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(Research Article)

Effect of pre-treatment on drying parameter of sweet potato (*Ipomea batatas)* slices using cabinet dryer

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Abstract

The study aims to examine the drying process of treated sweet potato slices to determine the effects of drying temperature, pre-treatment (blanching and salting), and slice thickness on drying rate and weight loss, an electrically powered cabinet dryer was used for the experiments this dryer allows for controlled drying at specific temperatures and airflow rates, the drying temperatures ranged from 70°C to 90°C and airflow rate of 2.5 m/s was used. The sweet potato slices were treated using blanching and salting with slices ranging from 3mm to 7mm. The study employed Response Surface Methodology (RSM) to analyze the results. The study found that the thickness of the sliced sweet potato had a linear effect on drying rate and weight loss. Additionally, the interaction between drying temperature and the selected pre-treatment (blanching and salting) was found to significantly influence drying rate and weight loss, when the significance level for the observed effects was set at $p < 0.05$. Conclusively the results of the investigation indicated that the cabinet dryer used in the study was capable of effectively handling the drying of roots and tuber crops, specifically sweet potato slices. This suggests that the drying process could potentially extend the shelf life of these agricultural materials.

Keywords: Temperature; Airflow Rates; Blanching; Salting; Drying; Sweet Potato Slices

1. Introduction

Sweet potato *(Ipomea batatas)* is an herbaceous perennial crop, having cluster of runner stems covered with tender leaves and shoots which are edible vegetables. It originated from Central America, but now widely cultivated throughout the world. Due to its low rainfall and soil fertility cultivation requirement. It is ranked seventh among the most important crops worldwide (Antonio *et al.,* 2008). Sweet potato can be consumed as a vegetable, boiled, baked or often fermented into food is used widely as ready to eat food such as noodles, Chinese style French fries, canned foods, e.t.c. (G. Loebenstein et al., 2000). Sweet potato is very rich in vitamin A and C, and the starch content of the fresh roots varies from 6.9% to 30.7%. Besides, it is high in energy and dietary fibre, low in fat and are important source of beta-carotene (Antonio *et al.,* 2008). Fresh sweet potato having relatively high moisture contents are very sensitive to microbial spoilage, even at refrigerated conditions. Hence, they must be consumed within a few weeks after harvest or be processed into various product such as flour. Derived nutritional needs from sweet potato are carbohydrates, fibres, carotene thiamine, riboflavin, niacin, potassium, zinc, calcium, iron and high quality protein. Despite the name "Sweet", it may be a beneficial food for diabetics, as preliminary studies an animals have revealed that helps to stabilize blood sugar levels lower Insulum resistance (Oke 2013).

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Depends on the initial material thickness, shape and moisture content and likewise other physical properties, such as bulk and true densities. Blanching is a pretreatment process prior to drying frequently applied to vegetable to inhibit enzymatic actions (Schmidt, 2013; Senadeera et al., 2000) or enhancing the firmness after rehydration of rice paddy (babagana, 2012). Its permeability and reducing resistance to thermal degradation, which leads to an increase in the drying rate (krokida, *et al.,* 2001).

However, it has been established by Oke (2013) that combined mechanism of capillary forces and vapour diffusion in responsible for moisture movement in the drying of potato.

Food preservation has been practiced in many parts of the world for thousands of years. Method of preservation include: canning, freezing, picking, curing (smoking or salting) and drying. Food spoilage can either be microbial, chemical or enzymatic origin and is some case some physical contaminants such as insects, stones and chaff among others can be a deterrent. Preservation by drying is based on moisture removal to inhibit microbial, chemical and enzymatic activity. It is a process of moisture removal die to simultaneous heat and mass transfer. (Babagana *et al*., 2012).

