# STUDY ON THE QUALITY OF SPICES

**PÎRVULESCU LUMINIȚA[1], IANCU TIBERIU[1], ADAMOV TABITA[1], PUJA ANDELA[2], BORDEAN DESPINA-MARIA*[2]**

*[1]Banat´s University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Faculty of Management and Rural Tourism, Romania*

*[2]Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Faculty of Food Engineering, Romania*

*Corresponding author's e-mail: despinabordean@usab-tm.ro, despina.bordean@gmail.com

***Abstract:*** *Due to the large nutritional and biological variations between the different varieties of each species of fruit or vegetable, the identification of the best genotypes is important for producers and consumers, in order to obtain high quality products. The first use of spices in food was for preserving meat, due to their antimicrobial properties. Over time, spices have become indispensable in gastronomy to enhance the aroma and taste of culinary dishes. With the development of spice extraction procedures, spices have been widely used in the pharmaceutical industry and beyond. At the same time, spices have become important sources of natural colors, flavors, antimicrobials and antioxidants for the food industry. The aim of the present study is to evaluate the quality of pepper powder (paprika) as a spice, and the nutritional value of capsicum, in generally*.

***Key words****: quality, nutritional values, spice, paprika powder*

## INTRODUCTION

The results of many studies show that the consumption of fruits and vegetables are beneficial for human health in preventing and even treating many chronic diseases. Thus, in recent years, a number of plant substances have attracted attention due to their role in the prevention of cardiovascular disease, oncological diseases, as agents for the prevention of atherosclerosis and in slowing down the aging process. Also, many of these substances have special biological properties, such as antimicrobial, antiviral, antifungal activity. Interest in the antimicrobial properties of active compounds is reinforced by the suggestion that they may influence the behavior of microorganisms. Thus, their use as natural additives in the food industry is increasing in recent years [2,8,10,14].

By definition, "spices are aromatic flavorings from seeds, fruits, bark, rhizomes, and other plant parts, used in to season and preserve food, and as medicines, dyes, and perfumes" [16].

The capsicums, also known as pepper or chili produce pods which contain their seeds and due to the fact than "any seed-containing part of a plant is a fruit", capsicum, practically are fruits [17], but from culinary perspective they can be considered vegetables [18] as well as spices, because paprika powder can be referred as a powdered spice made from a mixture of capsicum fruits [19].

Peppers belong to the Solanaceae family, the genus *Capsicum* and the species *Annum, Frustescens* or *Chinense*. Due to their sensory properties, color, aroma and other chemical properties, they are widely used in the food industry, gastronomy and everyday consumption [5,12].

Hot pepper (*Capsicum annuum L*.) is a widespread plant. Its fruits have different shapes and sizes, the colors varying from yellow to red, from intense purple to dark green, depending on the genotype or the period of reproduction. Hot pepper is used primarily as a spice, then as a flavoring and coloring agent, but at the same time as an alternative medicine for treating various diseases such as inflammation, diabetes, back pain, etc. [3,6,12].

Fresh peppers are an excellent source of nutrients, especially ascorbic acid, carotenoid pigments (including β-carotene), polyphenols and capsacinoids, all of which are of considerable interest due to their antioxidant properties. It is also widely used as a colorant in cosmetics and is also valuable due to its nutritional and therapeutic properties [2,9].

The assortment of colors is associated to the occurrence of pigments such as α- and β-carotene (orange- red), anthocyanins (purple), chlorophyll (green), as well as lutein, zeaxanthin, and β-cryptoxanthin (yellow / orange). The genus Capsicum also has a great variety in health-promoting chemical compounds, such as carotenoids, capsaicinoids, flavonoids, different vitamins and minerals (K, Ca, Mg, Fe, S and P) and essential oils, with antimicrobial, anticancer, anti-inflammatory and antioxidant properties [4,5].

Based on the definition that "quality is the ongoing process of building and sustaining relationships by assessing, anticipating, and fulfilling stated and implied needs" [20], the main purpose of the study intends to evaluate the quality of capsicum, as a spice, as a fruit and as a vegetable.

