Effect of Varieties, Solar Drying and Zeer Pot Refrigeration Lining Media on Physico – Chemical Characteristics of Chili Pepper Fruits

ABSTRACT

Chili peppers are perishable and undergo physio - chemical changes to cause postharvest loss of chili peppers. The main objective of this study was therefore to investigate effect of varieties, solar drying and zeer pot refrigeration lining media on physico – chemical characteristics of chili peppers.A 2 x 3 x 3 factorial experimental design in Randomized Complete Block Design (RCBD) was used to collect data for laboratory analyses. The study found – out that, varieties of chili peppers had significant effect ($p < 0.05$) on physico – chemical characteristics of chili peppers with red cayenne significantly recorded the best pericarp thickness (0.21mm), porosity (72.3%) total soluble solids (2.42%). pH (5.38) but titratable acidity (0.56%) of chili pepper fruits was significantly ($p < 0.05$) higher in scotch bonnet. Also, on effect of solar drying on physico – chemical characteristics of chili pepper fruits, there were significantly ($p < 0.05$) better thickness of pericarp (0.23mm), total soluble solids (2.47%), titratable acidity (0.62%) and pH (4.64) shown in unblanched solar dried chili pepper fruits while the best porosity (71.19%) was noted in controlled chili pepper fruits. Again, on effect of lining media of zeer pot refrigeration on physico – chemical characteristics of chili pepper fruits, thickness of pericarp (0.22mm) was significantly ($p < 0.05$) higher in wood shavings used as zeer pot lining media but total soluble solids (2.03%) and porosity (69.27%) were best indicated in styrofoam used as zeer pot lining media. Titratable acidity (0.54%) and pH (5.00) were better shown in sand used as lining media of zeer pot refrigeration.

Keywords: Varieties, solar drying, zeer pot refrigeration, physico – chemical and chili peppers

1.INTRODUCTION

Chili peppers are rich in foodnutrients such as vitamin A and C, potassium, folic acid, fibre and low in sodium and caloric content [1]. Consumption of chili peppers prevents anaemia, cancer, heart diseases, cataract, weight, arthritis, diabetes etic [2, 3, 4]. Heat extracted from chili peppers are used to produce a wide range of alcoholic beverages as well as used in preparation of culinary and pharmaceutical products [5].

Chili peppers are produced all over the world with leading producers been China, Mexico and Turkey, contributing about 70% of the world's production of chili peppers[6]. Ghana is ranked eleventh (11th) producer of chili pepper in the world and second (2nd) best producer of chili peppers in Africa with estimated total production of 88,000 metric tons [7]. In Ghana, production of chili peppers are usually done by peasant or commercial farmers [8].
Solar drying is the use of solar drying device to dry agricultural products by harvesting the sun radiation which is used for the drying of agricultural products [9] to improve the quality of dried agricultural products for healthy consumption of agricultural products [10] together transforming agricultural products into storable and marketable products [11].

Comment [B_Ali1]: Add latest values.

Zeer pot also known as evaporative cooler or pot - in – pot is a storage device used forstoring agricultural products for future use [12]. Again, zeer pots are natural fridges which do not require the use of electricity or fossil fuel to operate but capable of reducing temperature (40^0F) of agricultural products to extend the shelf – life of agricultural products [13]. Harvested chili peppers undergo physico - chemical changes to cause deterioration of chili peppers. Ghana postharvest loss of chili peppers is estimated to be 20 – 50% of the total production[14]. Hence, it is important to study the best effect of varieties, solar drying processes and zeer pot refrigeration lining media on physico – chemical characteristics of chili peppers to reduce postharvest losses of chili peppers.

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2.MATERIALS AND METHODS

2.1. Study Area

The study was carried - out in the Dormaa – East District with total land area of 456 Square Kilometres. It lies within the middle belt of Ghana, with latitude between 7^0 08^1 North and 7^0 25^1 degrees and longitude 2^0 35^1 West and 2^0 48^1 West [15].