Sweet potato (*Ipomea batatas*), is a low input tropical crop that has great nutritive and agronomic characteristics (Woolfe, 1992). Currently, Nigeria is the largest producer in African and the second largest producer of sweet potato in the world after China (FAO, 2008). Sweet potato is rich in complex carbohydrates, dietary, fibre, iron, calcium and vitamins. The tubers are most frequently boiled, field or baked. The can also be processed to make starch for ethanol production and as partial flour substitute for cake or bread producing. Many food, products such as tomato sauce, ketchup, dried cake, spongy cake and biscuit utilize sweet potatoes part of their ingredients (Zuraida, 2003) new uses such as for the production of noodles, cookies, doughnuts and increase the demand for sweet potatoes. (Indrasari *et al*., 1994).

Prior to drying most food product are usually subjected to some form of pre-treatments, among which are hot water blanching and sulphitiry. Blanchiny helps to inactivate enzyme that may lead to quality degradation (Uthman et al., 2014) and to improve the acceptability of the final product (Babajide et al., 2006). According to Mathew, 2001) blanching also leads to structural softening and hence facilitates moisture removal. Hot water blanching and the use of chemicals such as sulphur, methyl and ethyl ester emulsions pre-treatment in aqueous solution of sodium hydroxide, sodium chloride, potassium and sodium carbonate, calcium chloride have been applied to overcome the waxy or fibrous barrier on roots fruits and vegetables (Krokida, 2001; Doymaz, 2007).

Drying of agricultural products is an essential process in their preservation, which normally provides longer shelf and lighter weight for easy transportation and small space for storage. Drying as a food preservation technique can reduced wastage of a harvest surplus, allow storage to combat food shortage and in some cases facilitate export to high value markets (Mathew, 2001).

Drying is a very important process in food processing as dried products store and preserve much better than fresh products. There is scarcity of knowledge on conceptual design, analysis and optimization of dryers for food. (Oyedokun et al., 2022).

2. Material and methods

Freshly harvested and uninjured Sweet potato (*Ipomea batata*) was purchased from Ipata Market in Ilorin East, Ilorin, Nigeria. An electrically powered dryer designed and available at the Department of Agricultural and Bio-Environmental Engineering, Kwara State Polytechnic, Ilorin, Nigeria was used for the drying. The dryer which consists of a heat source, an air blower, the drying chamber and a chimney was instrumented with a temperature controller/ monitor, an airflow controller/ monitor, a solid state relay and a thermocouple was used in this study. Figure 1 shows the potato plant and sliced samples.

Figure 1a Sweet potato Plant

Figure 1b Sweet Potato Slice

2.1. Sample preparation

The sweet potat*o (Ipomea botatas)* used for the study were sorted, peeled, sliced, washed and allowed to drain for two (5) minutes, before drying. The freshly harvested sweet potat*o* was sorted, peeled, sliced, washed to remove and allowed to drain for two (5) minutes. before blanching (soaked in hot water of 100^{o}C for 2 minutes) and salting (soaked in salt solution of 20g salt in 75cl of water for 5 minutes), drained for 30 minutes The thickness of the sliced sweet potat*o* was measured to be 3mm, 4mm, 5mm, 6mm and 7mm.

Three replicates of 100 kg each of 3mm, 4mm, 5mm, 6mm and 7mm were immersed in the salt solution and hot water for blanching and salting for 5 minutes. The choice of the immersion time was based on the preliminary investigation. The samples was then dried using the cabinet dryer. The cabinet drying of sweet potat*o* was 70^{o}C, 75^{o}C, 80^{o}C, 85^{o}C and 90^{o}C and 2.5 m/s. The choice of temperature and airflow rate was based on preliminary investigation. The sweet potat*o* samples were allowed to dry until three consecutive weight was achieved.

All results obtained in this study were subjected to Analysis of Variance (ANOVA) statistics. A Statistical Package for Central Composite Design (CCD) of a standard response surface methodology (RSM) with three factors and 5, 2 and 5 levels. Design expert 11.00 software was employed for the analysis.

