( $331.32 \pm 0.02\%$ ). Comparison shows significant difference ( $p < 0.05$ ) between Capsicum annum and Capsicum frutescens. Capsicum annum has the highest phosphorus value ( $37.24 \pm 0.03\%$ ) which was significantly higher than that of other pepper varieties, followed by Capsicum frutescens and Capsicum genus having the lowest phosphorus value ( $28.75 \pm 0.04\%$ ) in this order. Iron content shows that Capsicum annum has the highest iron content ( $139.24 \pm 0.05\%$ ) which was significantly ( $p < 0.05$ ) higher than that of Capsicum genus ( $71.41 \pm 0.04\%$ ) and Capsicum frutescens ( $67.16 \pm 0.04\%$ ). Comparison shows significant difference ( $p < 0.05$ ) between Capsicum genus and Capsicum frutescens. Capsicum annum ( $26.92 \pm 0.05\%$ ) contains significant ( $p < 0.05$ ) amounts of copper when compared with Capsicum genus ( $18.22 \pm 0.07\%$ ) and Capsicum frutescens ( $17.08 \pm 0.05\%$ ). Capsicum genus has the highest amount of cobalt content ( $13.27 \pm 0.09$ ) which was significantly higher than that of the other pepper varieties, with Capsicum frutescens having the lowest cobalt content ( $4.38 \pm 0.06\%$ ). Capsicum annum ( $2.11 \pm 0.05\%$ ) contains significant ( $p < 0.05$ ) amounts of Zinc when compared with any of the pepper varieties. Comparison shows significant difference ( $p < 0.05$ ) between Capsicum genus and Capsicum frutescens. Nickel content of Capsicum annum ( $2.11 \pm 0.05\%$ ) was significantly ( $p < 0.05$ ) higher than that of the other pepper varieties, followed by Capsicum genus and Capsicum frutescens having the lowest Nickel content ( $1.08 \pm 0.04\%$ ) in this order.

Results of phytochemical composition of Capsicum annum, Capsicum genus, and Capsicum frutescens as shown in Table 4 shows that Capsicum annum has the highest flavonoids content ( $4.91 \pm 0.31\%$ ) which was significantly ( $p < 0.05$ ) different from Capsicum frutescens but not significantly ( $p > 0.05$ ) different when compared to Capsicum genus. However, there was no significant difference ( $p > 0.05$ ) between Capsicum genus and Capsicum frutescens. Tannin content of the pepper varieties shows no significant difference ( $p > 0.05$ ). Alkaloid content of Capsicum genus ( $3.02 \pm 0.02\%$ ) was significantly

different ( $p < 0.05$ ) from that of the other pepper varieties. However, there was no significant difference ( $p > 0.05$ ) between *Capsicum annuum* and *Capsicum frutescens*. *Capsicum frutescens* ( $2.81 \pm 0.11\%$ ) contains significantly ( $p < 0.05$ ) high amounts of anthraquinones when compared to other pepper varieties. Comparison shows significant difference ( $p < 0.05$ ) between *Capsicum* genus and *Capsicum annuum*. The phenolic content of *Capsicum annuum* ( $3.00 \pm 0.12\%$ ) has the highest phenolic content which was significantly ( $p < 0.05$ ) different from *Capsicum* genus ( $5.54 \pm 0.27\%$ ) and *Capsicum frutescens* ( $2.35 \pm 0.05\%$ ). Also, *Capsicum* genus was significantly ( $p < 0.05$ ) different from *Capsicum frutescens*. The saponin content of *Capsicum annuum* was significantly ( $p < 0.05$ ) higher than that of the other pepper varieties, followed by *Capsicum* genus and *Capsicum frutescens* having the lowest saponin content ( $1.94 \pm 0.15\%$ ). There was no significant difference ( $p > 0.05$ ) between *Capsicum* genus and *Capsicum frutescens*. *Capsicum* genus ( $1.02 \pm 0.04\%$ ) was significantly different ( $p < 0.05$ ) from both *Capsicum annuum* ( $0.55 \pm 0.03\%$ ) and *Capsicum frutescens*

( $0.53 \pm 0.04\%$ ) in its glycosides content. However, there was no significant difference ( $p > 0.05$ ) between *Capsicum annuum* and *Capsicum frutescens*. Terpenoids content shows that *Capsicum annuum* ( $3.25 \pm 0.11\%$ ) has the highest terpenoids content which was significantly different ( $p < 0.05$ ) from the other pepper varieties. Comparison shows significant difference ( $p < 0.05$ ) between *Capsicum frutescens* and *Capsicum* genus. Limonoids content of *Capsicum annuum* ( $0.57 \pm 0.05\%$ ) was significantly different ( $p < 0.05$ ) from *Capsicum* genus ( $0.74 \pm 0.02\%$ ). However, *Capsicum frutescens* did not show any limonoid content. Carotenoids content shows that *Capsicum frutescens* ( $1.67 \pm 0.04\%$ ) was significantly different ( $p < 0.05$ ) from the other pepper varieties. There was no significant different ( $p > 0.05$ ) between *Capsicum* genus and *Capsicum annuum*.