## MATERIALS AND METHODS

For the study case were used over 100 selected research papers as well as USDA nutritional database. The nutritional values were analyzed using PAST statistical program [21].

## RESULTS AND DISCUSSION

### *Quality characteristics of pepper*

Due to the biodiversity of capsicum species, the chemical composition has a vast variability. The domesticated forms differ in the colors of the fruits and flowers and, at the stage of maturity, retain the fruits on the stalk. The genus Capsicum can be classified according to the structure of the flower and the fruit. Pepper fruits of diverse varieties have a sequence of colors from white to burgundy [1,4]. The intensity of the color (red) and the scale of sharpness are the key quality parameters [1,4].

Other studies reported large variations in fruit morphology, particularly the shape, size and length between *C. chinense*, *C. annuum* and *C. frutescens*. *C. annuum* has the major variant in shape, size and color of fruits. According to various descriptors, the shape of the fruit can be elongated, almost round, triangular. Other differences are the shape of the fruit at the end of the flower (sharp, blunt, clogged and pointed), the cross-section ripening of the fruit (slightly wavy, intermediate and wavy) and the surface of the fruit (smooth, semi-wrinkled and wrinkled) [4,10].

### *Chemical composition of the pepper*

Peppers show large nutritional benefits, due to their phytochemical content, which is influenced by environmental conditions, stage of ripening and genotype. Characterization of phytochemical modifications in peppers at all stages of maturity or during storage time, are crucial, as they influence aroma and taste, antioxidant activity as well as consumer preferences [7,10].

*C. annuum* varieties represent good sources of vitamins C, E and A. Vitamin contents depend on genotype, stage of ripening, harvest time, processing and storage after harvest. Pepper fruits contain large levels of ascorbic acid with vary from 20 - 247 mg / 100 g and can raise during fruit ripening. The differences in fruit growth and maturity, generated by the genetic profile and environmental conditions, also affect their chemical

composition. For example, some pepper varieties grown under water stress, in greenhouse conditions, had a lower ascorbic acid content [4,5].

The most important minerals found in peppers are: potassium, magnesium, calcium, sodium, zinc, iron, phosphorus, manganese, selenium and boron. Their content varies greatly depending on the variety, stage of maturity and changes in the environment during growth. It can also be influenced by agricultural practices [4,10].

Pepper is considered a source of phenolic compounds, including phenolic acids, flavonoids, capsaicin. Numerous studies have shown the health benefits of phenolic compounds due to their capability to reduce free radicals in vivo and in vitro, with an essential role in heart disease and several forms of cancer. These health measures can be attributed to the antioxidant capacity of the pepper, which is largely influenced by the stage of growth and ripening of the fruit, but also by the influence of the growing area and environmental factors. The effect of ripening stage on the total content of phenolic compounds in hot peppers measured by the Folin-Ciocalteu method and phenolic concentration in *C. annuum*, were similar in the first and second stage of ripening, (76.0 and 73.8 mg / g in small, green fruits); amounts that decreased in the last stage of maturity (43.2 mg / g in red fruits) [3,6,7,10,11].

Pepper is considered a carotenogenic fruit, due to the fact that the color of the fruit is changeable (unripe fruit are green, yellow or white) and have the capacity to change to red - dark red, brown and sometimes dark-brown (almost black) in the ripening stage. The carotenoid content can vary from 0.1 to 3.2 g / 100 g. Ketocarotenoids give the bright red color, while β-carotene, violaxanthin, zeaxanthin and β-cryptoxanthin produce yellow-orange color of fruits. Carotenoids have many important functions in the human body with physiological benefits [1,13,14].

Capsaicinoids are secondary metabolites in charge for the spicy and strong taste of pepper fruits. The two major capsaicinoids (capsaicin and dihydrocapsaicin), over 90% content, are found in the "fruit pericarp, placenta and seed tissues of all peppers" [9,12]. Their biosynthesis is a genetically controlled feature, and environmental conditions play an significant role, in accordance with the genotype. Capsaicinoid concentration is an key parameter to show the measure of hotness of hot peppers, and SHU is a drop measurement developed by Scoville. There are five classes of sting developed by Scoville: non-stinging (0 - 700 SHU), mild stinging (700 - 3000 SHU), moderate stinging (3,000 - 25,000 SHU), stinging (25,000 -70,000 SHU) and very stinging (> 80,000 SHU) [4, 9, 12].

