Effect of Microwave oven Drying on some Nutritional and Anti-nutritional Content of Pretreated Paw-paw (*Carica Papaya*) Pulp Using Response Surface Methodology

Elijah George Ikrang*[1], Akindele Folarin Alonge[1],Mfrekemfon Godswill Akpan[1]

[1]Department of Agricultural and Food Engineering, University of Uyo, Nigeria

*Corresponding Author elijahikrang@uniuyo.edu.ng

Abstract

This study was conducted to investigate the effect of pretreatment and microwave oven drying on the nutritional and anti-nutritional content of Paw-paw (Carica papaya) pulp using response surface methodology (RSM). The response surface method used had 3 factors at 2 levels with full factorial central composite design used for the design matrix. The independent variables(factors) were Blanching Time (BTime), Ultrasound Time (UTime) and Ultrasound Energy (UEnergy). The Pawpaw fruit (C*arica papaya*) samples were purchased from Itam Market, Uyo, Akwa Ibom State, Nigeria. The samples were washed with clean water thoroughly removing all dirts and placed on a flat clean kitchen plastic tray and peeled vertically. After peeling, the pawpaw fruit was sliced into two halves vertically to enable the removal of dark brown seeds. The sample were then cut into 4mm to 6mm.thickness and 5mm x 6mm size in preparation for pretreatment and microwave oven drying. The thickness was 3mm. The pretreatment followed the outlined design matrix and thereafter was dried in a microwave oven. The drying temperature for Microwave Oven was 60^0C and pretreatment blanching temperature was 90^0C. The pawpaw slices were dried and monitored for every 30minutes till the moisture content was at equilibrium with the environment. The average sample weight for each of the 15 (fifteen) experimental runs were 50g. The response variable considered in the study were nutrient - Vitamin-C, Carotene; Minerals; Iron, Potassium and Anti-nutrients- Phytate and Oxalate content of the pulp. It was observed that the fresh paw-paw pulp had the following composition: Vitamin-C; 105mg/ml; Carotene; 43.90mg/ml, Iron; 0.36mg/ml, Potassium; 167mg/ml, Phytate; 0.95mg/ml and Oxalate; 0.38mg/ml. The dried pretreated paw-paw pulp had the following nutritional and anti-nutritional composition; Vitamin-C; a range of 112.73mg/ml to 118.12mg/ml, Carotene; a range of 50.28 to 50.45mg/ml, Iron; a range of 0.48mg/ml to 0.61mg/ml, Potassium; a range of 177.75mg/ml to 183.27mg/ml, Oxalate; a range of 0.27mg/ml to 0.53mg/ml and Phytate; a range of 0.89mg/ml to 1.31mg/ml. It was observed that the dried samples nutrient and anti-nutrients content increased as compared to the fresh samples.

Introduction

Background of the Study

Carica papaya fruit is obtained from the commonly grown papaya tree also popularly referred to as papaw or paw-paw tree. It is one of the species in the genus *Carica* of the family *Caricaceae* (Chávez, *et al.,* 2017). About 43% of the Worlds papaya production in 2020 was produced in India. The papaya tree is small, sparsely branched with a sole stem growing from 5 to 10 m in height. It also has spirally arranged leaves arranged around the top of the canopy. The lower trunk shows indications where leaves and fruits were borne. Usually the leaves are large, 50–70 cm in diameter, with seven lobes (Heywood, 2007).

Every papaya plant parts contain latex (milky fluid that coagulates on exposure to air, containing proteins, sugars, oils, tannins, resins, alkaloids, starches, , and gums) in articulated laticifers. Papayas are dioecious (contains only male or female reproductive structures in its flowers) (Ronse, 2010). In Asia the latex is employed as an abortifacient, antiseptic for wound dressing and a cure for dyspepsia, while in Africa, the root infusion is reputed for treating venereal diseases, piles, and yaws. In Cuba, the latex is used in the treatment of psoriasis, ringworm, and cancerous growth (Sharmeen, *et al,* 2012)

. Its fruits and seed extracts are known to have anti-bacterial activity against Staphylococcus aureus. (Sharmeen, *et al,* 2012). Papaya fruit contains vitamins A and C, small quantity amount thiamine, riboflavin, calcium, iron, potassium, magnesium and sodium. When unripe papaya is a good source of carbohydrates, vitamins and proteins, and the content decreases as it ripens (Chukwuka *et al,* 2013). Papaya at different stages is a good source of vitamin A and mineral elements (Ca, Mg, Na and K) (Chukwuka *et al.,* 2013). Unripe pawpaw contains the highest amount of all the anti-nutrient such as saponin, alkaloid, tannin, flavonoid and phenol. (Chukwuka *et al.,* 2013). Papaya acts as an antioxidant, antimicrobial, anti-carminative, anti-cancer, and has hepato-protective, immunological, and other therapeutic attributes (Saeed, *et al.,* 2014).

