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Effect of Simultaneous Application of Ultrasound and Microwave on Level of Wrinkle and the Ability of Water Reabsorption during Bell Pepper Drying by Oven

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ABSTRACT

One of the very significant features in dried foods is their ability of absorbing water. Reabsorption of water is a key feature in dried foods, so the more a product has the ability in absorbing water, the better condition will be established. The aim of the research has been investigating effects of microwave, ultrasound and oven on drying bell pepper. Hence, pepper slices were pretreated using microwave and ultrasound separately and then they were placed inside oven for the final drying. In this research three microwaves power (200, 300 and 400 watt), three microwave times(5, 10 and 15 seconds), three oven temperatures (50, 60 and 70 degree Celsius), three different frequencies of ultrasound (30, 70 and 110 kilohertz) and three different times of using ultrasound (10, 20 and 30 minutes) were applied. The results indicated that using microwave with lower level of time and power, oven with lower temperature and ultrasound with higher level of frequency and fewer times can lead to improvement in the product which can be suggested as a fine pretreatment in producing bell pepper.

KEYWORDS: bell pepper, water absorption, microwave, ultrasound, drying.

1.INTRODUCTION

Due to drying and reducing moisture level of foodstuff, the possibility of microbial corruption is increased and the speed in other chemical and enzyme reactions will be significantly reduced (Jang et al, 2006). Moreover drying has a protective influence on the product, it reduces weight and size significantly and as a result transportation and storing costs will be reduced. Also it leads to producing products which can be consumed easier (Shabani, Goldareh. 1999).

Keeping fruits and vegetables with drying approach does need a certain skill. From aspect of form and structural composition of these products, removing moisture should be done in a way that has the least effect on the quality. In other words, the product which is produced in the drying process should be able to return to its primary quality to a great level, so that if in the final drying phase the product does have fine nutrition quality with poor water absorption power, it will be regarded poor and cannot be consumed practically (Lee et al, 2006).

Hot air leads to physical sample reaction in the food level and a hard and impenetrable shell (surface) is formed. This phenomenon which is called surface hardening causes reduction in drying speed and a product will be established with dry outer surface whose internal part is wet. The recent process can be minimized by controlling drying condition. Falling (reduction) of nutrition value and key qualitative indices in materials is only one of the cases which occurs during drying process for foodstuff (Cheng et al, 2005. Madamba et al, 1994 and Lozano et al, 1983).

Due to high level of disorder and certain texture of materials dried in microwave, their power and ability in absorbing water is more. (Khraishes, 2004). Meantime, in the products which dried in oven with hot air, the final product will receive a hard and dense condition due to appearance of wrinkle in materials. This way water can hardly penetrate into them which leads to delay in water absorption (Cheng, 2005).

Shabani and Tavakoli pour (2012) sampled synthetic of drying bell pepper thick layer. In this research, drying synthetic parameters were investigated after drying pepper by hot air drier in 60, 70 and 80 degrees Celsius. The results demonstrated that 80-degree-centigrade temperature has the maximum speed and the least time for drying. Also, wrinkle level rises with the temperature increase and the highest level of wrinkle is observed in 80 degrees centigrade.

Level of rehydration was reduced with temperature increase and the highest level of rehydration was observed due to reduction of ruining microtubules.

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Yal et al (2008) dried green pepper in 30, 35, 40, and 45 degrees centigrade with relative moisture level of 19-50 % in form of a thick layer. Moisture content of pepper layers was reduced exponentially with drying time. Drying time in 40 degrees centigrade was less than 45 degrees centigrade. And that qualitative parameters were reduced with the temperature rise (from 30 to 45 degrees centigrade). In this research, according to less energy consumption and higher quality of products, drying green pepper in dryer with heat pump was advised.
Based on what we have mentioned, accurate investigation of the ability for water absorption in dried materials and the factors which influence on them can be useful in reaching results on drying optimization process.