Results of microbiological quality of *Capsicum annuum*, *Capsicum* genus, and *Capsicum frutescens* as shown in Table 5 shows that *Escherichia coli* and *salmonella* species were absent from the different pepper varieties. The total viable count, *Aspergillus flavus*, and *Staphylococcus species* were  $< 1000$ ,  $< 10$  and  $< 100$  respectively.

**Table 1.** Proximate composition of *Capsicum annuum*, *Capsicum* genus, and *Capsicum frutescens*

Pepper varieties	% moisture	% Protein	% Fat	% Ash	% Insoluble	%soluble fire	% Carbohydrate
<i>Capsicum annuum</i> (Drum pepper)	$9.43 \pm 0.02$	$11.67 \pm 0.03$	$1.75 \pm 0.02$	$9.78 \pm 0.04$	$13.22 \pm 0.04$	$9.44 \pm 0.02$	$66.98 \pm 0.05$
<i>Capsicum</i> genus (Long chili pepper)	$11.16 \pm 0.06^*$	$9.62 \pm 0.03^*$	$0.41 \pm 0.02^*$	$10.78 \pm 0.04^*$	$8.71 \pm 0.02^*$	$6.44 \pm 0.02^*$	$68.28 \pm 0.11^*$
<i>Capsicum frutescens</i> (Small chili pepper)	$10.14 \pm 0.04^{*a}$	$11.97 \pm 0.5^a$	$0.35 \pm 0.03^*$	$16.677 \pm 0.04^{*a}$	$1.02 \pm 0.04^{*a}$	$0.76 \pm 0.02^{*a}$	$58.81 \pm 0.^a$

Values are expressed as mean  $\pm$  SEMD,  $n=3$

\*: Significantly different from Drum pepper at  $P < 0.05$

a: Significantly different from Long chili pepper at  $P < 0.05$

**Table 2.** Vitamins composition of *Capsicum annuum*, *Capsicum* genus, and *Capsicum frutescens*

Pepper varieties	Vit C mg/100g	Vit A $\mu$ g/100g	Vit E mg/100g	Niacin mg/100g	Vit B6 mg/100g	Folic acid $\mu$ g/100g	Vit K $\mu$ g/100g
<i>Capsicum annuum</i> (Drum pepper)	$47.55 \pm 0.44$	$1.55 \pm 0.03$	$0.71 \pm 0.05$	$0.68 \pm 0.04$	$0.12 \pm 0.01$	$8.14 \pm 0.02$	$6.68 \pm 0.05$
<i>Capsicum</i> genus (Long chili pepper)	$27.13 \pm 0.05^*$	$1.26 \pm 0.03^*$	$0.41 \pm 0.02^*$	$0.58 \pm 0.04^*$	$0.11 \pm 0.01^*$	$6.44 \pm 0.02^*$	$6.28 \pm 0.11^*$
<i>Capsicum frutescens</i> (Small chili pepper)	$22.21 \pm 0.02^{*a}$	$1.07 \pm 0.05^{*a}$	$0.35 \pm 0.03^*$	$0.47 \pm 0.04^*$	$0.10 \pm 0.01$	$7.16 \pm 0.02^{*a}$	$5.81 \pm 0.04^{*a}$