Papaya fruits can be eaten as breakfast and also as an ingredient in jellies, preserves, or cooked in various ways (Vyas, *et al.,* 2016). The juice makes a popular beverage, young leaves, shoots and fruits cooked as vegetable. In cosmetic industries, the plants and plant extracts are mostly used for various purposes such as; moisturizing, whitening, tanning, color cosmetic, sunscreens, radical scavenging, anti-oxidant, immune stimulant, washing, preservatives, and as thickeners (Vyas, *et al.,* 2016).

In various researches, various pretreatments have been applied to various drying methods of agricultural materials such as sulfuring or sulfite dip, salt solution, blanching, blanching and sulfiting, dipping in 0.5% ascorbic acid solution chilling, and freezing, blanching, dipping and sulfiting, sucrose, blanching in hot water at 85°C steam, water. lemon juice, salt solution, honey dip (Minh, 2019). The basic drying methods used in the drying of fruits include sun and solar drying, atmospheric drying including batch continuous methods and sub-atmospheric dehydration (vacuum, belt/drum and freeze dryers) (Osunde, 2017).

In recent times the scope has been extended to incorporate the use of low-temperature and low-energy methods like osmotic dehydration. As drying process involves transient heat and mass transfer, the choice of the method depends on various factors which should be taken into consideration (Haghi and Amanifard, 2008).

The anti -nutritional and nutritional content of Carica papaya fruit vary with different drying methods as these methods makes use of many parameters and mode of operation. Since heat affects nutrients available in a dried fruits using various drying mode, microwave drying method with pretreatment on pawpaw fruit was chosen for this work. The objective of this study. are to evaluate the nutritional and anti- nutritional contents of *carica papaya* fruit as affected by microwave oven drying using response surface methodology (RSM) The specific objectives are;

1.To determine some nutritional and anti-nutritional content of pretreated Carica papaya fruit using Microwave oven at 60^0C.

2.Develop response surface graphs for the microwave drying of the fruits.

Materials and Method

The experiment design had three factors at two levels from a central composite design resulting in (fifteen) 15 runs with duplicate. The factors were blanching rime(BTime), ultrasound time(UTime) and ultrasound Energy(UEnergy). This experiment design followed the design Metrix from MiniTab (version 21) software as shown on Table 1.o.

Materials needed for the work are knife, distill water, food slicer, wire mesh, stainless metal tray. digital pocket thermometer and microwave oven

Sample Collection: The Pawpaw fruit (*carica papaya*) samples were purchased from Itam Market, Uyo,Akwa Ibom State, Nigeria. Samples purchased numbered two (2) weighing 1.160kg and 830g, total weight being 1.99kg.

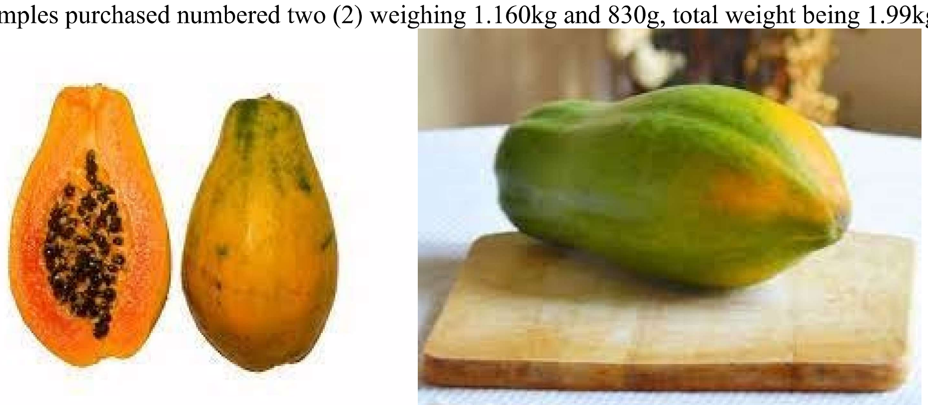

Figure1.1 Papaya (pawpaw)

Sample Preparation

The samples as shown in Figure 1.1 were washed with distilled water thoroughly removing dirt. Sample was placed on a flat clean plastic tray and peeled vertically. After peeling, the pawpaw was sliced vertically to enable the removal of dark brown seeds, also the peels and the seeds were discarded. The pawpaw was then cut into different sizes to enable thin layer pretreatment and drying. The pawpaw was sliced into thin layer dimensions using Food slicer machine (SL524B) 220-240V 50Hz,150W). The slices varied between 4mm to 6mm. in length and breadth with a thickness of 3mm. After slicing, the weight of the sample containers were recorded. The weight of the samples were also noted. Weight of sample in container – weight of container was noted for each of the fifteen (15) samples. The samples were then subjected to pretreatment prior to drying

Pretreatment

The various pretreatment factors were blanching rime, ultrasound time and ultrasound Energy. The pretreatment procedure was done sequentially prior to microwave drying as shown in Table1.0

Table 1.0 Pretreatment arrangement with Design Matrix.