Legislative Instrument (LI1851) of 2007 divided Dormaa - East, which is approximately 1.8 percent of the Bono Region's total geographical area, from Dormaa Municipality (formerly Dormaa Central Municipality), with Wamfie serving as the district capital [15]. The District is bordered to the west by Dormaa Central Municipal, to the north by Berekum Municipal, to the east by Sunyani West District, and to the south by Asuonafo North Municipal and Asutifi North District. As to the 2010 population and housing census, the District has 112,111 residents, comprising 53,589 males and 58,522 females [15].

The district is located in a semi-equatorial zone with two distinct rainy seasons (major and minor) [16]. The main season often peaks between April and June. On the other hand, the minor season lasts from September to November. The yearly rainfall average ranges from 124 to 175 millimetres. There is severe dry season from November to March every year. The District has average temperature of 30°C and lowest of 26°C in August. The main activity in the area is agriculture which constitutes 57 percent of the labour force which are mostly the adults which are engaged in crops, livestock and poultry production. They are also employed in the formal sector such as teachers, nurses, police etc. They predominately speak bono [16].

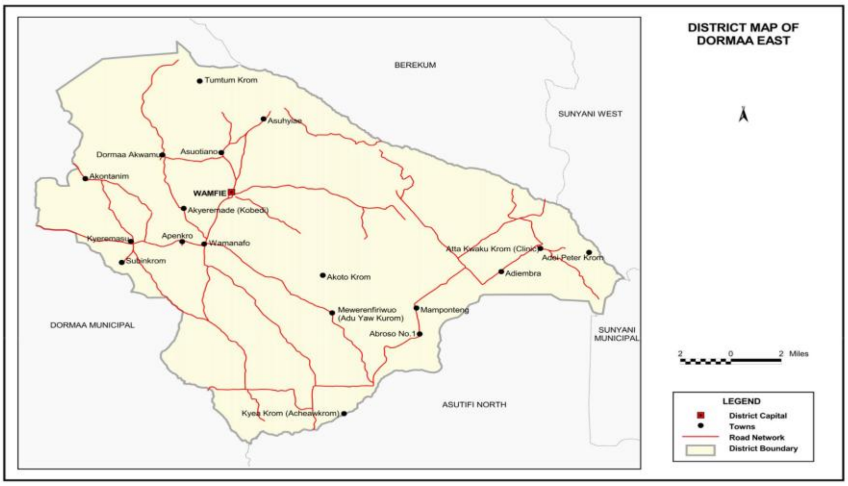

Figure 1. Map of the study area

2.2.Source of Chili Pepper Fruits and the Various Lining Media for Solar Drying andZeer Pot Refrigeration

One bag (1) of fresh scotch bonnet and one (1) bag of red cayenne were bought from chili pepper traders in the various major market centres in the respective communities, Asuotiano, Wamfie and Wamanafo. The various lining materials (one (1) bag each) of sand (0.02mm), styrofoam (0.05mm) and wood shaving (thickness = 0.02mm and length = 4.5 cm) were collected from each respective communities.

2.3.Preparation of Chili Pepper Fruits

Chili pepper fruits were sorted to eliminate diseased fruits, washed and divided into two (2). One (1) group was blanched for minutes (3) minutes at 100^0C using coalpot and thermometer. The other group was unblanched.

2.4. Development of Solar Dryer

Solar dryers were developed using the design of [17] with length (60 cm), width (40 cm) and height (85 cm). They were made of wood and the solar collection chambers were made of transparent polythene sheet fabricated to form triangular shape and hinged to one side of the drying chamber and other side provided with handle. The drying chambers were in the form of tables where metal meshes and black polythene sheets were cut and fabricated on the tables of the drying chambers. Inlet holes were created in front of the solar dryer and outlet holes were created at the opposite upper part of the solar dryer.

2.5. Procedures for Solar Drying Chili Pepper Fruits

Blanched chili peppers were dried from 8:00 am to 6:00 pm for two (2) weeks but unblanched chili peppers were dried for three (3) weeks. After drying of chili pepper fruits, the fruit stalks were removed or destalked.

