Project STA507 Deign of experiment

Objective: The main objectives of this project focused on determining the optimum conditions for drying potatoes using solar dryers. Three operating parameters were chosen: the air temperature ,the velocity and the sample thickness. The design of experiments adopted was the Box-Behnken design.

Summary: Drying is one of the main ways of preserving perishable foodstuffs. By eliminating water, we inhibit the action of microbial germs (yeasts, molds, bacteria) responsible for spoilage. It is also a necessary step in the freezing of certain products, as the elimination of water reduces their weight and volume. In summary, drying improves product preservation, facilitates transport, reduces the risk of post-harvest losses and, above all, expands the marketing of these products by making them available all year round.

One application of solar drying is the drying of agricultural products such as vegetables and fruit. Dried products can be used in a wide variety of ways: vegetable pieces can be used to make soups or powders for sauces. Potatoes are another dried agricultural product.

When trying to understand the influence of different parameters (temperature, drying air speed and potato slice thickness) on drying time and color change, it is common to use a classic method that varies only one factor at a time. This traditional method, known as trial-and-error, is imprecise and requires a large number of trials. It also fails to achieve the real optimum, as the interaction between variables is not taken into account. A more reliable and robust method uses statistical analysis and experimental design.

Design of experiments (DOE) are techniques for quantifying the effects of various factors on a response, and for optimizing them in well-defined experimental domains. A series of trials is organized to manipulate the factors and describe the method for obtaining the optimum response. Response surface methodology (RSM) is one of the experimental designs used for optimization. It is a technical empirical model dedicated to evaluating the relationship of a set of controlled and observed experimental factors with the results.

In this project, we propose an optimization method for determining mathematical models of potato drying by applying the Box Behnken design to 15 trials. These models reveal the relationship between the three operating parameters - drying temperature, drying air velocity and sample thickness - and the responses studied (drying time and color change).

Data description:

Parameter variation range for the Box-Behnken design

The three factors deemed likely to affect the drying operation are all quantitative factors, i.e. factors whose adjustment can be controlled, and which can adopt any real numerical value within the chosen range.

Thus, we have the factors and their ranges of variation as follows:

- Drying air temperature (T) between 40°C and 55C°. The choice of this experimental value is based on previous literature data.

-Drying air velocity (V) varies between 2.5 and 5 m/s.

-The thickness of the potato slices (E) is between 0.5 and 1 cm.

Table .1 shows the three factors that were studied simultaneously in order to quantify the effect of each on the potato drying process.

The drying experiments were carried out using a fractional factorial design with two levels and three variables. Table 1 shows the low and high levels for each variable.

Factors	T (°C)	V (m/s)	E (cm)
Low level	**40**	**2.5**	**0.5**
Center	**50**	**3.75**	**0.75**
High level	**55**	**5**	**1**

Table1

The results of the experimental design for potato drying are shown in Table 2.

	Real Variables			Coded Variable		
N°trails	T(°C)	V(m/s)	E(cm)	T	V	E
(01)	40	2.5	0.75	-1	-1	0
(02)	55	2.5	0.75	1	-1	0
(03)	40	5	0.75	-1	1	0
(04)	55	5	0.75	1	1	0
(05)	40	3.75	0.5	-1	0	-1
(06)	55	3.75	0.5	1	0	-1
(07)	40	3.75	1	-1	0	1
(08)	55	3.75	1	1	0	1
(09)	47.5	2.5	0.5	0	-1	-1
(10)	47.5	5	0.5	0	1	-1
(11)	47.5	2.5	1	0	-1	1
(12)	47.5	5	1	0	1	1
(13)	47.5	3.75	0.75	0	0	0

(14)	47.5	3.75	0.75	0	0	0
(15)	47.5	3.75	0.75	0	0	0

Table2

The responses studied are drying time and color change ΔE. Table.3. shows the color change of dried potatoes for the 15 trials.

	Factors			**Responses**	
N°Trails	T (°C)	V (m/s)	E (cm)	**Temps de séchage (min)**	**ΔE (-)**
(01)	*40*	*2.5*	*0.75*	420	20,91
(02)	*55*	*2.5*	*0.75*	330	17,74
(03)	*40*	*5*	*0.75*	430	15,77
(04)	*55*	*5*	*0.75*	396	20,60
(05)	*40*	*3.75*	*0.5*	292	20,24
(06)	*55*	*3.75*	*0.5*	308	21,16
(07)	*40*	*3.75*	*1*	590	16,69
(08)	*55*	*3.75*	*1*	510	17,65
(09)	*47.5*	*2.5*	*0.5*	320	22,49
(10)	*47.5*	*5*	*0.5*	225	15,47
(11)	*47.5*	*2.5*	*1*	565	14,77
(12)	*47.5*	*5*	*1*	410	16,05
(13)	*47.5*	*3.75*	*0.75*	370	14,34
(14)	*47.5*	*3.75*	*0.75*	385	17,29
(15)	*47.5*	*3.75*	*0.75*	378	15.81

This project is divided into the following sections:

-Introduction on DOE

-Essais experimental design, results and technique.