Physicochemical Investigation of Convective Solar Drying for Post-Harvest Conservation of Hot Peppers in Adrar, Algeria

A. Loumani, A. Mediani, A. A. Larbi ,M. Foullanine, W. Braham Chouch, Ch.Tigani, Z. Belkacem and A. Djaber

Unité de Recherche en Energies Renouvelables en Milieu Saharien, URERMS, Centre de Développement des Energies Renouvelables, CDER 01000, Adrar, Algeria

*Corresponding author; Email: akil076@live.fr

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ABSTRACT

In this study, the impact of convective solar drying on the physiochemical characteristics of hot peppers harvested in Algeria was investigated. The freshly harvested peppers underwent convective drying until they reached a desired stable weight. Various parameters including moisture content, water activity (Aw), pH, crude protein, crude fat, total sugars, and polyphenol content were measured. The drying process, using an optimal method, took approximately 2 to 3 days and resulted in moisture content levels of (32.41 %), Aw of (0.26%), pH of (4.1), acidity of (2.8), ash content of (73.38%), dry matter of (67,59 %), total protein content of (0.83%), sugar content of (2.9%), polyphenol content of (89%), and crude fat content of (0.23%). In comparison, the values for the freshly harvested hot peppers were (89%), (0.92%), (5.34%), (3.6%), (8%), (11%), (1.64%), (1.64%), (125%), and (0.36%) respectively. These findings confirm that solar drying effectively preserved the nutritional quality of the hot peppers, with minimal losses in some properties compared to the values of the freshly harvested peppers.

I. Introduction

Fundamentally, consuming fresh produce is the most beneficial choice for humans due to the high content of carbohydrates, fiber, minerals, antioxidants, and vitamins. However, the main problem is that approximately 25% to 50% of fruits and vegetables crops are lost or wasted after harvest due to physiological and pathological deterioration[1], [2]. For farmers in underdeveloped countries, extending the shelf life of agricultural products is crucial in order to improve their agricultural productivity [3]. After harvest, solar drying is an essential method for preserving perishable agricultural products and extending their shelf lives [4]. According to this method, a reduction in moisture content and water activity increases shelf life by preventing to the proliferation and decay of microorganisms and the loss of nutritional compounds [5]. Depending on the climatic conditions, this process may occur. Convective air-drying in indirect solar dryers has been investigated in fruit types such as peaches, figs, plums, grapes, and cherries, as well as vegetables such as celery, corn, carrot, tomato, garlic, and peppers, for both hot and sweet varieties [6]. The pepper plant is the most common product consumed by native people in the Adrar region, particularly the spicy variety, which is used in cooking popular foods. Hot pepper is widely consumed by the locals, in many ways, fresh, pickled, and dried. And sun-solar drying using the traditional method [7]. The *capsicum annuum* is the most widely cultivated of the 25 species belonging to this genus (Chauxand Foury, 1994) [8]. The main objective of our study is to determine the physicochemical properties of this hot pepper variety of *Capsicum annuum* and evaluate the nutritional value.

II. Materials and Methods

II.1. Plant Material

Peppers are varieties of hot peppers of the species *Capsicum annuum* with very large fruits. Both the fruit and the plant are included in the term. It is an annual plant of the *Solanaceae* family native to Mexico, Central America and South America [9]. The fruits of the plant are eaten raw or cooked as vegetables , referring to both the plant and the fruit [10]. Pepper was chosen for our experiment. The choice is motivated by its relative abundance, the added value of its processing, the service rendered to the economy and the improvement of income in the agro-food sector [8].

II.2. Sampling

Figure 1 provides a visual representation of the hot pepper variety cultivated and consumed by the local community in the Adrar province. The image showcases the distinctive characteristics of the hot pepper, such as its vibrant colors, elongated shape, and unique texture. This particular variety holds significant cultural and culinary importance in the region, as it is a staple ingredient in local dishes and adds a distinct flavor and spice to the cuisine. The cultivation and consumption of this hot pepper variety reflect the rich agricultural traditions and culinary heritage of the Adrar province.