According to USDA FOOD DATABASE, Figures 1 and 2 show the nutritional profiles of sweet red pepper [15] and hot pepper [22].

The sweet pepper is described by high content of water (92.2 g/100g), total folate (46 µg /100g), carotene(1,6 mg/100g), lutein and zeaxanthine (51 µg/100g ), vitamin C (128 mg/100g) and vitamin A (3130 UI). The pepper is characterized by: high content of K (211 mg/100g), Mg (12 mg/100g), P (26 mg/100g), Zn (0,25 mg/100g), Mg (0,112 mg/100g) and Fe(0,43 mg/100 g) - (*https://fdc.nal.usda.gov/fdc-app.html#/food-details/170108/nutrients*).

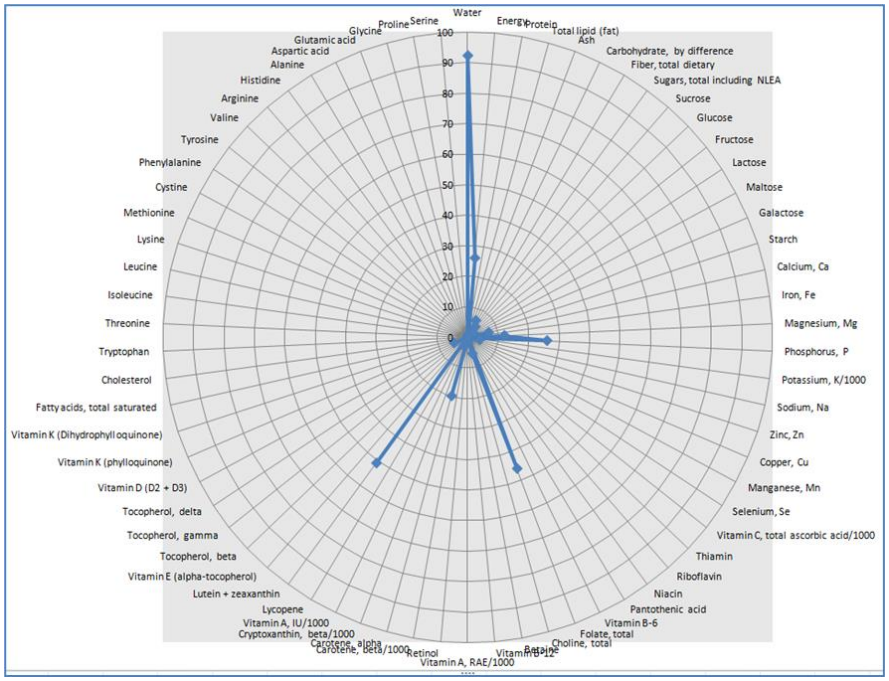


**Figure 1. Star representation of sweet red pepper, nutritional compounds**

The sweet pepper is described by high content of water (92.2 g/100g), total folate (46 µg /100g), carotene(1,6 mg/100g), lutein and zeaxanthine (51 µg/100g ), vitamin C (128 mg/100g) and vitamin A (3130 UI). The pepper is characterized by: high content of K (211 mg/100g), Mg (12 mg/100g), P (26 mg/100g), Zn (0,25 mg/100g), Mg (0,112 mg/100g) and Fe(0,43 mg/100 g) - (*https://fdc.nal.usda.gov/fdc-app.html#/food-details/170108/nutrients*).

