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EMPIRICAL MODELLING AND OPTIMIZATION OF DRYING RATE AND QUALITY ATTRIBUTES OF TOMATO (*LYCOPERSICON ESCULENTUM*) USING RESPONSE SURFACE METHODOLOGY (RSM)

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Abstract

Empirical modelling and optimization of drying rate and quality attributes of tomato was done using response surface methodology (RSM). The experimental design was performed in a rotatable central composite design, of design expert software version 6.0.6. Process factors or independent variables considered were pre-drying treatments at five levels which include; the control, 40 ^{o}Bx, 1hr, 40 ^{o}Bx, 2hr, 60 ^{o}Bx, 1hr and 60 ^{o}Bx, 2hr which were coded as 1, 2, 3, 4, 5 respectively and drying air temperatures at five levels which include; 50, 55, 60, 65 and 70 ^{o}C. Samples (except the control) were pretreated in osmotic solutions with varied concentrations and soaking time. Five model equations were developed for the responses which were drying rate, vitamin C, total soluble solids (TSS), protein and ash contents. The models developed were all significant as shown by analysis of variance (ANOVA) at $p\leq0.05$, and were 0.0009, 0.0002, 0.0085, 0.0186 and 0.0291 respectively. The R^2 and R^2_{Adj} values for drying rate, total soluble solids, vitamin C, protein and ash contents were found to be 0.9238 and 0.8693, 0.9115 and 0.9168, 0.8498 and 0.7425, 0.8090 and 0.6725, 0.7804 and 0.6234 respectively. The validation procedure also shows that the experimental and predicted model values were close to each other. These show that the developed models have good fits and can satisfactorily describe the behaviour of responses with respect to process factors. Optimization result shows that only ash content was minimized while others were maximized and best combination of process factors for each response were selected based on desirability value of close to 1, which were 1.000, 1.000, 1.000, 0.831 and 1.000 for drying rate, total soluble solids, vitamin C, protein and ash contents respectively.

1.0 Introduction

Tomato (*Lycopersicon esculentum*) is one of the fruits and vegetables that have high economic value and widely consumed by people in every part of the globe [1,2,3]. It is not only consumed because it is delicious; but due to its numerous health benefits to the human body, and it has been proved to be a strong preventive measure against cancer and other deadly diseases [4]. Tomato is a rich source of vitamin A, C and lycopene contents [1,5]. Due to the fact that tomato is a short duration crop that can easily deteriorate after harvest and only a small percentage of the fruit can be consumed during its surplus season,as a result a large percentage of the fruit goes to waste on yearly basis since there is no adequate technology to handle the surplus, in Nigeria. This calls for preservation of this fruit, to which many types of research have been conducted and drying was found to be one of the best technique, as it is economical and easy to practise. It is an age-long fruits and vegetable preservation technique which is termed heat and mass transfer process. The importance of drying as a food preservation technique can not be overemphasised, preservation of food through drying is made possible since the reduction in moisture content of the product will hinder the activities ofenzymes and microbes, and hence the entire metabolic reactions. Research has shown that drying air temperature is an important parameter which, if not properly controlled can negatively influence the quality attributes of the dried product even though this may have positive influence on the drying efficiency which contributes to the overall energy efficiency [4,6] and therefore the need to use osmotic pre-drying treatment; since findings have shown that osmotic dehydration of fruits and vegetables prior to drying improves quality by reducing colour degradation by enzymatic browning, reduced heat damage to texture and increased retention of volatiles and also known to be an excellent energy saver as moisture is removed without phase change [7]. The size and shape of the product being treated; have an influence on the concentration of solutes during osmotic dehydration especially during short duration soaking since the surface area of the product to volume ratio of the osmotic solution has influence, with higher ratios enhancing mass transfer during dehydration [7]. It is important to model drying processes such as the use of characteristic drying rate curve and empirical models: which is essential for the design of innovative and energy efficient drying methods [8]. In this experiment,Central Composite Design (CCD) of Response Surface Methodology (RSM), was used to determine the effects of process parameters on drying rate and quality attributes of dried tomato product. It is a collection of mathematical and statistical methods that are applied in experimental designs, development of models, evaluation of factors effects and determination of optimum conditions [9]. It helps in the modelling and optimization of multiple variables which determine the optimum process conditions by combining experimental design with interpolation by first or second order polynomial equations in a sequential testing procedure [10]. This methodology has been used succesfully by [11] to model and optimize drying rate and quality parameters of dried osmo pre-treated green bell pepper and also by [12] for the empirical modelling of bioethanol production process from corn stover and [1] on optimization of process conditions for the development of tomato foam. Others who have carried out process optimization using response surface methodology include [12, 13, 14 and 15].The aim of this research is to use Central Composite Design (CCD) of Response Surface Methodology (RSM) design to determine the effects of two (2) independent variables on the drying rate and nutritional attributes of osmo pre-treated dried tomato samples. A mathematical correlation between the variables was developed and their interactive effects on drying rate and nutritional attributes of osmotic pretreated dried tomato.