Figure 2. Solar dryer

2.6. Procedures for Making Zeer Pot Refrigerator

Zeer pot refrigerators were developed using zeer pot design described by [18]. They were made of clay obtain in the communities, prepared to make it more elastic by pounding with pestle and potter's wheel was used to form outer clay pots (height (25cm), upper width of the pot (28 cm) and the base width of the pot (15 cm)) and inner clay pots (height 18 cm, upper width (14 cm) and base width (12 cm)) with their lids and allowed to dry for two (2) weeks under a shed. The dried clay pots were fired in an oven and allowed to cool for three (3) days before removing the fired zeer pots from the oven.

2.7. Procedures for Zeer Pot Refrigeration of Chili Peppers

The zeer pots were labelled with the use of paper tape and permanent marker. The bottom of the outer clay potswere filled to a height of 6 cm with the various lining materials of zeer pot. The inner clay pots were placed in outer clay pots and the space between inner and outer clay pots were filled with various lining media (sand (sieved), styrofoam (crushed) and wood shavings) to the top level. The weight of the zeer pots were measured using weighing scale with zeer pots filled with styrofoam, wood shavings and sand weighing 6.96kg, 7.18kg and 15.52kg respectively. Solar dried chili pepper varieties were placed in the various labelled zeer pot refrigerators. Each zeer pot refrigerator was kept 14cm apart (14 cm between rows and 14 cm within rows and each experimental set up was kept in each three (3) communities for three (3) month under room temperature (26 - 34^{0}C). Water (600ml)was used to replenish zeer pots every day on each morning.

Figure 3.Zeer pot refrigerators with different lining media

2.8.Experimental Design and Treatments

A 2 x 3 x 3 factorial experimental design in Randomized Complete Block Design (RCBD) with eighteen (18) treatments (Two (2) levels of chili pepper varieties, three (3) levels of solar drying processes and three (3) levels of types of lining media used in zeer pot storage). The two (2) levels of chili pepper varieties were scotch bonnet and red cayenne, the three (3) levels of solar drying processes were control, blanched and unblanched chili peppers and the three (3) levels of zeer pot lining media were sand, styrofoam and wood shavings. The experiment was replicated three (3) times with total sample population of fifty – four (54). After three (3) months of storage, samples of stored chili peppers were taken into labelled zip bags and placed in ice chest cooler, transported within four (4) hours to Food Science Laboratory, Kwame Nkrumah University of Science and Technology (KNUST) for Laboratory analyses.

2.9.Physico – Chemical Characteristics Analyses

Physico – chemical characteristics analyses were conducted in laboratory to determine the effect of varieties, solar drying and zeer pot refrigeration lining media on physico – chemical properties of chili pepper fruits.

2.9.1. Determination of thickness of pericarp of chili peppers

Vernier caliper was used to measure the thickness of pericarp of chili pepper fruits.

2.9.2. Determination of fruits porosity of chili peppers

Porosity was measured as described by [19], mass and volume relationships. Material was put into vessel of a specific weight and volume, and it was then weighed. Using the equation below, the porosity (ε) in percentage (%) of the chilli peppers was calculated.

$$\text{Percentage (\%) porosity } (\varepsilon) = \left(1 - \frac{\rho b}{\rho t}\right) \times 100$$

Where

ε = porosity (%), ρt= true density (g/cm^3), and ρb = bulk density (g/cm^3)

2.9.3. Total soluble solids determination

Using a handheld refractometer, the total soluble solids content was ascertained by dicing chilli peppers and extracting the juices by pressing the material. To quantify the total soluble solids, a drop of juice (about 0.1 ml) was placed on the refractometer's lens. Results were expressed in percentages of soluble solids [20].

2.9.4. Determination of titratable acidity

5g of sample was weighed into conical flask. 25ml of distilled H_2O was added.0.1 N NaOH was titrated to pH of 8.1[20].

Titratable acidity = $\frac{V\ (NaOH)x\ N\ (NaOH)x75x100}{V(of\ sample\ )\ x\ 1000}$

Titratable acid as tartaric acid (g / 100ml)

2.9.5. Determination of pH

10g of sample was weighed into clean, dry erlenmeyer and 100ml was added recently boiled H_2O at 25^0. Shaked until particles were evenly suspended and mixture was free of lumps. Digested 30 minutes, shaking frequently. It was stood for 10 minutes more, decanted supemate into the H –ion vessel, and immediately determined pH, using pH meter [20].