3. Result

Table 1 Results of independent variables and output parameters

S/No	Std	Run	A:Drying Temperature (^{o}C)	B:Slice Thickness (mm)	C:Treatment	Drying Rate (g/min)	Weight loss (g)
1	20	1	80	4	Salting	0.324	0.68
2	11	2	80	5	Blanching	0.319	0.67
3	7	3	80	4	Blanching	0.310	0.65
4	6	4	85	5	Blanching	0.370	0.66
5	22	5	80	5	Salting	0.370	0.66
6	19	6	85	5	Salting	0.370	0.66
7	15	7	90	3	Salting	0.440	0.66
8	14	8	70	3	Salting	0.310	0.65
9	21	9	80	6	Salting	0.311	0.65
10	26	10	80	5	Salting	0.370	0.66
11	2	11	90	3	Blanching	0.447	0.67
12	10	12	80	5	Blanching	0.319	0.67

13	9	13	80	5	Blanching	0.319	0.67
14	16	14	70	7	Salting	0.237	0.64
15	12	15	80	5	Blanching	0.319	0.67
16	13	16	80	5	Blanching	0.319	0.67
17	18	17	75	5	Salting	0.300	0.62
18	5	18	75	5	Blanching	0.310	0.65
19	25	19	80	5	Salting	0.370	0.66
20	24	20	80	5	Salting	0.370	0.66
21	23	21	80	5	Salting	0.370	0.66
22	4	22	90	7	Blanching	0.371	0.66
23	3	23	70	7	Blanching	0.241	0.65
24	17	24	90	7	Salting	0.361	0.65
25	8	25	80	6	Blanching	0.305	0.64
26	1	26	70	3	Blanching	0.314	0.66

Table 2 Drying rate ANOVA for response surface model

Source	**Sum of Squares**	**Df**	**Mean Square**	**F Value**	**p-value Prob > F**	
Model	0.050529	3	0.016843	44.51433	< 0.0001	significant
A-drying temperature	0.037636	1	0.037636	99.46779	< 0.0001	
B-slice thickness	0.010678	1	0.010678	28.22019	< 0.0001	
C-C	0.002215	1	0.002215	5.855017	0.0242	
Residual	0.008324	22	0.000378			
Lack of Fit	0.008324	14	0.000595			
Pure Error	0	8	0			
Cor Total	0.058853	25				

4. Discussions

4.1. Analysis of variance (ANOVA) of drying rate

Table 2 shows the analysis of variance (ANOVA) of drying rate data obtained from the study. The analysis shows that drying temperature, slice thickness and pretreatment are significant on the drying rate at $p \leq 0.05$.

This shows that drying temperature is the major factor that affects the drying rate of the potato chips, and follow by slice thickness. In this way any change in the temperature of the drying air will affect the drying rate and consequently the drying time significantly.

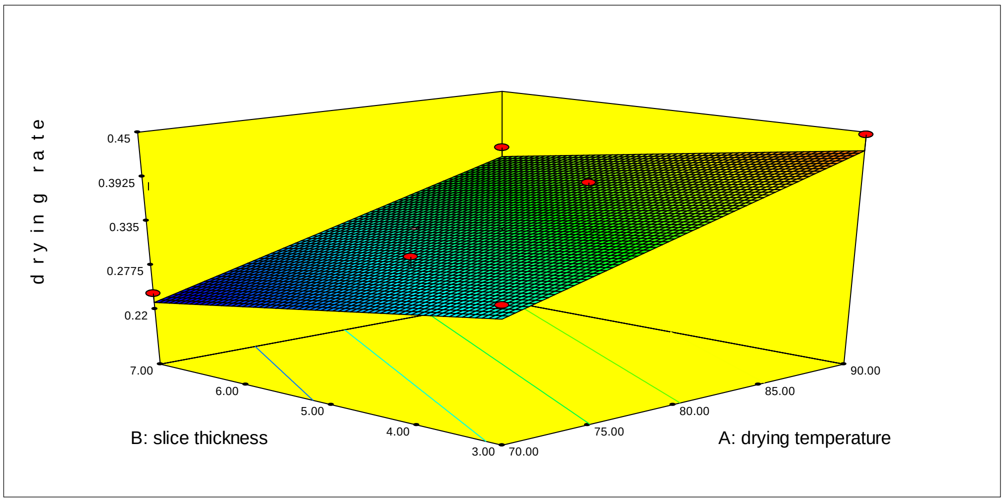

Figure 2 Effects of Slice Thickness and Drying Temperature on Drying Rate

4.2. Effect of slice thickness and drying temperature on drying rate

Figure 2 shows the effect of drying temperature (A) and slice thickness (B) on drying rate of potato chips. There is a linear relationship between the drying temperature and drying rate. The highest drying rate of the potato chips was 0.447 (g/min) at treatment combination of 90^{0}C drying temperature 3 mm slice thickness and blanching treatment. While the minimum drying rate of 0.237 was recorded at 70^{0}C drying temperature 7 mm slice thickness and salting treatment.