2.0 Materials and Methodology:

3.1 Materials Selection

Tomato Roma variety that was considered ripe, fresh and firm were bought from a local farmer in proximity to the Nigerian Stored Products Research Institute (NSPRI), Ilorin, Kwara State, Nigeria. Where the experiment was conducted in the month of March. The fruits were sorted visually according to size, shape, and colour to ensure uniformity of the samples. The initial moisture content of the sample was determined according to AOAC method [16] and was found to be 94.5% (wet basis). The samples were washed under running water and sliced to a uniform thickness of 5 mm as shown in plate I. Thereafter the seeds were removed; as the presence of seeds in the sliced samples can help speed up deterioration rate of the fruits as a result of microbial action on the fruits.

Plate I: 5mm Sliced and Deseeded Fresh Tomato Sample used for the Drying Experiment

Plate II: Samples Arrangement inside Dryer

2.2 Osmotic Brix Preparation and Pre-drying Treatments

The samples underwent pre-drying treatment in osmotic solutions of 40 ^{o}Brix and 60 ^{o}Brix; and osmotic dehydration time of 60 min and 120 min. The 40 ^{o}Brix concentration was prepared by weighing 453 g of commercial sucrose and 60 ^{o}Brix prepared by weighing 680 g of commercial sucrose both dissolved in 925 ml of distilled water at room temperature for 10 min under rigorous agitation. The concentration of the brix was monitored with the use of a portable refractometer scale (Eijkelkamp, model #300002). 300 g of the samples were weighed into four places with the use of a top loading balance (Snowrex Counting Scale SRC 5001 manufactured by Saint Engineering Ltd., Saint house, London) with an accuracy of 1 g (0.001 kg) and measures up to 5000g (5 kg). Each of the four parts was treated in different concentration and dehydration time with the first part dipped in 40 ^{o}Brix osmotic concentration for 60 min, second part dipped in 60 ^{o}Brix osmotic concentration for 60 min, the third part dipped in 40 ^{o}Brix osmotic concentration for 120 min and the fourth part dipped in 60 ^{o}Brix osmotic concentration for 120 min. After pre-drying treatment, the samples were drained for 10 min and then subjected to drying.

2.3 Drying Procedure

After proper draining, the samples were arranged in a hot air thin layer cabinet dryer with three trays, each sample was tagged in its position on the tray as shown in Plate II. The dryer uses electricity and it has a heater with 1.8 kW, positioned directly in front of a blower with a backward-curved centrifugal fan of 0.5 hp a.c. motor. The drying unit connected to the temperature regulator/thermostat (0-400 °C graduated in 10 °C) responsible for controlling the temperature of the heater, in accordance with the pre-selected temperature. The drying experiment was conducted in the month of march in Ilorin when the ambient temperature was 29 °C and the relative humidity was monitored to be 61%. Drying process was terminated when the products have reached the targeted final moisture content of about 7 % wet basis, suitable for storing dried tomato. Thereafter products were withdrawn from the dryer and allowed to cool before packaging and taking to the laboratory for chemical analysis.

Drying rate was calculated according to [6] as shown in equation (1), and the data obtained were analyzed statistically using analysis of variance (ANOVA) for the response surface quadratic model, of Design expert software version 6.0.6 (2002), Minneapolis MN, USA.

$$Drying\ rate\ (DR) = \frac{M_i - M_f}{t}$$

M_i = Initial mass of tomato samples (g)

M_f =Final mass of tomato samples (g)

t = Drying time (hr)

2.4 Experimental Design

Design expert software version 6.0.6 was used to design the experiment, a rotatable central composite design was adopted under response surface methodology as it allows each numeric factor to be varied over five (5) levels. In this experiment, there are two numeric factors, namely drying air temperature and pre-drying treatment. Drying air temperature was varied by the design expert software at five levels between 50-70 °C (50, 55, 60, 65and 70 °C) while pre-drying treatment was coded as 1, 2, 3, 4 and 5, with each representing the control (untreated), 40 °Bx 1hr, 40 °Bx 2hr, 60 °Bx 1hr and 60 °Bx 2hr respectively. The experimental layout consisted of 13 assays, having 5 center points and 8 axial points altogether as shownin Table 1.