2.10.Data Analysis

Data obtained from the laboratory were subjected to Analysis of Variance (ANOVA) using Statistix 8.1. Where treatment means were significant, they were separated by Turkeys Highest Significant Difference (HSD) at 5% probability level.

3.RESULTS

3.1. Effect of Varieties, Solar Drying and Zeer Pot Refrigeration Lining Media on Physico – Chemical Characteristics of Chili Peppers

Physico – chemical analyses were conducted to determine effect of varieties, solar drying and zeer pot refrigeration lining media on physico – chemical characteristics of chili pepper fruits. The results showed that there were significant difference ($p < 0.05$) in the physico – chemical characteristics of chili pepper fruits.

3.1.1. Effect of varieties on physico – chemical characteristics of chili pepper fruits

Physico – chemical analyses were conducted to determine effect of varieties on physico – chemical characteristics of chili peppers. The results were presented in table.1. There were significant difference ($p < 0.05$) in the physico – chemical properties of chili pepper fruits.

3.1.2. Thickness of pericarp of chili pepper fruits

There was significant difference ($p < 0.05$) in the thickness of chili pepper fruits. Red cayenne recorded the highest pericarp thickness (0.21mm) and scotch bonnet recorded the least thickness of the pericarp (0.18mm).

3.1.3. Porosity of chili pepper fruits

There was significant difference ($p < 0.05$) in the porosity of chili pepper fruits. Scotch bonnet recorded significantly ($p < 0.05$) highest porosity (77.26%) while red cayenne showed the least porosity (72.3%).

3.1.4.Total soluble solids of chili peppers

Red cayenne significantly ($p< 0.05$) demonstrated the highest total soluble solids (2.42%) but scotch bonnet revealedthe least total soluble solids (1.20%).

3.1.5.Titratable acidity of chili peppers

Titratable acidity followed similar trend as porosity with scotch bonnet significantly ($p < 0.05$) registered the highest titratable acidity (0.56%) and red cayenne recorded the least titratable acidity (0.36%).

3.1.6. pH of chili peppers

pH of chili peppers continued similar trend with porosity and titratable acidity with scotch bonnet significantly ($p < 0.05$) recorded highest pH (6.29) and the least pH was shown in red cayenne (5.38).

Table 1. Effect of varieties on physico – chemical characteristics of chili pepper fruits

Varieties	Thickness (mm)	Porosity (%)	TSS (Brix%)	TA (%)	pH
1	0.18b	77.26a	1.20b	0.56a	6.29a
2	0.21a	72.3b	2.42a	0.36b	5.38b
HSD (0.05)	0.01	0.69	0.09	0.03	0.12
CV	6.30	1.68	9.01	12.79	3.74

Means with the same letters (s) in the columnare not significantly different from each other ($p > 0.05$, according to Tukeys HSD)

NB: 1 = Scotch bonnet

2= Red cayenne

3.2. Effect of Solar Drying Processes on Physico – Chemical Characteristics of Chili Pepper Fruits

To find out how solar drying affectedphysico-chemical characteristics of chilli pepper fruits, physico-chemical analyses were performed on the solar-dried samples. The results were presented in Table 2, which showed a significant difference ($p < 0.05$) in the physico-chemical properties of the solar-dried chilli pepper samples.

3.2.1. Thickness of pericarp of chili pepper fruits

There was significant difference ($p < 0.05$) in the thickness of pericarp of solar dried chili pepper fruits. Unblanched - solar dried chili pepper fruits had significantly highest thickness of pericarp (0.23mm) followed by blanched - solar dried chili pepper fruits (0.21mm) and control chili pepper fruits recorded the least thickness of pericarp of chili peppers (0.14mm).

3.2.2. Porosity of chili pepper fruits

Porosity was significantly ($p < 0.05$) greater (78.42%) in blanched - solar dried chili pepper samples followed by unblanched solar dried chili pepper samples (74.75%) and least recorded in controlled chili pepper fruits (71.19%).