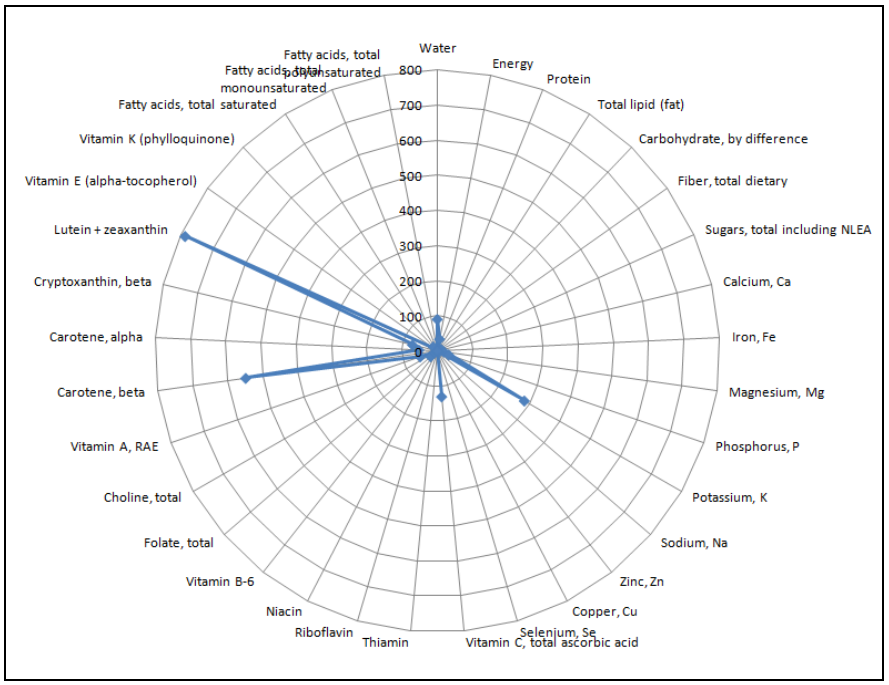


**Figure 2. Star representation of hot red pepper, nutritional compounds**

The hot pepper is described by high content of lutein and zeaxanthin (785µg/100 g), beta carotene (548 µg/100 g), vitamin C (131mg/100 g), and potassium (285 mg/100 g), high content of K (285 mg/100g), Mg (19 mg/100g), P (34 mg/100g), Zn (0.20 mg/100g),

Mg (19 mg/100g) and Fe(0.64 mg/100 g) - (*https://fdc.nal.usda.gov/fdc-app.html#/food-details/1103367/nutrients).*

If we compare the two assortments of pepper based on the USDA nutritional values (table 1) we discover that we can obtain a more complete paprika spice due to their complementary nutritional values (figures 3 and 4).

**Table 1.**

**Comparative presentation of main nutritional values for two capsicum (pepper) species based on the information collected from USDA databases**

| Name | Unit | *Hot pepper raw | **Sweet Pepper raw |
|---|---|---|---|
| Water | g | 89.9 | 92.2 |
| Energy | kcal | 34 | 26 |
| Protein | g | 1.39 | 0.99 |
| Total lipid | g | 0.4 | 0.3 |
| Carbohydrates | g | 7.66 | 6.03 |
| Fiber | g | 2.2 | 2.1 |
| Sugars | g | 4.71 | 4.2 |
| Calcium, Ca | mg | 13 | 7 |
| Iron, Fe | mg | 0.64 | 0.43 |
| Magnesium, Mg | mg | 19 | 12 |
| Phosphorus, P | mg | 34 | 26 |
| Potassium, K | mg | 285 | 211 |
| Sodium, Na | mg | 6 | 4 |
| Zinc, Zn | mg | 0.2 | 0.25 |
| Copper, Cu | mg | 0.088 | 0.017 |
| Selenium, Se | µg | 0.4 | 0.1 |
| Vitamin C | mg | 131 | 128 |
| Thiamin | mg | 0.056 | 0.054 |
| Riboflavin | mg | 0.078 | 0.085 |
| Niacin | mg | 1.26 | 0.979 |
| Vitamin B-6 | mg | 0.463 | 0.291 |
| Folate, total | µg | 25 | 46 |
| Choline, total | mg | 9.2 | 5.6 |
| Vitamin A, | µg | 51 | 157 |
| Carotene, beta | µg | 548 | 1620 |
| Carotene, alpha | µg | 52 | 20 |
| Cryptoxanthin, beta | µg | 72 | 490 |
| Lutein + zeaxanthin | µg | 785 | 51 |
| Vitamin E | mg | 2.13 | 1.58 |
| Vitamin K | µg | 16.2 | 4.9 |
| Fatty acids | g | 0.067 | 0.059 |