Table 1. Central Composite Design for the Experiment (Coded value)

Assay	Process Variables	
	X_1	X_2
1	0.0	0.0
2	-1.0	+1.0
3	0.0	-0.5
4	+1.0	+1.0
5	0.0	0.0
6	-1.0	-1.0
7	+0.5	0.0
8	0.0	0.0
9	0.0	+0.5
10	+1.0	-1.0
11	0.0	0.0
12	0.0	0.0
13	-0.5	0.0

3.0 Results and Discussion

3.1 Model Equation Developed

Model equations were developed based on the functional relationship that exists between the input variables and the output variables. Data obtained from the research conducted were inputted to the design expert software which in turn generated the equations for the various responses being considered

Model equations developed in terms of the coded factors were as follows:

Drying rate (g/hr) $= +26.86 + 4.02A - 3.90B - 1.50A^2 + 3.14B^2 - 0.40AB$ $(R^2_{Adj} = 0.8693)$ (1)

TSS (%) $= +29.77 - 0.55A - 0.27B + 2.09A^2 - 7.64B^2 + 0.80AB$ $(R^2_{Adj} = 0.9168)$ (2)

Vitamin C (mg/100g) $= +23.18 - 1.82A - 6.13B + 0.19A^2 + 6.28B^2 + 0.30AB$ $(R^2 = 0.7425)$

(3)

Protein (%) $= +14.23 - 0.33A - 2.12B - 0.43A^2 + 3.18B^{2-}\ 0.15AB$ $(R^2_{Adj} = 0.6725)$ (4)

Ash (%) $= +2.56 - 0.088A - 0.78B - 0.29A^2 + 1.09B^2 - 0.075AB$ $(R^2_{Adj} = 0.6236)$ (5)

Where;
A= Drying air temperature (^{0}C)
B= Pre-drying treatment (^{0}Brix hr)

3.2 Model Adequacy Checking

The adequacy of the developed model equations was done with the use of some specific statistical tools namely; R^2, R^2_{Adj}, PRESS, Model P-value, Adequate precision, and Coefficient of variation (%) as shown in Table 2. The R^2 and R^2_{Adj} values for drying rate, total soluble solids (TSS), vitamin C, protein and ash contents were found to be 0.9238 and 0.8693, 0.9115 and 0.9168, 0.8498 and 0.7425, 0.8090 and 0.6725, 0.7804 and 0.6234 respectively. For a model to be rated as being adequate, one of the criteria used is that the value of R^2 and R^2_{Adj} must be relatively close, according to [17], which was considered to be true for all the responses analyzed in this experiment,all developed models were good and of good fit according to [10], since the values of R^2 of 0.9238, 0.9115, 0.8498, 0.8090 and 0.7804 imply that 92.38%, 91.15%, 91.68%, 84.98%, 74.25%, 80.90% and 78.04% respectively,of the variations could be satisfactorily explained by the models. The result of analysis of variance (ANOVA) was presented in Table 2, and was seen that the models had F-values of 16.97, 27.45, 7.92, 5.93 and 4.98 for drying rate, TSS, vitamin C, protein and ash contents respectively. These show that the models developed were significant as confirmed by the design expert software. Also, the P-value (Prob. >F) of 0.0009, 0.0002, 0.0085, 0.0186 and 0.0291 at 0.05 significant level implies that the models developed were significant since the Prob. >F was less than 0.05 for drying rate, TSS, vitamin C, protein and ash contents and these show that the probability of their F-values occuring due to noise (i.e factors which were uncontrollable) were only 0.09%, 0.02%, 0.85%, 1.86% and 2.91% respectively. Additionally, according to [17], the lower the value of the coefficient of variation (C.V) the better the goodness of fit and these can be seen in Table 2 that the models developed have a low coefficient of variation which indicates that the models have good fits.

Furthermore, for a model to be accepted as being good, the adequate precision value is also a criterion that can be used to rate the model. It measures the signal to noise ratio. The adequate precision value must be greater than 4 [18]. Table 2 has shown that for all the models developed adequate precision values were above 4. This is an indication that the models developed can satisfactorily describe the behaviour of the responses with respect to the pre-drying treatmentsand drying air conditions.