3.2.3. Total soluble solids of chili pepper fruits

Unblanched - solar dried pepper samples were significantly ($p < 0.05$) higher (2.47%) followed by blanched solar dried samples (2.04%) and control samples recorded the least total soluble solids (0.92%).

3.2.4.Titratable acidity of chili pepper fruits

Similar to the trend of thickness of pericarp of chili peppers and total soluble solids,unblanched solar dried chili pepper samples had the highest titratable acidity (0.62%) followed by blanched solar dried chili pepper samples (0.49%) and the least titratable acidity was recorded in controlled chili pepper samples (0.28%).

3.2.5. pH of chili pepper fruits

pH content of solar dried chili pepper samples was significantly ($p < 0.05$) high in controlled chili pepper samples (6.95) followed by blanched solar dried pepper samples (5.93) and the least was indicated in unblanched solar dried samples (4.64).

Table 2. Effect of solar drying on physico – chemical characteristics of chili peppers

Solar	Thickness (mm)	Porosity (%)	TSS (Brix%)	TA (%)	pH
1	0.14c	71.19c	0.92c	0.28c	6.95a
2	0.21b	78.42a	2.04b	0.49b	5.93b
3	0.23a	74.75b	2.47a	0.62a	4.64c
HSD (0.05)	0.01	1.03	0.13	0.05	0.18
CV	6.30	1.68	9.01	12.79	3.74

Means with the same letters (s) in the columnare not significantly different from each other ($p > 0.05$, according to Tukeys HSD)

NB: 1 = Controlled chili pepper

2= Blanched solar dried chili pepper

3 = Unblanched solar dried chili pepper

3.3. Effect of Zeer Pot Lining Media on Physico – Chemical Characteristics of Chili Pepper Fruits

Physico – chemical analyses were conducted to determine the effect of zeer pot refrigeration lining media on physico – chemical characteristics of chili pepper fruits. Table 3 showed that there were significant difference ($p < 0.05$) in the physico – chemical characteristics of stored chili pepper samples.

3.3.1. Thickness of pericarp of chili pepper fruits

Chili peppers stored in wood shavings lining media of zeer pot refrigeration significantly ($p < 0.05$) recorded highest thickness of pericarp (0.22mm) which was followed by chili peppers stored in sand lining media of zeer pot refrigeration (0.20mm) and chili peppers stored in styrofoam lagging material of zeer pot refrigeration had the least (0.17mm) thickness of pericarp (0.17mm) of chili peppers,

3.3.2. Porosity of chili pepper fruits

Similar to the trend of thickness of pericarp of chili peppers, wood shaving used as lining media of zeer pot refrigeration recorded significantly the best porosity (80.67%) followed by sand used as lining media of zeer pot refrigeration (74.42%) and the lowest was recorded in styrofoam used as lining media of zeer pot refrigeration (69.27%).

3.3.3. Total soluble solids of chili pepper fruits

Styrofoam lining media of zeer pot refrigeration (2.03%) and sand lining media of zeer pot refrigeration (1.91%) recorded higher total soluble solids which were not significantly different ($p > 0.05$) from each other. However, styrofoam lining media of zeer pot refrigeration (2.03%) had the best total soluble solids as compared to sand (1.91%). The least total soluble solids were recorded in wood shavings lining media of zeer pot refrigeration (1.49%).

3.3.4.Titratable acidity of chili pepper fruits

Titratable acidity was significantly ($p < 0.05$) greater in sand lining media of zeer pot refrigeration (0.54%) followed by wood shavings lining media of zeer pot refrigeration (0.44%) and styrofoam lining media of zeer pot refrigeration (0.41%) which were not significantly different ($p > 0.05$) from each other. Comparatively between styrofoam lining media of zeer pot refrigeration and wood shavings lining media of zeer pot refrigeration, styrofoam lining media of zeer pot refrigeration had the least titratable acidity (0.41%).

3.3.5. pH of chili pepper fruits

Wood shavings lining media of zeer pot refrigeration continued similar trend of thickness of pericarp and porosity by recording significantly ($p < 0.05$) higher pH content (6.50) of chili pepper fruits. This was followed by styrofoam lining media of zeer pot refrigeration (6.01) and the least pH content was shown in sand lining media of zeer pot refrigeration (5.00).