**Hot pepper raw - USDA FOOD DATABASE, https://fdc.nal.usda.gov/fdc-app.html#/food-details/1103367/nutrients*
***Sweet Pepper raw - USDA FOOD DATABASE, https://fdc.nal.usda.gov/fdc-app.html#/food-details/170108/nutrients*

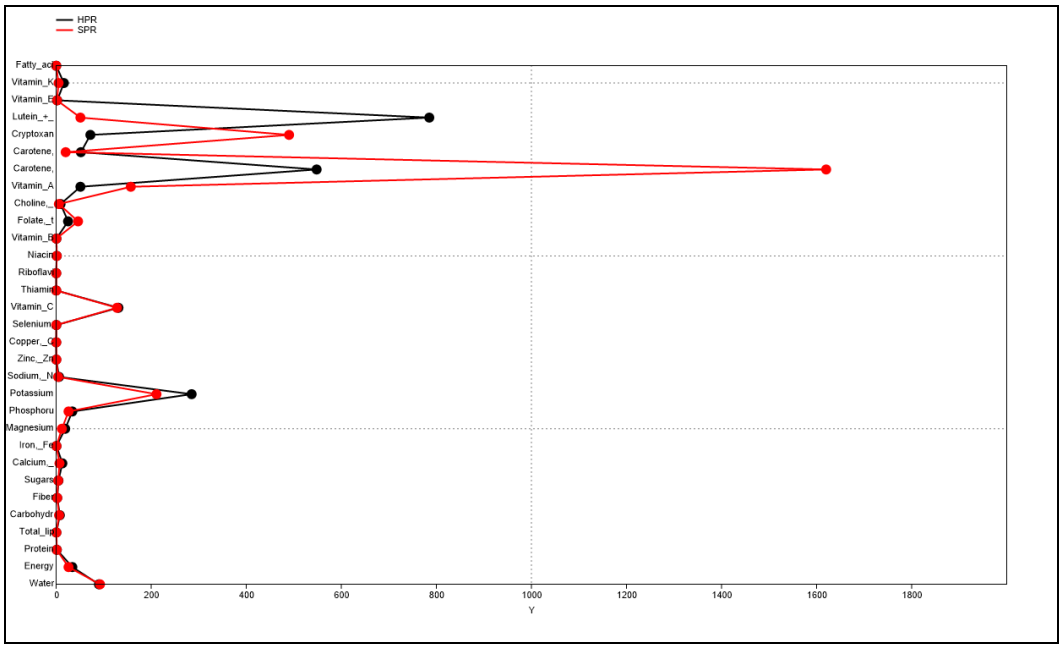


**Figure 3. Comparative representation of the nutritional values of sweet pepper and hot red pepper**

*Legend: HPR = hot pepper raw, SPR = sweet pepper raw*

As we can observe the hot pepper or chili is described by higher content of most of the components, while sweet pepper is describe by ten times higher content of beta carotene, 3 times higher content of vitamin A, two times higher content of folate and seven times more beta cryptoxanthin.