Values are expressed as mean  $\pm$  SEMD,  $n=3$

\*: Significantly different from Drum pepper at  $P < 0.05$

a: Significantly different from Long chili pepper at  $P < 0.05$

**Table 3.** Minerals Composition of *Capsicum annuum*, *Capsicum* genus, and *Capsicum frutescens*

Pepper varieties	Ca (mg/100g)	Na (mg/100g)	K (mg/100g)	Mg (mg/100g)	P (mg/100g)	Fe (mg/100g)	Cu (PPM)	Zn (PPM)	Co (PPM)	Ni (PPM)
<i>Capsicum annuum</i> (Drum pepper)	$134.35 \pm 1.24$	$1.66 \pm 0.01$	$324.21 \pm 0.05$	$328.42 \pm 0.05$	$37.24 \pm 0.03$	$139.24 \pm 0.05$	$26.92 \pm 0.05$	$244.12 \pm 0.55$	$6.4 \pm 0.06$	$2.11 \pm 0.05$
<i>Capsicum</i> genus (Long chili pepper)	$104.18 \pm 0.15^*$	$1.12 \pm 0.02^*$	$349.42 \pm 0.04^*$	$274.88 \pm 0.02^*$	$28.75 \pm 0.04^*$	$71.41 \pm 0.04^*$	$18.22 \pm 0.01^*$	$38.02 \pm 0.05^*$	$13.27 \pm 0.09^*$	$1.25 \pm 0.05^*$
<i>Capsicum frutescens</i> (Small chili pepper)	$106.27 \pm 0.07^{*a}$	$1.17 \pm 0.02^*$	$331.32 \pm 0.02^{*a}$	$236.72 \pm 0.02^{*a}$	$31.44 \pm 0.05^{*a}$	$67.16 \pm 0.04^{*a}$	$17.08 \pm 0.05^{*a}$	$32.18 \pm 0.08^{*a}$	$4.38 \pm 0.06^{*a}$	$1.08 \pm 0.04^{*a}$

Values are expressed as mean  $\pm$  SEMD,  $n=3$

\*: Significantly different from drum pepper at  $P < 0.05$

a: Significantly different from long chili pepper at  $P < 0.05$

**Table 4.** Phytochemical Properties of *Capsicum annum*, *Capsicum genus*, and *Capsicum frutescens*

Pepper Varieties	Parameter tested									
	% Tannins	% Flavonoid	% Alkaloids	% Anthraquinones	% Phenolic	% Saponin	% Glycosides	% Terpenoids	% Limonoids	% Carotenoids
Capsicum annum (Drum Pepper)	1.44±0.22	4.91±0.31	1.55±0.11	1.22±0.05	3.00±0.12	3.76±0.13	0.55±0.03	3.25±0.11	0.57±0.05	1.97±0.06
Capsicum genus (Long Chili Pepper)	1.21 ±0.12	3.87±0.41	3.02±0.02*	1.71±0.05*	5.54±0.27*	2.18±0.04*	1.02 ±0.04*	1.43±0.02*	0.74±0.02*	0.21±0.04*
Capsicum frutescens (Small Chili Pepper)	0.98±0.12	2.43±0.34*	1.09±0.02 <sup>a</sup>	2.81±0.11* <sup>a</sup>	2.35±0.05* <sup>a</sup>	1.94±0.15*	0.53±0.04 <sup>a</sup>	2.25±0.12* <sup>a</sup>	0.00±0.00* <sup>a</sup>	1.67±0.04* <sup>a</sup>

Values are expressed as mean

\* Significantly different from drum pepper at P<0.05

a: Significantly different from long chili pepper at P<0.05

**TABLE 5.** Microbiological Quality of *Capsicum annum*, *Capsicum genus*, and *Capsicum frutescens*

Pepper varieties	Coliform (E.coli)	TVC (cfu/mg)	Salmonella spp	Aspergillus flavus	Staphylococcus Spp
Capsicum annum (Drum pepper)	0	<1000	0	<10	<100
Capsicum genus (Long chili pepper)	0	<1000	0	<10	<100
Capsicum frutescens (Small chili pepper)	0	<1000	0	<10	<100

Values are expressed as mean ±SEMD, n = 3

## 4. Discussion

Capsicum genus had the highest moisture content of 11.16% followed by Capsicum frutescens with a value of 10.14% while Capsicum annum had the least value of 9.43% showing significant difference (p<0.05) from the rest. The high levels of moisture in all the samples investigated suggests that the pepper would not be store for long without spoilage since high water activity could enhance microbial action bringing about food spoilage. Hence, dehydrating pepper increases the storage-life or shelf-life of peppers. This result corresponds with the findings of Esayas *et al.* (2011).

Capsicum annum showed significantly higher protein content (p<0.05) compared to the other pepper varieties while Capsicum genus had the least protein content. In general pepper needs to be combined with other foods of high protein value in order to meet the protein requirements of individuals (Ejoh *et al.*, 1996). This justifies the non-use of these pepper varieties as sole ingredients to provide the basic protein need. Usually, crude protein in pepper needs supplementation with other protein condiments.

Total lipids for the samples varied with Capsicum annum showing more appreciable values than Capsicum genus and Capsicum frutescens. Generally, the low values in some of the pepper varieties agree with the findings of many authors that pepper are poor sources of lipids (Gloria

*et al.*, 2010; Ejoh *et al.*, 1996).