Table 3. Effect of zeer pot refrigeration lining media on physico – chemical characteristics of chili pepper fruits

Lining media	Thickness (mm)	Porosity (%)	TSS (Brix%)	TA (%)	pH
1	0.20b	74.42b	1.91a	0.54a	5.00c
2	0.17c	69.27c	2.03a	0.41b	6.01b
3	0.22a	80.67a	1.49b	0.44b	6.50a
HSD (0.05)	0.01	1.03	0.13	0.05	0.18
CV	6.30	1.68	9.01	12.79	3.74

Means with the same letters (s) in the columnare not significantly different from each other ($p > 0.05$, according to Tukeys HSD)

NB: 1 = Sand
2= Styrofoam
3 = Wood shavings

4. DISCUSSIONS

4.1. Effect of Varieties, Solar Drying and Zeer Pot Refrigeration Lining Media on Physico – Chemical Characteristics of Chili Peppers

Physico – chemical analyses were done to determine effect of varieties, solar drying and zeer pot refrigeration lining media on physico – chemical characteristics of chili peppers. The results suggested that, there were significant difference ($p < 0.05$) in physico – chemical characteristics of chili pepper fruits.

4.1.1.Effect of varieties on physico – chemical characteristics of chili pepper fruits

Physico – chemical analyses were conducted to determine effect of varieties on physico – chemical characteristics of chili pepper fruits. Results from Table 1 indicated that, there were significant difference ($p < 0.05$) in physico – chemical characteristics of chili peppers.

Comment [B_Ali3]: Add some discussion why the effect was significant with some relevant references.

4.1.1.1. Thickness of pericarp of chili pepper fruits

There was significant difference ($p < 0.05$) in the thickness of pericarp of the chili pepper fruits with red cayenne recording the highest pericarp thickness (0.21mm) which was supported by investigation done by [21]. This high fruit pericarp might be due to good agronomical practices such as pruning of chili pepper plants which the nutrients that would be used for excessive growth were used to increase the size of the fruits which caused increase in thickness of pericarp of the chili pepper fruits [22]. Thickness of pericarp of the fruits protects the fruits against insects and microbial invasions and limits water loss and gas exchange or increase shelf – life of chili pepper fruits [23].

4.1.1.2. Porosity of chili pepper fruits

There was significant effect ($p < 0.05$) on porosity of chili pepper variety with scotch bonnet registered the highest porosity (77.26%) which matched with research done by [24]. Increased in porosity could be due to textural properties of the cellular scotch bonnet [25, 26]. Scotch bonnet with high pore formation in food affects quality of food during drying of food [27]. Tissue porosity affects gas exchange causing respiration of fruits and vegetables during storage [28].

4.1.1.3. Total soluble solids of chili peppers

Red cayenne had significantly ($p < 0.05$) higher total soluble solids (2.42%) which was supported by investigation done by [29]. The increased in total soluble solids in red cayenne as observed could be attributed to the genotype and the ripening stage of red cayenne fruits [30, 31]. Red cayenne has better taste (sweetness) than scotch bonnet [32].

4.1.1.4.Titratable acidity of chili peppers

There was significant difference ($p < 0.05$) in titratable acidity with scotch bonnet showed significantly ($p < 0.05$) higher titratable acidity (0.56%) of chili peppers [29]. The increased in titratable acidity in scotch bonnet could be as a result of genotype and the ripening stage of scotch bonnet [30, 31). The scotch bonnet fruits had better genotype tissue that retained titratable acidity and harvested at mature stage where titratable acidity was high, hence scotch bonnet had better sourness - taste in chili pepperfruits [33].

4.1.1.5. pHof chili peppers

Significantly, scotch bonnet recorded the highest pH (6.29) which aligned with studies done by [29]. The increased in pH in scotch bonnet could be related to the genotype and the ripening stage of scotch bonnet [30, 31). High pH value in scotch bonnet could prevent microbial growth in food [34].

