Effect of solar drying on the quality of potato

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***Abstract* — The effect of solar drying on the quality of the dried potato slices was investigated. The parameters studied included total colour change (ΔE), Reducing sugars and pH. The results of drying tests, using a hybrid solar system led towards the choice of the treatment under controlled air temperature of 50°C with air flow of 1 m/s. At this temperature the measured quality parameters confirmed that the final product could preserve its clear color, reducing sugar and pH. Finally, it could be stated that the present study, using solar energy, could offer a practical alternative to the conventional means actually using the cold room techniques.**

***Keywords*— Potato; Drying; Solar energy; Quality.**

I. Introduction

Many farmers of the world are faced with the problem of reducing the moisture content of their harvested crops to prevent spoilage during storage. The situation is worse for farmers in the rural areas of developing countries where there is no access to electricity. Most of the harvested crops are susceptible to deterioration due to poor preservation. Therefore, inorder to remove moisture drying is done [1]. Drying is one of the oldest and the most commonly used methods of preservation of fruits, vegetables and aquatic products as it lowers water activity and extends shelf-life [2].

Quality of fruits and vegetables during drying has been studied by several researchers, e.g.,

E. Demiray and Y. Tulek [3] studied the effect of air temperatures (45, 55 and 65°C) on color change kinetics of carrot slices was investigated.

D. Mennouche [4] tested the quality of Algerian Deglet-Nour dates Numerous quality parameters were simultaneously investigated relative to each treatment condition: microbiological degradation, sugar composition and color change.

J.M. Łechtanska et al. [5] and J. Szadzinska et al. [6] studied the quality of the dried green pepper. This was assessed based on the vitamin C retention, water activity, total color change and the ability to rehydration. Effects of high-humidity hot air impingement blanching under different times (30, 60, 90, 120, 150, 180, 210, and 240 s) on drying characteristics and quality attributes of red peppers in terms of surface colour, red pigment content, microstructure and texture were investigated by J. Wang et al. [7].

S. Chaouicha et al. [8] tried to track the impact of various controlling factors of hybrid solar drying on the color difference as a quality parameter of dried potato slices.

J. B. Hussein [9] studied the effect of hybrid solar drying method on the sensory properties of tomato. The assessed qualities include: color, taste, flavour and overall acceptability. Also, A. Wojdyło et al. [10] determined the effect of different dying methods on key quality parameters of dried jujube fruits.

A. Kita et al. [11] determined the content of polyphones, anthocyanins, reducing sugars and antioxidant activity which could improve the quality of potato chips.

S. Pareek and R.A Kaushik [12] studied the effect of drying methods (Direct solar, Oven, Microwave and Fluidized bed) on the quality of Indian gooseberry powder during storage. Assessed qualities include: Total sugars, Reducing sugars, ascorbic acid, tannins and titrable acidity.

After drying the samples were weighed and subjected to quality analysis. The quality of the dried samples was assessed by measuring their total color change [3-9], reducing sugars [4, 11, 12] and pH,.

II. Materials and Methods

A. *Sample preparation*

According to FAOSTAT, the production of potatoes in Algeria has increased at a very rapid rate in the last few years (2010-2014). In 2010, the production was only 3 300 312 tonnes and reached 4 673 516 tonnes in 2014 [13].

Potatoes used in this study were brought from the region of Oued-Souf which is located in a hot dry area at 33°30′ Nord latitude and 6°47′Est longitude [16], at 640 km southwards from the capital of Algeria. The samples of uniform size were selected. After washing, the potatoes were cut into slices of 0.005 m in thickness. The slices were then scattered on the grid of the drying room. The average total weight of the dried products was 400 g on the grid for each experiment. The initial moisture content of the potato samples was 4.47 kg water/kg dry matter.

B. *Drying experiments*

Drying experiments were performed on an indirect solar dryer assembled at LENREZA laboratory (Laboratory of Development of new and Renewable Energy in Arid and Saharan zones), University of Ouargla, Algeria. The dryer consists mainly of a solar collector and a drying room. A flat

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plate solar air collector of specific dimensions (Fig. 1) have been designed and fabricated to supply hot air for drying. The dimension of the collector is: 2.5 m in length, 1 m in width and 0.12 m in height. All air collectors were experimentally tested individually for their thermal performance on different configurations. Galvanized steel of 0.001 m thickness was used for the fabrication of all the collectors. The specific area of absorber tray was 2.5 m^2 which has been made of by using a 0.003 m thick aluminium sheet. The absorber tray was painted dull black to absorb the maximum amount of solar energy. To reduce the heat losses to the surrounding, a 0.06 m thick layer of glass-wool was placed at the bottom and lateral sides of the collector. A single pane transparent float glass 0.004 m [15] thickness was used for glazing to allow the solar radiation inside the solar collector. The single glazing has been considered especially for the maintenance of the collector. The distance between glazing and absorber tray was 0.06 cm for all collectors.