Figure 1: Photograph view of a sample varitey of the hot pepper
(*Capsicum annuum*)

II.3. Physical Characterization of Hot pepper (*Capsicum annuum*)

The length, circumference, and mass of the peppers were estimated using a meter tape and digit scale.
The Suitable harvests of hot peppers, which were similar in length, size, and diameter, were selected and transported in a hermitic box at C and 90% relative humidity. He sample was cleaned out the dust using the tap water. Then was cut into small slices, and then spread the same mass on the trays. The trays were placed in an indirect dryer (fig 2) (fig3). The process of drying was stopped until the stabilization of weigh [7].

Figure 2: Photograph view of type hybrid solar dryer

Figure 3: Trays loaded with the hot pepper (Capsicum annuum)

1) Determination of activity water

Water activity (Aw) is a major factor in preventing or limiting microbial growth and hurdle in the preservation of agricultural products. The determination of activity water was monitored by the measuring of small samples of fresh peppers and in final of process drying using activity water meter (Hygrolab) [11].

2) Determination of Moisture content

A glass petri dish containing fresh peppers samples was used to determine the moisture content. This sample contains 10 g of vegetable matter. It is cut into slices and placed on a perforated wooden plate. It is then dried in an oven at a temperature of 135 ± 2°C for 2 hours[12]. The calculation of Moisture was carried in following equation:

$$\text{Moisture } \% = \frac{ws-(w2-w1)}{ws} x100$$

Where:
W1: weight of dish (g)
W2: weight of dish after drying (g)
Ws: weight of sample (g)

3) Determination of protein

The crude protein was produced using the Kjeldhal method (AOAC, 1990)[13] . This method works by converting the organic nitrogen of the sample into mineral nitrogen using concentrated boiling NH4S2O4. After that, the ammonia is distilled and titrated with sulfuric acid in the presence of a colored indicator (acid boric) by acidimetry. The total protein content is calculated using the conversion factor (6.25), or 16% nitrogen in proteins.

4) Determination of total sugars

The determined sugars by the colorimetric method using phenol and sulfuric acid developed by DuBois et al, considered the most reliable method of measuring simple sugars and oligosaccharides content.
This technique is based on the action of concentrated and hot mineral acids. The hexoses and pentoses in the medium undergo extensive internal dehydration, followed by cyclization resulting in the formation of derivatives of furfural and 5-hydroxymethylfurfural, reacting with phenol. The formation of a yellow-red complex makes it possible to monitor the concentration of total sugars in the sample by reading the absorbance at 485 nm [14].

5) Determination of total polyphenol

Hot peppers are among the most nutritious vegetables with high levels of total polyphenols. The total polyphenols were determined using Folin-Ciocalteu's spectrophotometric method. Folin-Ciocalteu's reagent is a yellow acid consisting of a mixture of two acids: phosphotungstic acid (H3PW12O40) and phosphomolybdic acid (H3PMo12O40). It is reduced during the oxidation of phenols to form a blue complex stable of tungsten and molybdenum oxides. The coloration produced, including the absorption maximum is around760 nm, and is proportional to the amount of compounds phenolics present in plant extracts [15].

III. Results and Discussion

1) Physical properties

Table 1 shows that the hot pepper has a length (4.1cm), a circumference (5.2cm), and a mass (2.8g) that are similar to the measures computed by Michel, (2022) [6], who reported that the hot pepper harvested in Côte d'Ivoire had a length (3.37 cm), a circumference (6.55 cm), and a mass of 3.44 g. The obtained data confirm the garter size, circumference, and mass of the hot pepper in comparison to those of other countries this was also observed by Pegon, Zaman in 2009[12].

Table 1: Physical parameters of the Hot pepper of variety of
The species *Capsicum annuum*

Parameters	Hot Pepper (local)	Hot pepper (cote d'Ivoire)
Length (cm)	4.1	3.37
Circumferences (cm)	5.2	6.55
Mass (g)	2.8	3.44

2) Chemical properties

Based on Figure 4, it can be observed that the hot pepper exhibited higher levels of moisture content (67, 59%), Aw (0.26), pH (4.1), acidity (2.8), ash (32.41%), dry matter (73.38%), total protein (0.83%), total sugars (2.9%), and polyphenol content (89%), with lower values of crude fat (0.23%). In contrast, the fresh hot pepper had values of (89%), (0.92), (5.34), (3.6), (8%), (11%), (1.09), and (1.64) (125%), (0.36%).