The slice thickness increase slightly from 3 mm to 7 mm thickness. This trend is contrary to the work of (Rufus, 2012).

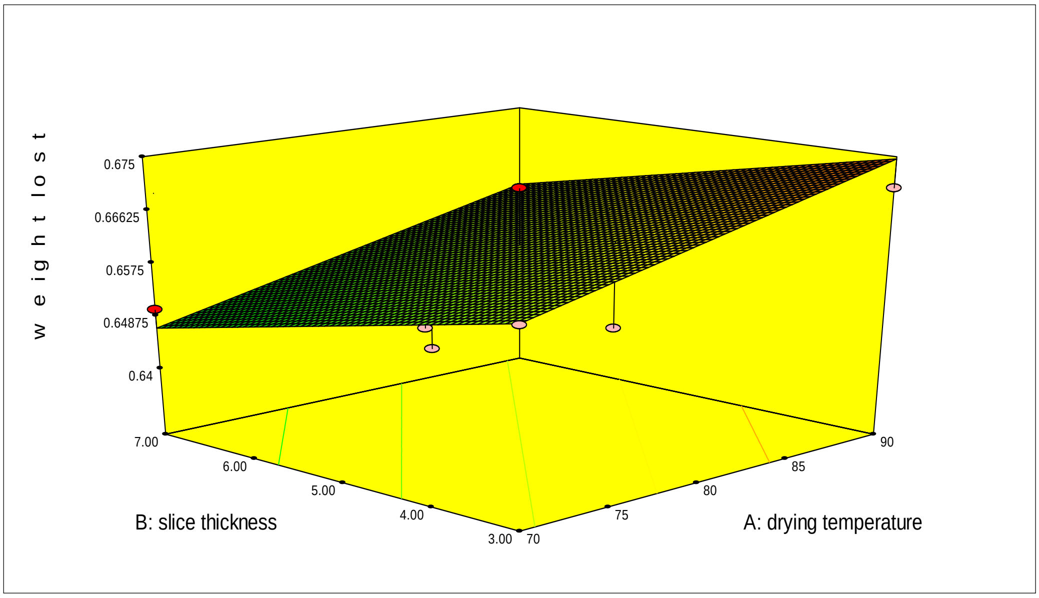

Figure 3 Effects of Slice Thickness and Drying Temperatue Weigth Loss

4.3. Effect of slice Thickness and Drying Temperature on Weight Loss

Figure 3 shown the interaction between slice thickness and drying temperature on weight loss the drying temperature increase from 70^{0}C to 90^{0}C with increase in weight loss. The maximum weight loss of dried potato chips of 0.68 g was observed at a drying temperature of 80^{0}C and a thickness of 4 mm. similarly lowest weight loss of dried potato chips of 0.62 g was recorded at a drying temperature of 75^{0}C slice thickness of 5 mm and salting treatment. This work is similar to the work of Uthman *et al.*, 2014

5. Conclusion

The results of the investigation indicated that the cabinet dryer used in the study was capable of effectively handling the drying of roots and tuber crops, specifically sweet potato slices. This suggests that the drying process could potentially extend the shelf life of these agricultural materials. In summary, the study focused on examining the drying process of treated sweet potato slices using various experimental factors. The research found that slice thickness, drying temperature, and the interaction between drying temperature and pre-treatment had significant effects on drying rate and weight loss. The study also demonstrated the effectiveness of the cabinet dryer for processing roots and tuber crops.

Compliance with ethical standards

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Disclosure of conflict of interest

We hereby declared there is no conflict of interest.

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