Table 2. Statistics for Checking Adequacy of Developed Model Equation

Statistics	Drying rate (g/hr)	TSS (%)	Vitamin C (mg/100g)	Protein (%)	Ash (%)
R^2	0.9238	0.9515	0.8498	0.8090	0.7804
R^2_{Adj}	0.8693	0.9168	0.7425	0.6725	0.6236
PRESS	206.07	38.21	532.64	113.25	16.49
Model F-value	16.97	27.45	7.92	5.93	4.98
Model P-value (Prob.>F)	0.0009	0.0002	0.0085	0.0186	0.0291
Adequate Precision	14.108	16.602	10.249	9.133	8.563
Coeff. of Variation	5.25	3.23	8.94	6.98	15.43

3.3 Validation of Models Developed

It is of paramount importance to validate models developed in order to ensure the models addressed the problem it is targeted towards solving, provide adequate information about the system being modelled and to confirm the reliability of the model developed [11]. Table 3(a)-(d) show the values of the experimental and predicted models, and the differences between them which were very close for all the process variable combinations of the five responses. Figure 1 shows the parity plot of experimental versus predicted values of drying rate which shows an even distribution of the points and tend towards a straight line.

Table 3(a):Experimental and Predicted Values by RSM for the Drying Rate

Assay	Variables X_1	X_2	Experimental Drying rate (g/hr)	Predicted Drying rate (g/hr)	Exp. -Pred. value
1	0.0	0.0	22.00	23.88	-1.88
2	-1.0	+1.0	30.70	32.31	-1.61
3	0.0	-0.5	21.40	20.38	1.02
4	+1.0	+1.0	29.30	28.01	1.29
5	0.0	0.0	22.20	21.34	0.86
6	-1.0	-1.0	29.70	29.38	0.32
7	+0.5	0.0	35.50	33.90	1.60
8	0.0	0.0	24.80	26.10	1.30
9	0.0	+0.5	26.80	26.86	-0.059
10	+1.0	-1.0	26.80	26.86	-0.059
11	0.0	0.0	26.80	26.86	-0.059
12	0.0	0.0	26.80	26.86	-0.059
13	-0.5	0.0	26.80	26.86	-0.059

Table 3(b): Experimental and Predicted Values by RSM for the TSS

Assay	Variables		Experimental	Predicted	Exp.-Pred.
	X_1	X_2	TSS (%)	TSS(%)	value
1	0.0	0.0	31.80	31.03	0.77
2	-1.0	+1.0	30.20	29.13	1.07
3	0.0	-0.5	30.20	29.96	0.24
4	+1.0	+1.0	30.20	29.96	0.54
5	0.0	0.0	31.40	32.41	-1.01
6	-1.0	-1.0	29.70	31.31	-1.61
7	+0.5	0.0	21.80	22.39	-0.59
8	0.0	0.0	21.80	21.86	-0.06
9	0.0	+0.5	29.90	29.77	0.13
10	+1.0	-1.0	29.90	29.77	0.13
11	0.0	0.0	29.90	29.77	0.13
12	0.0	0.0	29.90	29.77	0.13
13	-0.5	0.0	29.90	29.77	0.13

Table 3(c): Experimental and Predicted Values by RSM for the Vitamin C Content

Assay	Variables		Experimental	Predicted	Exp. -Pred.
	X_1	X_2	VitaminC(mg/100g)	Vitamin C(mg/100g)	value
1	0.0	0.0	27.90	29.97	-2.07
2	-1.0	+1.0	23.60	24.04	-2.44
3	0.0	-0.5	26.20	23.54	2.66
4	+1.0	+1.0	22.50	20.21	2.29
5	0.0	0.0	24.60	25.19	-0.59
6	-1.0	-1.0	21.70	21.55	0.15
7	+0.5	0.0	37.90	35.59	2.31
8	0.0	0.0	20.90	23.32	-2.42
9	0.0	+0.5	23.20	23.18	0.022
10	+1.0	-1.0	23.20	23.18	0.022
11	0.0	0.0	23.20	23.18	0.022
12	0.0	0.0	23.20	23.18	0.022
13	-0.5	0.0	23.20	23.18	0.022

