**Effect of ultrasound-assisted osmotic dehydration pretreatment on the convective drying of strawberry**

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**Abstract**

**Objective-** The work was planned to produce dietetic dehydrated strawberries with application of ultrasound osmotic dehydration (UOD) as pretreatment.

**Methodology-**A Box-Behnken design (BBD) were employed to characterize the UOD strawberry process, optimize and investigate the effect of independent variables like ultrasound time, concentration of osmotic solution and temperature on the water loss (WL), solid gain (SG) and weight reduction (WR). The same BBD were used to estimate the main effects of OD without ultrasound treatment.

**Results-**A multi-criteria optimization based on maximal possible values of WL and WR and minimal value of SG was achieved. This was 20.5 min of ultrasound time, 47.5 °Brix osmotic solution concentration and 31 °C medium temperature. The effects of UOD carried out under the optimized operating conditions on kinetics of convective air drying of strawberry at 40, 50 and 60 °C, and velocity of 1 m/s, using the phenomenological model of Coupled Washing/Diffusion (CWD). Starting accessibility, moisture effective diffusivity Deff value and activation energy (Ea) were calculated from similar-Fick’s law and analogous Arrhenius equation, respectively with and without shrinkage correction. Quality attributes were estimated through the assessment of the phenolic content, antioxidant activity, rehydration capacity, and X-ray powder diffraction characteristics.

**Conclusion-** The work indicates that the change in operation parameters such as ultrasound and OD time, solution concentration and system temperature has a significant on water loss, solid gain and weight reduction are discussed.

**Keywords:** Ultrasound assisted osmotic dehydration; Convective air drying; Dietetic dehydrated strawberry; Moisture diffusivity with shrinkage; Color and phytochemical analysis; X-ray diffraction.

**1. Introduction**

Due to its outstanding wealth of nutrient, delicious flavor and health benefits strawberry (cv. camarosa) is consumed to maintain good health by minimizing the risk of chronic illnesses such as the cardiovascular disease, hypertension, obesity and type 2-diabetes ([Giampieri et al., 2012](#_ENREF_2)). According to FAOSTAT (Food and Agriculture Organization 2013), the international production of strawberry was over 4.3 million tons in 2011. Dehydration could preserve nutritional components and provide extension of shelf-life of strawberry ([Knorr, Zenker, Heinz, & Lee, 2004](#_ENREF_3)). Consumption of healthy dehydrated strawberry as a part of foodstuffs (e.g., ice creams, cookies, breakfast cereals, cakes, energy bars and dairy products), has gained a noticeable increase([Gamboa-Santos et al., 2014](#_ENREF_1)).

**2. Materials and methods**

*2.1. Fresh materials*

Fresh strawberries of the same size, color and ripeness were purchased from a local market in Tunis (Tunisia) and stored in a refrigerator

**Table 2** Box-Behnken design matrix with experimental values of response variables for ultrasound and without ultrasound osmotic dehydration process.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **UOD** |  |  |  | **OD** |  |  |
| **X1** | **X2** | **X3** |  | **SG (%)** | **WL (%)** | **WR (%)** |  | **SG (%)** | **WL (%)** | **WR (%)** |
| 10 | 65 | 30 |  | -0.56 | 5.714 | 6.275 |  | -0.38 | 5.230 | 5.608 |
| 30 | 65 | 30 |  | 0.31 | 13.106 | 12.797 |  | 0.39 | 13.12 | 12.73 |
| 20 | 65 | 20 |  | -0.31 | 6.539 | 6.848 |  | 0.136 | 5.768 | 5.632 |
| 20 | 65 | 40 |  | 0.17 | 8.102 | 7.933 |  | 0.262 | 9.319 | 9.057 |
| 10 | 0 | 30 |  | -0.60 | 5.167 | 5.770 |  | -0.40 | 4.642 | 5.044 |
| 30 | 0 | 30 |  | -0.80 | 2.600 | 3.404 |  | -0.51 | 4.470 | 4.979 |
| 20 | 0 | 20 |  | -0.39 | 1.318 | 1.707 |  | -0.16 | 4.054 | 4.214 |
| 20 | 0 | 40 |  | -1.09 | 4.408 | 5.504 |  | -0.78 | 6.394 | 7.173 |
| 20 | 32.5 | 30 |  | -0.55 | 8.341 | 8.897 |  | -0.38 | 10.45 | 10.83 |
| 20 | 32.5 | 30 |  | -0.57 | 7.775 | 8.348 |  | -0.36 | 10.31 | 10.67 |
| 20 | 32.5 | 30 |  | -0.53 | 8.246 | 8.782 |  | -0.36 | 8.888 | 9.250 |
| 10 | 32.5 | 20 |  | -0.01 | 3.107 | 3.119 |  | 0.089 | 4.110 | 4.021 |
| 30 | 32.5 | 20 |  | -0.14 | 4.016 | 4.158 |  | 0.500 | 4.404 | 3.905 |
| 10 | 32.5 | 40 |  | -1.13 | 2.323 | 3.460 |  | -0.70 | 4.941 | 5.640 |
| 30 | 32.5 | 40 |  | 0.29 | 8.542 | 8.253 |  | 0.474 | 9.613 | 9.139 |

**3. Results and discussion**

*3.1. Effect of ultrasound assisted osmotic dehydration on WL and SG of strawberry*

The non-parametric Wilcoxon Matched Pairs Test at a 95% level of confidence was carried out to compare the results of the osmotic dehydration experiments with and without the application of ultrasound. The results showed a considerable difference signified by a positive significant Marked tests (2215 < Z < 3407) was observed between these two treatments considering SG (p = 0.00065), WL (p = 0.0076) and WR (p = 0.0267).



**Fig. 1.** The predicted vs. observed values of SG of ultrasound-assisted OD of strawberry using RSM.

**4. Conclusion**

This work evaluated the production of osmotic-dehydrated strawberry with low sugar content with applying ultrasound to decrease the sugar uptake from the fruit. The influence of operation parameters such as ultrasound and OD time, solution concentration and system temperature on water loss and solid gain are discussed. The effect of ultrasonic osmosis on weight reduction is also studied. OD concentration, ultrasound treatment duration and temperature increase the amount of water removed during OD. However, the ultrasound treatment decreases the intake of solids by the product. Then ultrasound OD is appropriated at higher WL and limited solids (sugar) uptake (dietetic products).

**References**

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