2. Materials and procedure

After being prepared, the samples were separated with the identical level and then were keptin 4 to 6 degrees centigrade temperature in fridge until the tests were conducted on them (the test lasted for one month). In order to dry, the samples were washed before examinations and the middle part of them were cut off in form of slices with 10-mm length and 10-mm width.

2-1- Ultrasound pretreatment

In this section, the samples were placed under ultrasound waves with frequency of 45 KHz for 10, 20 and 30 minutes. The examinations were conducted inside ultrasound bath (32-HD Model, made in Bandelin Germany Co)inconstant 30-degree-centigrade temperature for pretreatment.

2-2- Pretreatment with microwave

In order to improve drying process of pepper slices, home microwave was used (CF 3110 N-5 Model Samsung) in three power of 200, 300 and 400 watts and three times of 5, 10 and 15 seconds. In this section, the samples were placed inside a circular tray because the temperature was uniform.

2-3- Drying by oven

Oven is among non-persistent dryers which is designed for small and lab operations. After preparation pepper pieces had been placed in mesh trays in three temperatures of 50, 60 and 70 degrees centigrade inside an oven(binder-110, made in Germany) until they reached 6% moisture level. After drying the pieces were packed inside bags which had been labeled and then were kept in dry and cool place until the testing time.

2-4- rehydration

Water reabsorption of dried samples with 1 to 10 distilled water sample ratio was conducted in immersing form in distilled water for 2 hours. The samples were removed from water every 15 minutes and their surface moisture was weighted with towel (Lerici and mastro, 1988)

$$RR=\frac{Wr}{Wd}$$

RR= ability of absorbing water
Wd= final sample weight before dewatering (gr)
Wr= final weight after dewatering (gr)

2-5- Measuring wrinkle

To calculate wrinkle value and outward density of the samples, sheet size was measured during drying and in various moistures. 10 samples were removed from oven randomly in each test and in each moisture level and their size was measured. The sample sizes were measures applying Toluene displacement method by one Pycnometer unit (Mohsenin, 1986)

3- RESULTS AND DISCUSSION

Data were optimized in response surface method within central composite design (CC) using Design Expert software and the result was gained out of experimental tests in a defined condition. This experimental plan included 1 factorial point, 1 central point and 6 repetitions in central point. All the treatments were formed in 2 repetitions, dimensional and 3D charts were drawn and mathematical equations were gained by Design Expert Software.

3-1- Power effect of microwave, microwave time and oven temperature for water reabsorption

Regression and experimental data variance were analyzed in order to adapt mathematical model and to determine regression and significance coefficient. The data were related to reabsorption of dried pepper samples. The model`s being fit was investigated using lack of fit test which was not meaningful (P< 0/05), therefore the model associated with drying was fine for predicting in the range used.

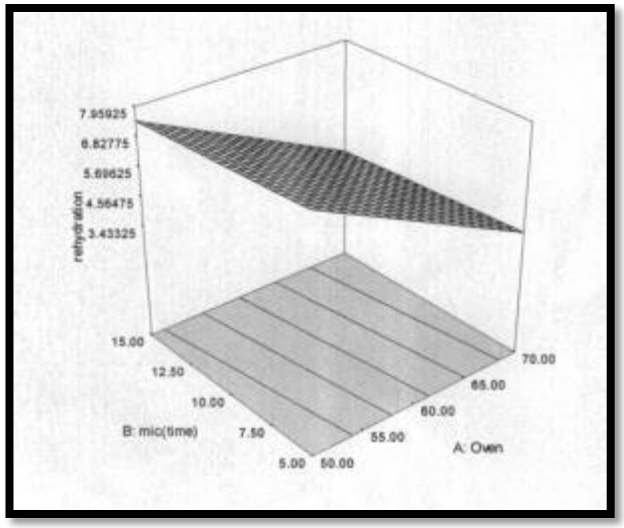

Figure 1: 3D chart for water reabsorption in different oven temperatures and different microwave times