Table 3(d): Experimental and Predicted values by RSM for the Protein Content

Assay	Variables		Experimental	Predicted	Exp. -Pred.
	X_1	X_2	Protein (%)	Protein (%)	value
1	0.0	0.0	14.70	15.91	1.21
2	-1.0	+1.0	14.10	15.40	-1.30
3	0.0	-0.5	14.90	13.95	0.95
4	+1.0	+1.0	14.00	13.13	0.87
5	0.0	0.0	14.40	14.14	0.26
6	-1.0	-1.0	13.90	13.47	0.43
7	+0.5	0.0	20.70	19.53	1.17
8	0.0	0.0	14.30	15.30	-1.00
9	0.0	+0.5	14.20	14.23	-0.035
10	+1.0	-1.0	14.20	14.23	-0.035
11	0.0	0.0	14.20	14.23	-0.035
12	0.0	0.0	14.20	14.23	-0.035
13	-0.5	0.0	14.20	14.23	-0.035

Table 3(e): Experimental and Predicted values by RSM for the Ash Content

Assay	Variables		Experimental	Predicted	Exp. -Pred.
	X_1	X_2	Ash (%)	Ash (%)	value
1	0.0	0.0	2.41	2.98	-0.57
2	-1.0	+1.0	2.39	2.88	-0.49
3	0.0	-0.5	2.51	2.28	0.23
4	+1.0	+1.0	2.34	2.02	0.32
5	0.0	0.0	2.69	2.35	0.34
6	-1.0	-1.0	2.35	2.18	0.17
7	+0.5	0.0	4.89	4.42	0.47
8	0.0	0.0	2.53	2.87	-0.34
9	0.0	+0.5	2.53	2.56	-0.025
10	+1.0	-1.0	2.53	2.56	-0.025
11	0.0	0.0	2.53	2.56	-0.025
12	0.0	0.0	2.53	2.56	-0.025
13	-0.5	0.0	2.53	2.56	-0.025

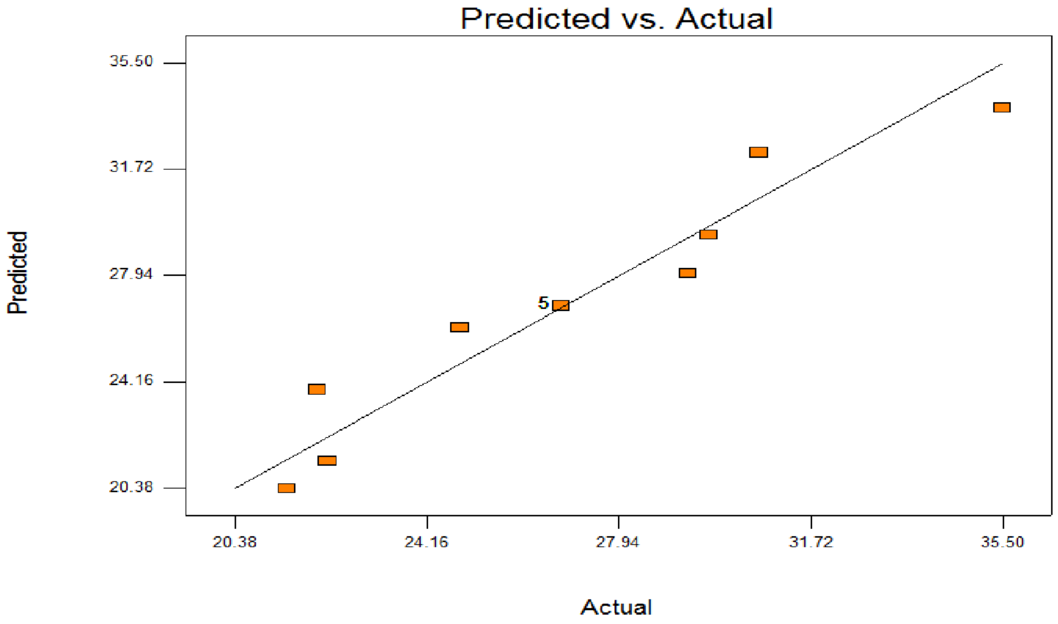

Figure 1: Parity plot showing experimental vs predicted values of drying rate (g/hr) of tomato

3.4 Effects of the Process Factors on the Responses

3.4.1 Drying rate

The interactive effects of drying air temperatures of 50, 55 60, 65 and 70 ^{o}C; and pre-drying treatments of 1, 2, 3, 4 and 5 on drying rate is shown in Figure 2 which is the response surface and contour plot which indicated that drying rate increases with increase in drying air temperature from 50 to 70 ^{o}C; and the maximum drying rate achieved was 34.08 g/hr. Pre-drying treatment also influences the drying rate as it tends to fall from 5 -3 and rises from 3 – 1. And this can be explained further that drying rate of the tomato samples was more favoured at higher temperature but disfavoured by lower drying air temperature and treating it with osmotic solution of sucrose as the figure shows that the least drying rate of 23.12 g/hr was obtained at a low temperature which falls within the range of 50-55 ^{o}C. This is in agreement with the finding of [19] that sucrose infused during osmotic dehydration reduces drying rate during subsequent air or freeze drying and also that increased drying air temperature results in increased rate of drying.