The drying room is composed of two metal galvanized sheets separated with a polystyrene layer. The dimension of the room is: 1 m in length, 0.63 m in width and 2.5m in height. The product to be dried (potato) was calibrated on a tray made of a galvanized metal grid.

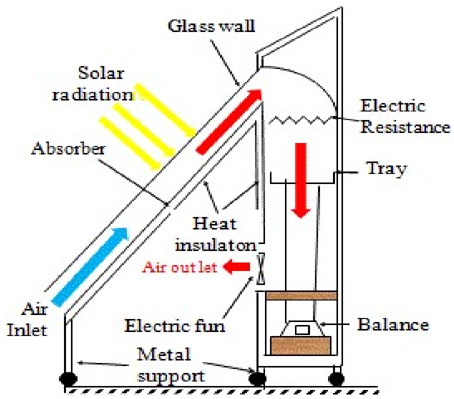

Fig. 1 Schematic diagram of the indirect solar dryer.

The design and operating parameters are shown in Table 1.

TABLE I
THE BASIC DESIGN AND OPERATING PARAMETERS

Parameters	Values
Location of collector	Ouargla University-Algeria
Tilted angle	31°
Collector orientation	South
Date	April 2016
Dimension of the collector	(2.5 x 1 x 0.025) m
Dimension of the drying room	(1 x 0.63 x 2.5) m
Fan	1500 kW
Fiber glass thickness	0.06 m
Absorptance of absorber [16]	0.94
Emissivity of absorber [16]	0.96
Emissivity of glass cover [16]	0.89
Transmittance of glass cover [16]	0.96

Ambient air entering the drying room, passing through the collector, is heated by thermal convective exchange with the absorber. The heated air passes through the surface of the humid potato slices, where is charged with water vapor and evacuated outside the dryer through the centrifugal fan, The fan was controlled by electronic controller. The dried potato mass are measured with an electronic balance of accuracy 0.01g placed in bottom of drying room as shown in Fig. 1

Fig. 2 Photo of the indirect solar dryer.

C. *Quality analysis*

After drying the samples were weighed and subjected to quality analysis. The quality of the dried samples was assessed by measuring their total color change, reducing sugar content and pH

The color attributes of dried potatoes in terms of L, a, and b values were measured using a CR-400 colorimeter (Konica Minolta Co., Tokyo, Japan) which was calibrated with a white standard board. The color parameters for the color change of the foods were quantified by Hunter [3]. The color difference (ΔE) was used to describe the color change during drying and was calculated using the color values of fresh potatos as the control.

$$\Delta E = \sqrt{(L-L_0)^2 + (a-a_0)^2 + (b-b_0)^2} \quad (1)$$

L, a and b color parameters represent brightness to darkness, redness (+) to greenness (-), and yellowness (+) to blueness (-), respectively. The reported color parameters are the mean values of 10 measurements. L represents (whiteness/darkness), a (redness/greenness) and b (yellowness/blueness) values. These values were also used for calculation of the total color change (ΔE).

The reducing sugar content of potatoes is generally determined by very accurate chemical methods, such as Bertrand's method. This method is based on the reducing action of sugar on the alkaline solution of tartarate complex with cupric ion; the cuprous oxide formed is dissolved in warm acid solution of ferric alum. The ferric alum is reduced

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to $FeSO_4$ which is titrated against standardized $KMnO_4$; Cu equivalence is correlated with the table to get the amount of reducing sugar. In Fehling method sugar solutions is taken in the burette a known volume of Fehling solution is taken in conical flask. This is titrated at a temperature 65-70°C. Titration is continued till it acquires a very faint blue color; add 3 drops of methylene blue indicator. The dye is reduced to a colorless compound immediately and the color changes from blue to red at the end point. [17]

Another quality parameter was determined using pH meter (HANNA Instruments). A small portion (4g) of fresh/dried potato was placed in 200 ml of distilled water

III. RESULTS AND DISCUSSION

A. Drying curves

Water content was determined using a moisture analyser. Sample weight (3 g); temperature analysis (105°C). The device stops automatically once the weight of dehydrated sample becomes constant. The mass values of each sample before and after dehydration were measured gravimetrically.