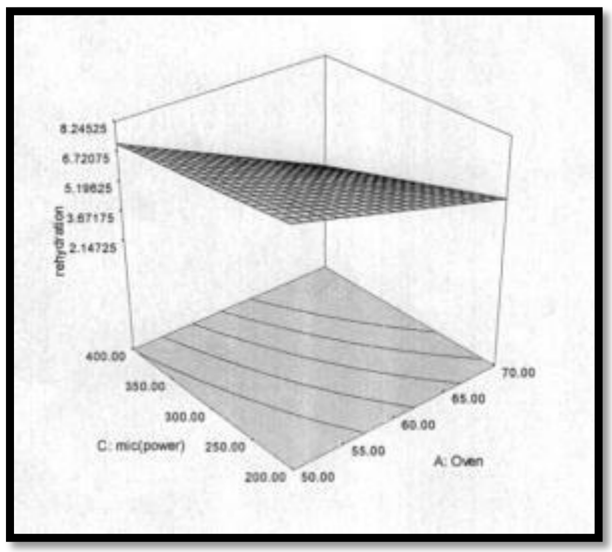

Figure 2: 3Dchart for reabsorption in different oven temperatures and different microwave times

According to the charts maximum level of water reabsorption in oven temperatures was 55 degrees centigrade, microwave time was less than7/5 watt and microwave powers were less than 250 watt. Also, the least level of reabsorption in oven temperatures was more than 65 degrees centigrade, microwave power was more than 350 watt and microwave time was more than 12/5 seconds.

Reduction in water reabsorption capacity and temperature increase is due to porosity reduction or falling of cellular structure which changed pores and as a result water distribution level towards cell was reduced. Studies of Sing et al (2008) also approves this. Also, the less pepper faces microwave radiation, the more we have water reabsorption. This could be due to quick effect of microwave radiation and histological changes which are produced.

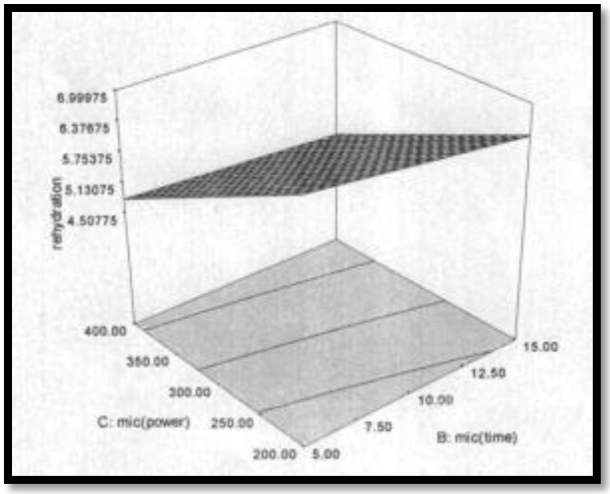

Figure 3: 3D chart for water reabsorption in different oven temperatures and different microwave times

According to the charts maximum level of water reabsorption in oven temperatures was 7/5 seconds and microwave time was less than 250 watt. Also, the least level of water absorption in oven temperatures was more than 12/5 seconds and microwave powers was more than 350 watt.

3-2- Effect of microwave power, microwave time and oven time on wrinkle

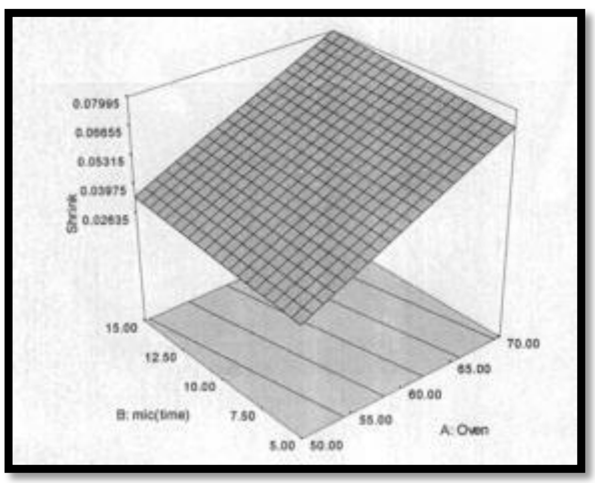

Figure 4: 3Dwrinkle chart in different temperatures of oven and different microwave times