The variety of hot pepper Capsicum annuum have very high humidity parentage, over 80%, several author have results close to our results such as Lopez-Hernandez et al., 1996 [7], which said that the humidity of hot pepper with variety of Capsicum annuum is 91%.these value are also close to that revealed in onion variety (Allium cepa) (89.06%) by Konate et al. 2017[6] and lower than garlic verity (*Allium sativum L*) (58.90%) by Loumani et al.2022[16] .indeed this higher moisture content is disadvantageous for extension of shelf life and for their storage since the hot pepper could be exhibit to spoilage and rotting by pathogen bacteria and yeast and molds. Similar results were observed by Ali et al in 2010[17]. For thus the treatment of fresh hot pepper by solar drying is crucial solution to prolonging the shelf life of this product with any degradation in quality.

In terms of pH and acidity values, the hot pepper has a higher pH than the local tomato variety Adrar in Algeria (4.10), as studied by Loumani et al. (2022)[18] .

The value of PH since 4.3 could lead to the proliferation of foodborne pathogen bacteria including coliforms. Therefore, it must be cleaned with tap water before consumption.

As hot pepper *Capsicum annuum* has a low lipid content and low protein content, our results are slimmer than those of Okouango et al. (2015)[19]. The lipid have essential roles in the composition, storage, and structure of cells.tein, their level is lower than eggplant varieties S.aethiopicum gilo (1.68 ± 0.04) and S. melogena (1.81 ±0.06) cited by (Michel et al .2022) [6].

The protein Proteins comprise muscle and skin and perform functions such as immunity (antibodies), carry oxygen in hemoglobin and help digestion (ANSES, 2021). The analysis of total sugar levels indicates that the hot pepper (*Capsicum annum*) has a poor level when compared to vegetables. Sugars are beneficial because they provide energy and keep muscle cells, brain cells, red blood cells, and other body tissues healthy. The Polyphenol contents may be significantly higher for this variety than other like sweet pepper (125.91mg / 100g ± 8.46) obtained by (Michel et al .2022)[6]. In conclusion, the results suggest that solar drying saves the Physiochemical variables with few losses, which does not affect the quality of products intended for human consumption significantly.

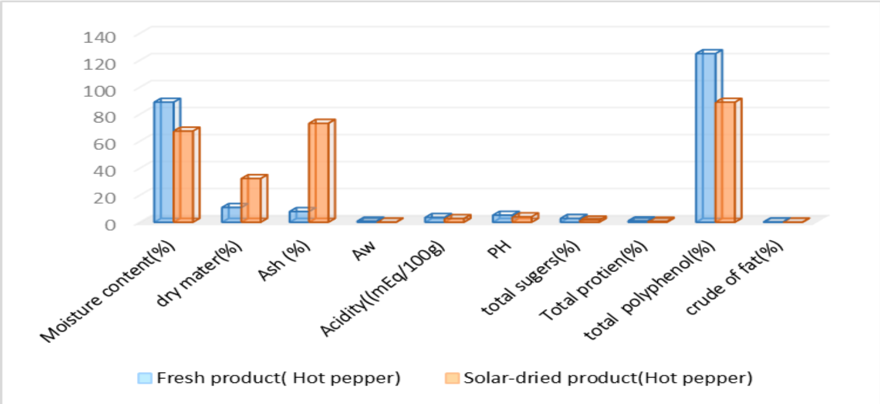

Figure 4: Histogram view the physicochemical parameters of Hot pepper (*Capsicum annuum)*

IV. Conclusion

Solar drying is an effective method for preserving and extending the shelf life of perishable products while retaining their nutritional value. This study demonstrated that hot peppers dried using solar drying exhibited improved consistency in terms of ash content, moisture level, pH, acidity, protein, fat, sugars, and polyphenol content compared to fresh hot peppers. Furthermore, minimal degradation was observed during the drying process.These findings highlight the importance of further research to gain a deeper understanding of the behavior of solar drying and to develop models that enhance and optimize this process. Exploring additional studies in this area will allow us to acquire advanced knowledge and expertise in solar drying, leading to improved efficiency and quality of dried products. By continuously enhancing this process, we can ensure better preservation of nutritional attributes and promote sustainable methods of food preservation.

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