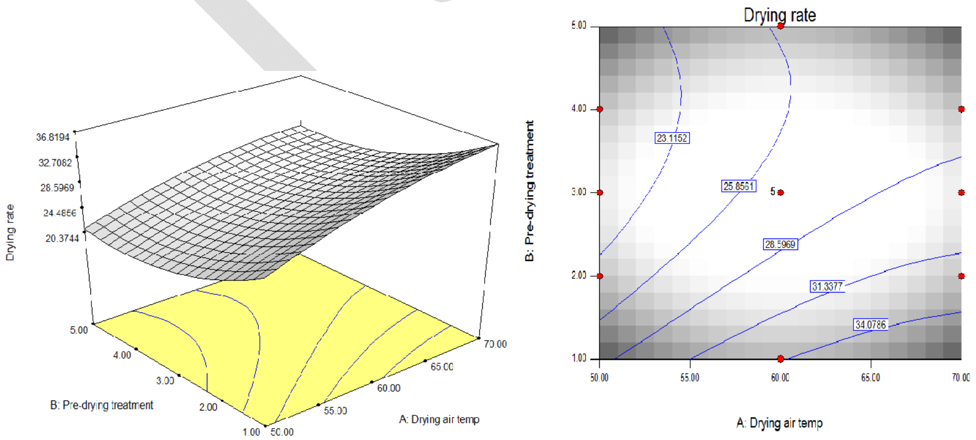

Figure 2: Response surface and contour plot of drying air temperature and pre-drying treatment vs drying rate (g/hr) of tomato samples

3.4.2 Total Soluble Solids Content

The effect of the process factors on the TSS content of dried tomato samples is shown in Figure 3, TSS increases from pre-drying treatment of 5 to 3 and decreases from 3 to 1; maximum retention of TSS of 30.67% was obtained at pre-drying treatment of 3, and drying air temperature which falls within the range of 50-55 °C. This is similar to the findings of [20], that samples treated in sucrose osmotic solution can increase the TSS value.

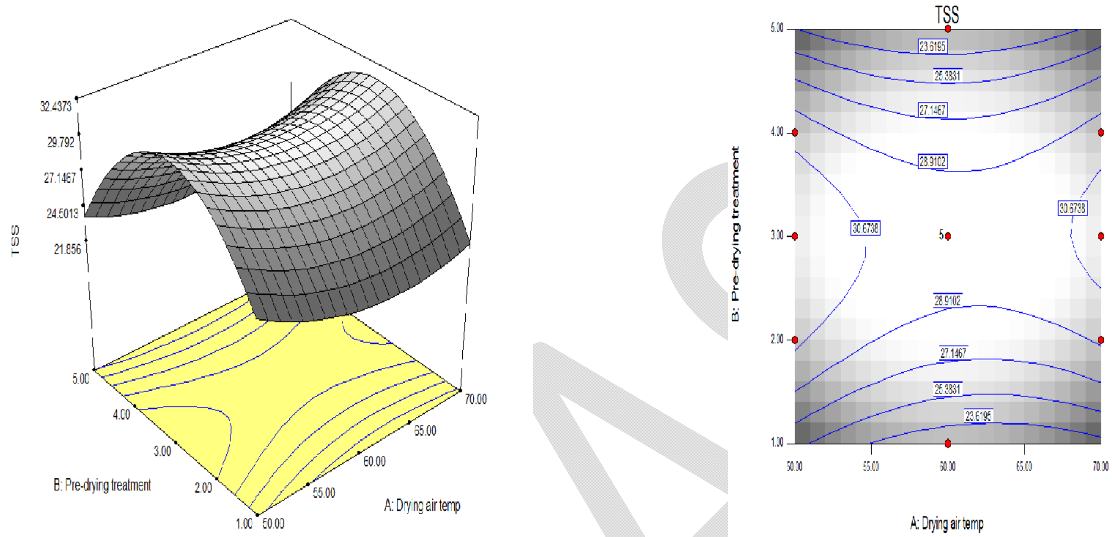

Figure 3: Response surface and contour plot of drying air temperature and pre-drying treatment vs TSS (%) of tomato samples

3.4.3 Vitamin C Content

The effect of the process factors on the vitamin C content of dried tomato samples is shown in Figure 4, maximum retention of vitamin C of 34.95 mg/100g was obtained at pre-drying treatment close to 1 (control samples), and drying air temperature of 55 °C. This is in agreement with the findings of [21, 22, 23, and 24]. According to [21,25], two independent mechanisms could explain this ascorbic acid loss during osmo-dehydration of fruits, which include losses by diffusion from the fruit tissue into the osmotic solution; and losses due to chemical degradation by diffusion.