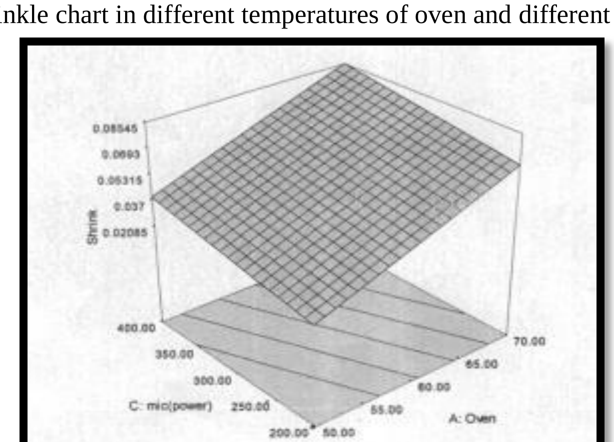

Figure 5: 3Dwrinkle chart in different temperatures of oven and different microwave times

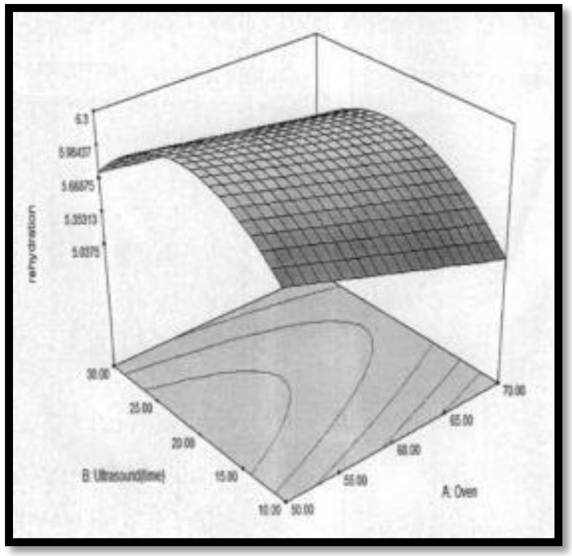

Figure 7: 3D chart for water reabsorption in different oven temperatures and different ultrasound times

As it can be observed from above, reabsorption level in pepper samples is increased with the increase of ultrasound process time in constant temperature. This reabsorption level rise originated from ultrasound time effect on microscope channel formation and as a result osmotic pressure difference between samples and distilled water which could lead to water absorption (Fernandez et al, 2005)

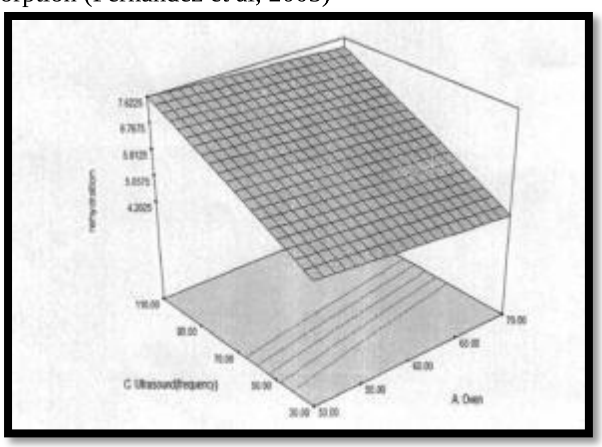

Figure 8: 3D chart for water reabsorption in different oven temperatures and different ultrasound times

According to the charts, the maximum wrinkle level in oven temperatures was more than 65 degrees centigrade, microwave powers were more than 350 watt and microwave time was more than 12/5 seconds. The least wrinkle level in oven temperatures was less than 55 degrees centigrade, microwave powers were less than 250 watt and microwave time was less than 7/5 seconds. Ongen et al (2005) reported similar results regarding drying olive with hot air. In this research wrinkle level increases with the temperature rise.