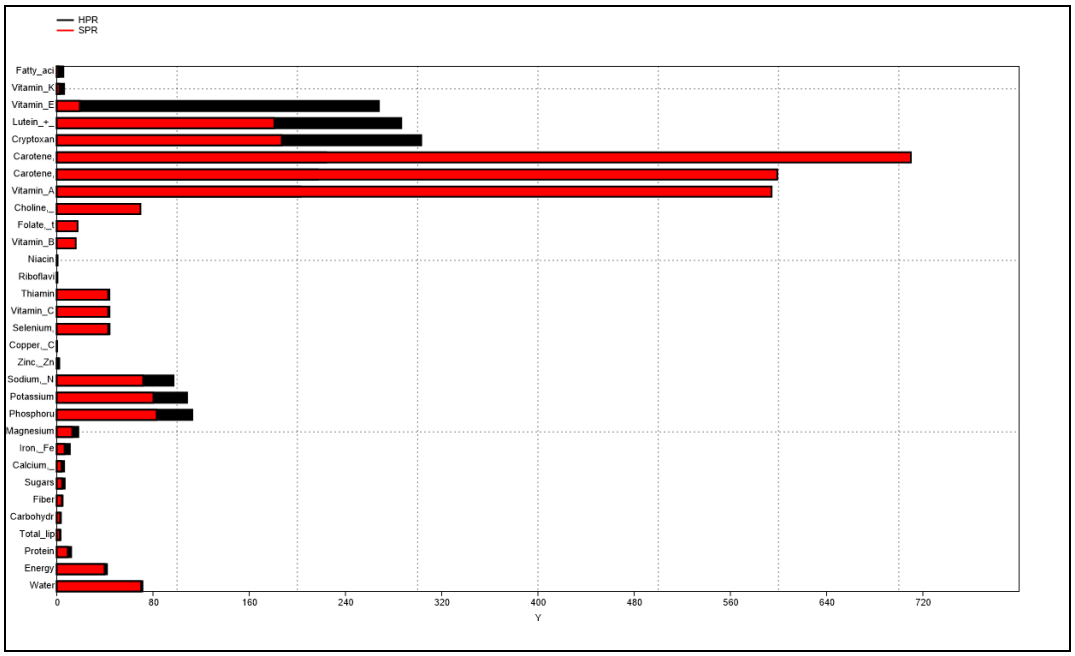


**Figure 4. The average values of potential combination of the two pepper assortments**

*Legend: HPR = hot pepper raw, SPR = sweet pepper raw*

Analysing chart 4 we recommend the use of bot assortments when preparing paprika, due to the high potential of increasing the nutritional compounds profile and indirectly the quality of spice.

## CONCLUSIONS

The quality of paprika spice is in accordance with the chemical and nutritional composition of the peppers assortments.

The use of multiple assortments of peppers might improve the nutritional values of the spice, in special if we add sweet pepper powder.

## REFERENCES

**[1] ARIMBOOR R., NATARAJAN R. B., MENON K. R., CHANDRASEKHAR L. P., MOORKOTH V**., 2015, Red pepper (Capsicum annuum) carotenoids as a source of natural food colors: analysis and stability—a review. Journal of Food Science and Technology, 52(3), 1258–1271. https://doi.org/10.1007/s13197-014-1260-7

**[2] BASHAIR M., JAVED N., ATIQ M., WAKIL W.**, 2016, Mineral Profiling of Chilli Pepper (Capsicum Annuum L.) Inoculated with Colletotrichum Capsici (Sydow), Butler and Bisby, Journal of Animal & Plant Sciences, 26 (5), Page: 1304-1312, ISSN: 1018-7081

**[3] DINU MARIA, SOARE RODICA, HOZA GHEORGHITA, BABEANU CRISTINA**, 2018, Changes in Phytochemical and Antioxidant Activity of Hot Pepper Fruits on Maturity Stages, Cultivation Areas and Genotype, South Western Journal of Horticulture, Biology and Environment, Vol.9, No.2, 65-76

**[4] HERNÁNDEZ-PÉREZ T., GÓMEZ-GARCÍA M. DEL R., VALVERDE M. E., PAREDES-LÓPEZ O.**, 2020, Capsicum annuum (hot pepper): An ancient Latin-American crop with outstanding bioactive compounds and nutraceutical potential. A review. Comprehensive Reviews in Food Science and Food Safety, 19(6), 2972–2993. https://doi.org/10.1111/1541-4337.12634