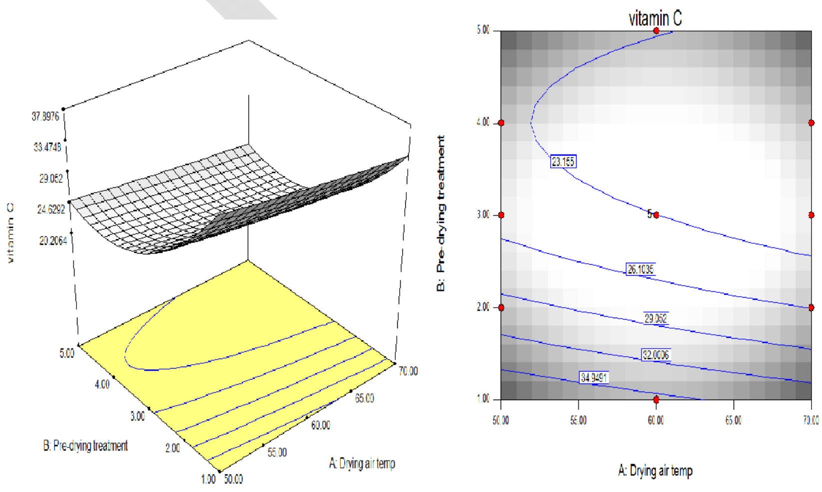

Figure 4: Response surface and contour plot of drying air temperature and pre-drying treatment vs vitamin C (mg/100g) of tomato samples

3.4.4 Protein Content

The effect of the process factors on the protein content of dried tomato samples is shown in Figure 5, maximum retention of the protein content of 18.47% was obtained at pre-drying treatment close to 1, and the minimum protein retention was seen at pre-drying treatment within the range of 3-4. This finding is in agreement with the statement made by [26] that protein loss is one of the major challenge encountered in osmotic treatment due to its leaching into solution.

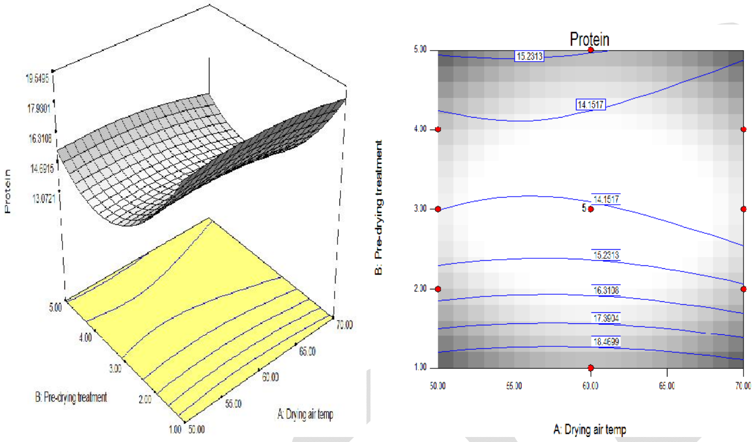

Figure 5: Response surface and contour plot of drying air temperature and pre-drying treatment vs protein (%) of tomato samples

3.4.5 Ash Content

Unlike other nutritional contents; ash content is the total of mineral content in foods [27] and other inorganic impurities present in the samples and therefore it is necessary for it to be low as much as possible in order not to exceed the acceptable daily intake, which can poise appreciable health risk to the consumers. Therefore much emphasis is laid upon the process factor that yielded the lowest ash content and as shown in Figure 6, theminimum ash content of 2.41% was achieved at a pre-drying treatment of 4.The figure also shows that ash content is affected by anincrease in drying air temperature. However, the maximum retention of ash content was obtained at pre-drying treatment close to 1 which is found to be 4.02%. In order to obtain a minimum retention of ash content pre-drying treatment of samples is required, as part of the ash present in the sample may have been extracted out of the sample's tissue into the osmotic solution during thedehydration process.