The moisture content of samples was calculated by using equation (2):

$$X_t = \frac{M_t - M_d}{M_d} \quad (2)$$

Where, X_t is the moisture content on dry basis (d.b) at instant t, M_t is the mass (g) of material at instant t and M_d is the dry mass of the material (g).

The moisture content, measured was about 82% (4.44 d.b), the final water content of the potato was 0.13 d.b [8]. The average total weight of the dried products was 400g on the grid for each experiment.

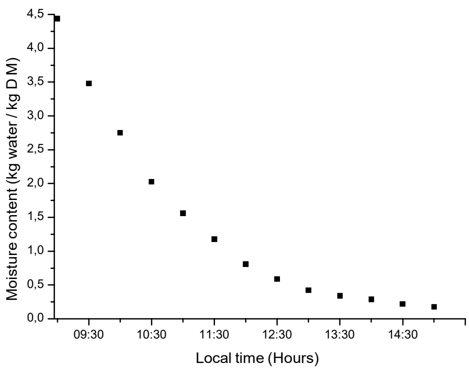

Fig. 3 Moisture content changes.

Fig. 3 demonstrates the variation of the moisture content (M) with time during the drying process. The high rate of water loss was observed within the three first drying hours between 9:00 and 12:00. Since 12:00 the water loss became less important at the end of the drying process.

B. Effect of drying on color change of potato slices

Color is visually considered one of the most important parameters in the definition of quality of fried potatoes and is the result of the Maillard reaction that depends on the content of reducing sugars and amino acids or proteins at the surface. [18]

Based on equation (1), the the total color change (ΔE) of potato slices were calculated, and the result is displayed in Fig.4.

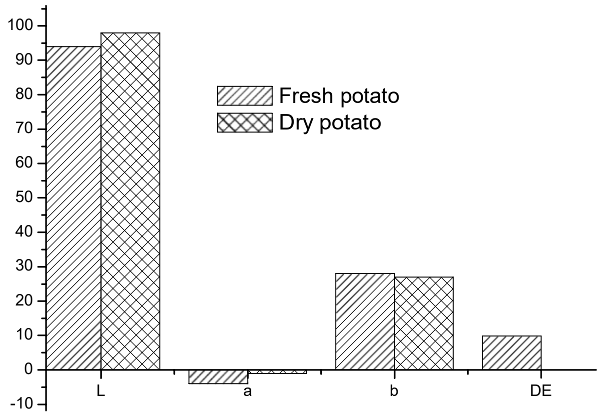

Fig. 4 Effect of drying on the total color change of dry potato.

Fig. 4 shows L, a, b values and the total color change (ΔE) between fresh and dried potato. It shows that L value increased from 94 to 98, also, a increased from -4 to -1. But b decreased from 28 to 27. As a whole, the total color change of potato slices about 9.82.

C. Effect of drying on the estimated reducing sugar by Bertrand's Method of potato slices

The reducing sugars contents were evaluated following the Bertrand's Method, as shown in Fig 5

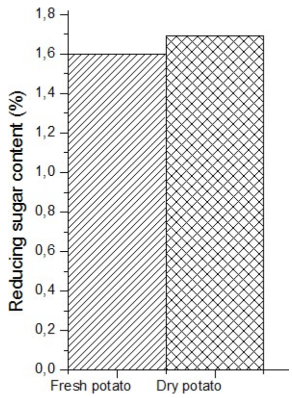

Fig. 5 Reducing sugar content of fresh and dry potato.

The value revealed that the reducing (fructose and glucose) sugar content (Fig .5) was affected by drying process.

The content of dry matter ranged about 18 g /100 g of fresh matter (FM). It was found that reducing sugar content of dried

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potato was not higher (1.69 g/ 100 g FM) than fresh (1.60 g/ 100 g FM).

D. Effect of drying on pH of potato slices

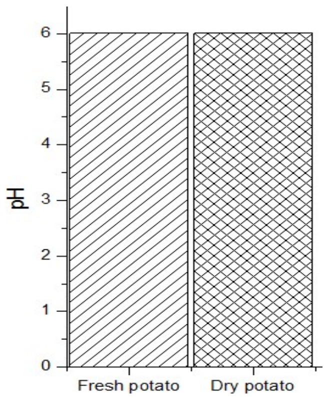

Fig. 6 pH of fresh and dry potato.

Fig. 6 represents the value of pH of the fresh potato and the dry potato. It was found the dried potato and the fresh one was similar (6.01).

IV. Conclusions

Potato chips obtained from drying process at 50°C have the same freshness. Reduced sugars content in dry potatoes are not higher than fresh ones. The pH has the same value, but a slight difference in the total colour between the fresh and the dry potato was observed.

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