4.1.2. Effect of Solar Drying on Physico – Chemical Characteristics of Chili Pepper Fruits.

Physico – chemical analyses were conducted to determine the effect of solar drying on physico – chemical characteristics of chili peppers. The results showed in table 2 indicated that, there were significant difference ($p < 0.05$) in physico – chemical characteristics of chili pepper fruits.

4.1.2.1. Thickness of pericarp of chili pepper fruits

There were significant difference ($p < 0.05$) in the pericarp thickness of chili pepper fruits with unblanched - solar dried chili pepper fruits were significantly high (0.23mm) which matched with investigation by [35]. The high thickness of pericarp in unblanched – solar dried chili peppers might be due to undestructed fruit cells by temperature which underwent diffusion processes both external and internal drying process to maintain high thickness of pericarp of the fruits [36, 37]. Thickness of pericarp of unblanched – solar dried chili pepper fruits protect the fruits from insects, microbial invasions, limits water loss, gas exchange and thickness of pericarp of chili peppers is the most needed part of chili peppers used by consumers [23].

4.1.2.2. Porosity of chili pepper fruits

There was significant difference ($p < 0.05$) in the porosity of chili pepper fruits with blanched - solar dried chili pepper fruits had significantly higher porosity (78.42%) [38]. This high porosity in blanched – solar dried could be as a result of heat applied to the chili pepper fruits which expanded the fragile cells or tissues in the chili pepper fruits to increase porosity of the chili pepper fruits [39]. High tissue porosity affects gas exchange causing respiration of fruits and vegetables during storage [40].

4.1.2.3. Total soluble solids of chili pepper fruits

Unblanched - solar dried chili pepper fruits were significantly ($p < 0.05$) higher in total soluble solids (2.47%) which was supported by [41]. This could be attributed to the fact that, unblanched chili pepper fruits accumulated more dry matter during drying to increase or improve total soluble solids of chili pepper fruits [42]. Total soluble solids affect the taste (sweetness) in fruits [32].

4.1.2.4.Titratable acidity of chili pepper fruits

Unblanched - solar dried chili pepper fruits recorded the highest titratable acidity (0.62%) which aligned with studied done by [43, 44). The increased in titratable acidity in unblanched – solar dried chili pepper fruits could be due to increase lactic bacteria which produced organic acid to increase titratable acidity in unblanched – solar dried chili pepper fruits. Unblanched – solar drying takes time to break the outer cells before the inner cells will break to aid drying of chili peppers and take time for these drying processes to take place, hence produce fermented chili chili pepper fruits to increase lactic acid bacteria to increase titratable acidity [45]. Titratable acidity determines the maturity and sour - taste in fruits [33].

4.1.2.5. pH of chili pepper fruits

Controlled samples of chili pepper fruits had significantly ($p < 0.05$) higher pH content (6.95) which agreed with research carried by [46]. High pH of controlled chili peppers may be attributed to the fact that, most peppers have high pH [47]. pH value in food will prevent microbial growth [34].

4.1.3. Effect of zeer pot refrigeration lining media on physico – chemical characteristics of chili pepper fruits

Physico – chemical analyses were conducted on lining media of zeer pot storage to determine effect of zeer pot refrigeration lining media on physico – chemical characteristics of chili pepper fruits. Table 3 showed that, there were significant difference ($p < 0.05$) in the physico – chemical characteristics of chili peppers stored in zeer pot lining media.

4.1.3.1. Thickness of pericarp of chili pepper fruits

Wood shavings lining media of zeer pot refrigeration significantly ($p < 0.05$)had higher thickness of pericarp (0.22mm) which was supported by [48]. High thickness of the pericarp might be due to large air spaces between the wood shavings which increased air movement to increase evaporative cooling effect of the inner pot to conserve the fruit pericarp structures in the chili pepper fruits [49]. Thickness of pericarp of the fruits protects the fruits against insects and microbial invasions and limits water loss and gas exchange. It is the part which contains the needed nutrients used by human beings [23].