**[5] HERVERT-HERNÁNDEZ D., SÁYAGO-AYERDI S. G., GOÑI I.,** 2010, Bioactive compounds of four hot pepper varieties (Capsicum annuum L.), antioxidant capacity, and intestinal bioaccessibility. Journal of Agricultural and Food Chemistry, 58(6), 3399–3406. https://doi.org/10.1021/jf904220w

**[6] HOWARD L. R., TALCOTT S. T., BRENES C. H., VILLALON B.,** 2000, Changes in phytochemical and antioxidant activity of selected pepper cultivars (Capsicum species) as influenced by maturity. Journal of Agricultural and Food Chemistry, 48(5), 1713–1720. https://doi.org/10.1021/jf990916t

**[7] KAVUNCUOGLU H., CAPAR T. D., YALCIN H.,** 2021, Total Phenolic Contents, Antioxidant Activities and Antioxidant Capacities of Some Selected Pepper (Capsicum Annuum L.) Pulps and Seeds, European Journal of Science and Technology, No. 21, 581-586

**[8] LEE Y., HOWARD L. R., VILLALÓN B.,** 1995, Flavonoids and Antioxidant Activity of Fresh Pepper (Capsicum annuum) Cultivars. Journal of Food Science, 60(3), 473–476. https://doi.org/10.1111/j.1365-2621.1995.tb09806.x

**[9] NWOKEM C.O., AGBAJI E.B, KAGBU J.A., EKANEM E.J.,** 2010, Determination of capsaicin content and Pungency Level of Five Different Peppers Grown in Nigeria, New York Journal, 3 (9), 17 – 21

**[10] OGUNLADE I., ALEBIOSU A.A., OSASONA A.I.,** 2012, Proximate, mineral composition, antioxidant activity and total phenotic content of some pepper varieties, International Journal of Biological and Chemical Sciences, 6 (8), 2221 – 2227

**[11] PÉREZ-JIMÉNEZ J., NEVEU V., VOS F., SCALBERT A.,** 2010, Identification of the 100 richest dietary sources of polyphenols: An application of the Phenol-Explorer

database. European Journal of Clinical Nutrition, 64, S112–S120. https://doi.org/10.1038/ejcn.2010.221

**[12] RAIMI MONSURAT M., SHITTU SURAJ A., OYETADE OLUMIDE A.**, 2014, Physicochemical Properties and Mineral Composition of Capsicum annum and Capsicum frutescens Oils, Journal of Applied Chemistry (IOSR-JAC), e-ISSN: 2278-5736, Volume 7, Issue 1, 112-116.

**[13] REYES-ESCOGIDO M. D. L., GONZALEZ-MONDRAGON E. G., VAZQUEZ-TZOMPANTZI, E**., 2011, Chemical and Pharmacological Aspects of Capsaicin. 1253–1270. https://doi.org/10.3390/molecules16021253

**[14] WAHYUNI Y., BALLESTER A. R., SUDARMONOWATI E., BINO R. J., BOVY,A. G.**, 2011, Metabolite biodiversity in pepper (Capsicum) fruits of thirty-two diverse accessions: Variation in health-related compounds and implications for breeding. Phytochemistry, 72(11–12), 1358–1370. https://doi.org/10.1016/j.phytochem.2011.03.016

**[15]** https://fdc.nal.usda.gov/fdc-app.html#/food-details/170108/nutrients

**[16]** https://www.masterclass.com/articles/a-list-of-the-27-essential-cooking-spices-you-need-to-know

**[17]** https://www.webmd.com/vitamins/ai/ingredientmono-945/capsicum

**[18]** https://www.eufic.org/en/healthy-living/article/is-a-pepper-a-fruit-or-a-vegetable-and-why

**[19]** https://simple.wikipedia.org/wiki/Paprika

**[20]** https://www.qualitydigest.com/magazine/2001/nov/article/definition-quality.html

**[21]** Hammer O., Harper D.A.T. and Ryan P., PAST: Paleontological Statistics Software Package for Education and Data Analysis, https://palaeo-electronica.org/2001_1/past/issue1_01.htm

**[22]** https://fdc.nal.usda.gov/fdc-app.html#/food-details/1103367/nutrients