The ash contents of all the pepper varieties are relatively high with Capsicum frutescens having the highest value of 16.77% and Capsicum annum having the least value of 9.78%. These values although high agree with the reported findings made by other researchers (Esayas *et al.*, 2011; Ejoh *et al.*, 1996). The high ash contents suggest the availability of minerals in the samples which is subsequently confirmed by the considerably high content of sodium (1.66mg/L), calcium (134.35mg/L), and Phosphorus (37.24mg/L) in Capsicum frutescens.

The insoluble and soluble fibre of the pepper varieties varied with the Capsicum annum showing more appreciable values than the Capsicum genus and Capsicum frutescens. Esayas *et al.* (2011) reported that percentage insoluble fibre content of these pepper varieties ranged from 1.00±0.6 to 7.3±2.2%. Insoluble fibre is essential in enhancing digestion and bowel movement (Papas *et al.*, 2004). Soluble fibre lowers blood cholesterol and glucose level.

High levels of carbohydrate were found in Capsicum genus while Capsicum frutescens showed relatively low values (p>0.05). However, these carbohydrates present, even when high in value might not be nutritionally assessable since most of them are bound to remain undigested in the body (Gloria *et al.*, 2010).

The level of vitamin C in the samples can make

significant contribution to lowering serum triglyceride concentration. *Capsicum annuum* can contribute most significantly among the pepper varieties, while *Capsicum frutescens* can contribute the lowest value. Their contribution to vitamin E, Niacin, Vitamin B<sub>6</sub> and vitamin A will be insignificant, as their values of these nutrients were negligible. Comparably, *Capsicum annuum* had the highest value of vitamin E, Niacin, Vitamin B<sub>6</sub> and vitamin A. The levels of vitamin C and vitamin K coupled with the presence of folic acid in the pepper qualify them as good sources of antioxidant which prevent or remove free radicals from the body, thereby preventing tumor growth. Antioxidants such as ascorbic acid (vitamin C) have been associated with prevention of nutritionally associated diseases such as cancers, diabetes, obesity (Hunt *et al.*, 1980), and the *Capsicum annuum* was high in these antioxidants, hence it has health-promoting benefits.

The calcium, sodium, magnesium, phosphorus, iron, copper, zinc and nickel content of *Capsicum annuum* in this study were higher than the other pepper varieties. The *Capsicum annuum* were good sources of calcium, magnesium, sodium, phosphorus, and can make some contribution to these micronutrient intakes, though it is normally used in small quantities in cooking. Sodium is an electrolyte which functions in the control of fluid balance in the body, controls extracellular fluid, and is essential for osmosis. It is important in maintaining acid-base balance in the body and participates in the transmission of nerve impulses essential for normal function (Onwaka, 2005). Calcium, in combination with phosphorus, is a component of bones and teeth to give strength and hardness. It is needed for normal nerve and muscle action, blood clotting, heart function and cell metabolism (Neiman *et al.*, 1992), hence the *Capsicum annuum* have health promoting properties. Also, the *Capsicum annuum* can serve as sources of meeting part of the daily requirements for zinc and iron.

The results of phytochemical showed that flavonoids, saponins, tannins, terpenoids were higher in *Capsicum annuum*. The presence of tannins, flavonoids, alkaloids, anthraquinones, phenolic compounds, saponins, glycosides, terpenoids, carotenoids is an indication of medicinal potentials of the pepper varieties particularly *Capsicum annuum*. Flavonoids are free radical scavengers, super antioxidants which prevent oxidative cell damage and have strong anti-cancer activity (Salah *et al.*, 1995). Alkaloids are efficient therapeutic substance. Pure isolated alkaloids are used as basic medicinal agent because of their bacterial properties (Stray, 1998). Glycosides are important medicinally due to their action on the heart, and tannins play an important role in preventing bacteria from adhering to the walls of the urinary tract, thereby preventing urinary tract infection. Hence, *Capsicum annuum*, *Capsicum genus*, and *Capsicum frutescens* possess medicinal properties. *Escherichia coli* and *salmonella* were absent in all the pepper varieties. Also, the presence of *staphylococcus specie* and *Aspergillus specie* in the pepper varieties were

less than 100% and 10%.

## 5. Conclusion

The present study has shown the phytochemical composition, vitamins composition, minerals composition, proximate composition and microbiological quality of *Capsicum annuum* (Drum pepper), *Capsicum genus* (Long chili pepper), and *Capsicum frutescens* (Small chili pepper). The pepper varieties contain substantial quantities of minerals, vitamins, and phytochemicals. Comparatively, the average nutritive value of *Capsicum annuum* is superior to those of the other pepper varieties analyzed. The findings suggest that all the three pepper contains appreciable amounts of nutrients; however it is observed that no one particular pepper is rich in all nutrients, hence the need to consume the pepper as combinations with themselves.

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