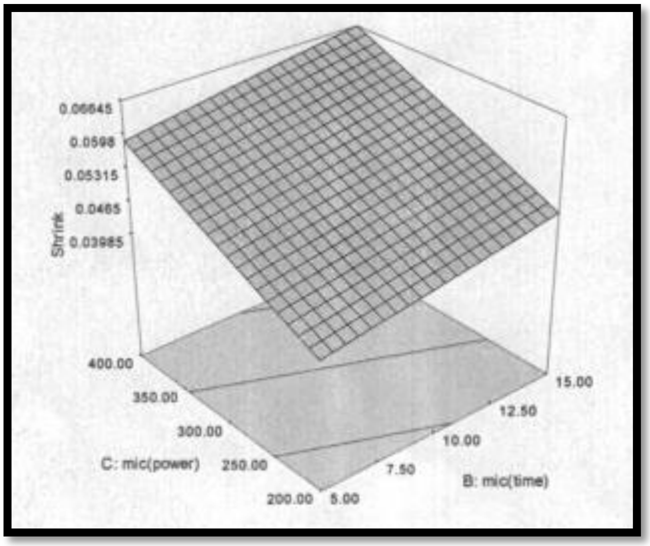

Figure 6: wrinkle 3D chart in different time and power of microwave

According to the chart the highest level of wrinkle in microwave time was more than 12/5 seconds and microwave power was more than 350 watt. The least wrinkle level in microwave time was less than 7/5 seconds and microwave power was less than 250 watt.

3-3- Ultrasound power effect, ultrasound time and oven temperature on water reabsorption

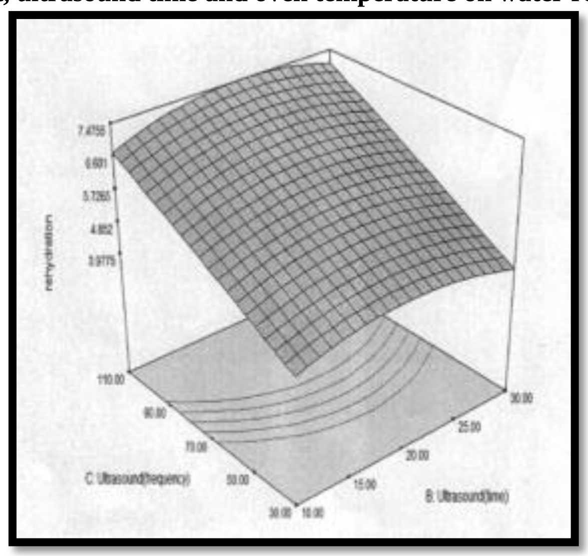

Figure 9: Water reabsorption 3D chart in different ultrasound times and different ultrasounds powers

According to the chart, water reabsorption level in pepper samples increases with the ultrasound process time rise in ultrasound constant powers. This rise is due to ultrasound time effect on formation of microscope channels and as a result osmotic pressure difference between sample and distilled water which could lead to water absorption (Fernandez et al, 2005)