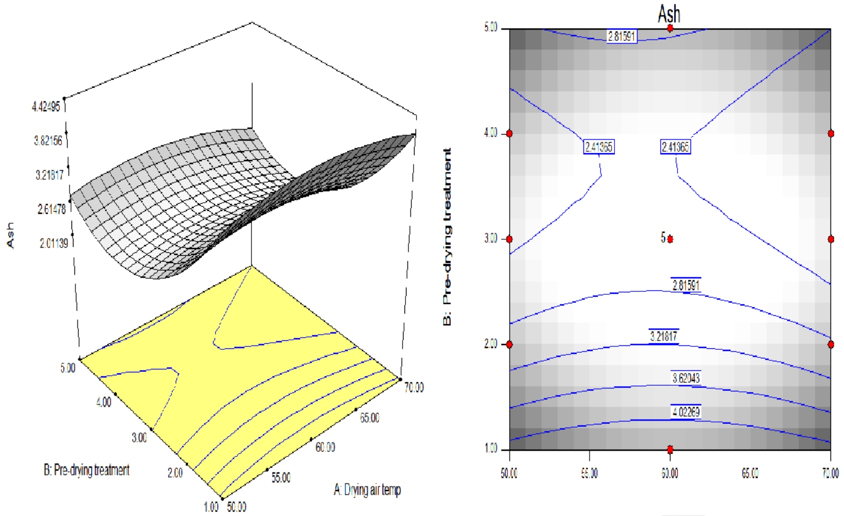

Figure 6: Response surface and contour plot of drying air temperature and pre-drying treatment vs ash (%) of tomato samples

3.4.6 Optimization of the Process Parameters

Numerical optimization interface of design expert software version 6.0.6 was used to optimize the process parameters involved to yield optimum rate of drying, TSS, vitamin C, protein and ash contents of the dried tomato samples. On the interface, the lower and upper limits (boundaries) were set for each of the process parameters and also for the responses. The interface allows the level of importance of the response to be set from 1 to 5 and goal of optimization to be set to either maximize or minimize depending on the interest of researcher as regards the optimization conducted. In this research, all responses were maximized on the interface except for ash content that was minimized. The goal of the process parameters was set to ‘ is in range’ and not otherwise in order to avoid being bias, and to also ensure that both lower and upper limits have equal chances of influencing the responses and not favoured in anyway.

After running the optimization procedure for the each of the responses ten solutions were generated and suggested as the optimization result, each combination wasranked based on the value of its desirability which varies from 0 to 1. The closer it is to 1 the better the combination of the process parameters of the solution [18], which was used as a basis to select all the five solutions for each of the responses listed in Table 5. The various combinations of the process factors were being optimized, which in turn produced the optimum yields of the responses; these guarantees high drying rate that is capable of minimizing overall production cost by saving energy consumed, as drying efficiency will contribute towards energy efficiency [28]; and also yield products of high nutritional qualities, that will be beneficial to the overall health and general well-being of the consumers.

Table 5: Optimization result for the responses generated by Response Surface Methodology (RSM)

SN	Response	Drying air temp.(^{0}C)	Pre-drying treatment	Optimized output	Goal	Desirability
1	Drying rate (g/hr)	67.99	1.07	36.1142	Maximize	1.000
2	TSS (%)	50.53	2.75	32.1711	Maximize	1.000
3	Vitamin C (mg/100g)	50	1	37.8976	Maximize	1.000
4	Protein (%)	57.88	1	19.5495	Maximize	0.831
5	Ash (%)	66.11	3.84	2.2506	Minimize	1.000

4.0 Conclusion

To improve the drying process of tomato fruits in a convective dryer, empirical model development is a right step to take. Central Composite Design (CCD) of Response Surface Methodology (RSM) used resulted in second order polynomial models for describing drying rate, TSS, vitamin C, protein and Ash contents of tomato. All models equation developed satisfactorily explained the behaviour of the output parameters of the dried samples. Optimization result shows that ash content was minimized while others were maximized and all had their desirability value to be 1 or very close to 1. Control samples had the fastest drying rate and better retention of vitamin C and protein contents which were 36.11 g/hr, 37.89 mg/100g and 19.55% respectively. Samples dried at air temperature in the range of 50-55 ^{o}C had better retention of nutritional contents but slower drying rate. The results of this research show that all input parameters considered were important in modelling drying processes of tomato fruits and were influential on predicting their drying rates and nutritional compositions. These would go a long way to minimize production cost of dried fruits and as well enhance their quality parameters.

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