4.1.3.2. Porosity of chili pepper fruits

Porosity of chili peppers was significantly ($p < 0.05$) higher in wood shavings lining media of zeer pot refrigeration (80.67%) which matched with studies done by [50]. The increased in porosity might be due to high porosity of wood shavings lining media of zeer pot refrigeration been bad conductor of heat to decrease cooling effect in the inner pots to increase heat to expand the cells of chili peppers [51] and the wood shavings are made of ligin (27%), 70% cellulose and hemicellulose which underwent decomposition during storage to increase heat in the inner pots to expand the cells of chili peppers to increase porosity of chili pepper [52]. Pore formation in food affects quality of food during drying of food [53]. Tissue porosity affects gas exchange causing respiration of fruits and vegetables during storage [40].

4.1.3.3. Total soluble solids of chili pepper fruits

Styrofoam had the best total soluble solids (2.03%) which agreed with investigation conducted by [54]. Increased in total soluble solids could be attributed to styrofoam been made of air (98%) which increased the cooling effect to reduce metabolic activities to increase total soluble solids of chili peppers [55]. Total soluble solids affect the taste (sweetness) in fruits [32].

4.1.3.4.Titratable acidity of chili pepper fruits

Sand used as lining material of zeer pot storage had higher titratable acidity (0.54%) which aligned with studies carried out by [54]. The high titratable acidity could be as a result of sand lining media been a good conductor of heat and had high porosity for easy movement of air so as temperature increased it increased the cooling effect to reduce oxidation of the chili pepper samples in the sand lining media to increasetitratable acidity [56]. Titratable acidity determines the maturity and sour - taste in fruits [33].

4.1.3.5. pH of chili pepper fruits

Wood shavings lining media of zeer pot refrigeration had significantly ($p < 0.05$) higher pH content (6.50) which matched with studies done by [54]. The high pH of chili peppers could be attributed to high air spaces in the wood shavings lining media of zeer pot storage which enabled more air to enter the wood shavings lining material to increase the cooling effect and reduced respiration of chili pepper fruits in order to increase the pH of chili pepper fruits [49]. High pH value in food will prevent microbial growth [34].

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusions

With regard todetermination of effect of varieties, solar drying and zeer pot refrigeration lining media on physico – chemical characteristics of chili pepper fruits. Results on effect of varieties of physico – chemical characteristics of chili peppers indicated that, there were significant difference ($p < 0.05$) in physico – chemical properties of chili peppers with red cayenne had significantly ($p < 0.05$) the best pericarp thickness (0.21mm), porosity (72.3%) total soluble solids (2.42%). pH (5.38) but titratable acidity (0.56%) of chili pepper fruits was significantly ($p < 0.05$) higher in scotch bonnet. Also, on effect of solar drying on physico – chemical characteristics of chili pepper fruits, there were significantly ($p < 0.05$) better thickness of pericarp (0.23mm), total soluble solids (2.47%), titratable acidity (0.62%) and pH (4.64) in unblanchedsolar dried chili pepper fruits while the best porosity (71.19%) was noted in controlled chili pepper fruits. Again, on effect of lining media of zeer pot refrigeration on physico – chemical characteristics of chili pepper fruits, thickness of pericarp (0.22mm) was significantly ($p < 0.05$) higher in wood shavings used as zeer pot lining media but total soluble solids (2.03%) and porosity (69.27%) were significantly ($p < 0.05$) thebest in styrofoam used as zeer pot lining media. Titratable acidity (0.54%) and pH (5.00) were significantly ($p < 0.05$) better shown in sand used as lining media of zeer pot refrigeration.

5.2 Recommendations

i. More investigations should be revitalized by research institutions to investigate why scotch bonnet had low pericarp thickness, total soluble solids and high porosity as well aspH.

ii. Research should be conducted by research institutions on why controlled chili peppers were low in thickness of pericarp, total soluble solids, titratable acidity as well as high pH (6.95) and blanched solar dried chili peppers recorded the higher porosity.

iii. More investigations should be carried – out by research institutions to find – out why styrofoam lining media of zeer pot refrigeration had least thickness of pericarp and titratable acidity

iv. More studies should be conducted by research institutions to find - out why wood shavings used as lining media of zeer pot had low total soluble solids and high porosity as well as pH of chili peppers.

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