3-4- Effect of ultrasound power, ultrasound time and oven temperature on wrinkle

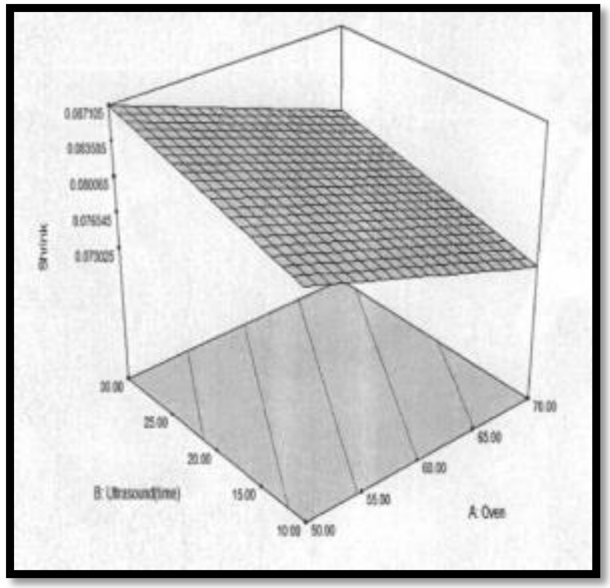

Chart 10: wrinkle 3D chart in different oven and ultrasound times

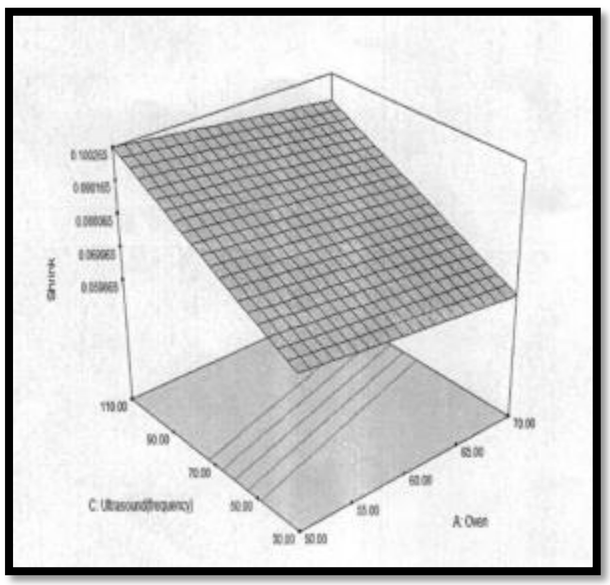

Chart 11: wrinkle 3D chart in different oven and ultrasound times

According to the charts, maximum wrinkle level in oven temperatures is less than 55 degrees centigrade, ultrasound powers are more than 70 hertz and ultrasound time is less than 15 seconds. The least wrinkle level in oven temperatures is more than 55 degrees centigrade, ultrasound power is less than 70 hertz and ultrasound time is less than 20 seconds.

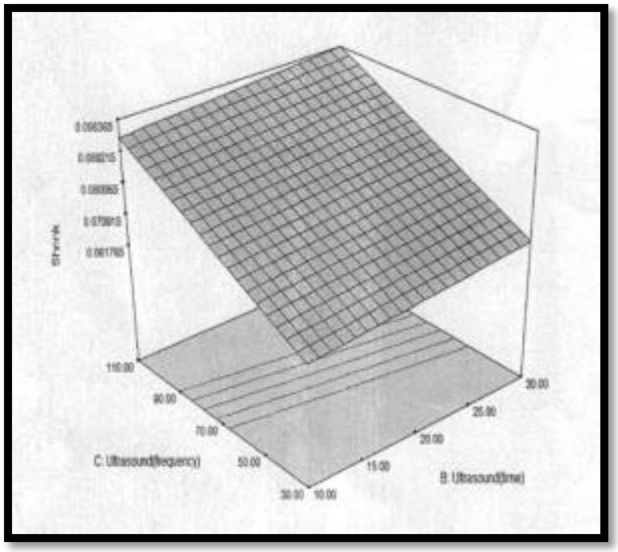

Figure 12: wrinkle 3D chart in different time and power of ultrasound

According to the chart, the maximum wrinkle level in ultrasound time is less than 20 seconds and ultrasound power is more than 70 hertz.

The results indicated microwave and ultrasound pretreatments have significant influence on water reabsorption and wrinkle. Little wrinkle level of a product demonstrates that the product is dried in a better condition, so making a product under low-level wrinkle condition is the best approach. Also due to cavitation, cell devastation and porosity rise, these two treatment cause water reabsorption rise and wrinkle reduction in pepper. The key point regarding these treatments is using lower level of power and less time which could lead to increase of product quality.

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