Runs	**UTime (mins)**	**Energy (%)**	**BTime (sec)**
1	5	80	60
2	7	100	30
3	5	80	30
4	5	100	60
5	7	100	90
6	3	100	30
7	3	60	90
8	7	80	60
9	7	60	90
10	3	60	30
11	3	80	60
12	5	60	60
13	5	80	90
14	3	100	90
15	7	60	30

Blanching time: The pawpaw fruit samples were blanched at 90^{0}C at different time intervals ranging from; 30, 60, to 90sec.

Ultrasound time: This ranged from; 3, 5 to 7 mins. Ultrasound energy; This ranged from 60, 80 to 100% energy level.

Drying Method

Microwave Oven

The weighed samples kept in an air tight containers were arranged on a wire mesh tray to be dried in the Microwave oven. ss shown in Figure 1,2 The drying temperature for Microwave Oven was 60^{0}C. The pawpaw slices dried were monitored at 30minutes interval for weight reduction until equilibrium moisture content was obtained.

Figure.1.2 Pawpaw slices in Microwave Oven.

The paw-paw slices were arranged in a wire mesh and placed at the different tray slot for drying and the microwave door/latch was closed and the timer was set for drying to start.

Nutritional Analysis

The nutritional content analysis was carried out on fresh and dried samples on the 15 samples per batch to observe the drying operation.

Proximate analysis: Proximate composition of the samples was carried out using official AOAC (2005) methods for moisture content, crude fat, crude fibre, ash, crude protein. A nitrogen-to protein conversion factor of 6.25 was used. Carbohydrate content was calculated by difference. The iron content of the sample was determined by using the sample ash. The ash was placed in porcelain crucibles, then a few drops of distilled water were added, followed by 2ml of concentrated HCl. 10ml of 20% HNO3 was added, then evaporated on a hot plate. The samples were then filtered through a Whatman filter paper into a 100ml volumetric flask. The mineral element, iron, was determined by an atomic absorbance spectrophotometer (AOAC, 2005). The determination of other mineral content was carried out by the use of destruction method following AOAC method 99911 (2002). Determination of phytates and oxalates were done by method used by. Mwanri et. al. 2018. Determination of Vitamin C (Ascorbic Acid) was done by method of Hussian *et al*. (2006).

Results and Discussion

Results for Effects of Blanching time, Ultrasound time and Ultrasound energy on the Nutritional and anti-

Nutritional content

of Paw-Paw (*Carica papaya*)

The summary of the proximate, nutritional and anti-nutritional content of untreated Paw-paw pulp are shown on Table2. The effect of pretreatment (Blanching time; 30, 60 and 90seconds, Ultrasound time; 3, 5 and 7 mins, Ultrasound Energy; 60, 80 and 100%) and Microwave drying at 60^{0}C selected in analyzing the nutritional and anti-nutritional content of Paw-Paw pulp is presented in Table .3

Table 2 Proximate and nutritional Composition of untreated Paw-paw Samples

S/N	Proximate comp.	Unit (%)
1	Moisture	78.03 ±0.23
2	Lipid	0.20±0.03
3	Fibre	0.70±0.13
4	Ash	0.88±0.53
5	Protein	0.37±0.03
	Nutrient	**Unit (mg/100g)**
1	Carotene	43.90±0.23
2	Vitamin C	105±0.13

3	Potassium	167±0.87
4	Oxalate	0.38±0.03
5	Phytate	0.95±0.09
6	Iron	0.36±0.04
7	Manganese	0.04±0.01

Table 3 Effects of Blanching time, Ultrasound time and Blanching Temperature on the Nutritional and Anti-Nutritional content of Paw-Paw (*Carica papaya*).

Runs	BTime (sec)	UTime (mins)	UEnergy (%)	Oxalate (Mg/100g)	Phytate (Mg/100g)	Potassium (Mg/100g)	Iron (Mg/100g)	Carotene (Mg/100g)	Vitamin C (Mg/100g)
1	60	5	80	0.38±0.03	1.11±0.03	178.04±0.07	0.51±0.05	50.35±0.07	114.00±0.01
2	30	7	100	0.30±0.09	0.89±0.03	180.07±0.01	0.56±0.02	50.38±0.033	118.12±0.07
3	30	5	80	0.43±0.04	1.16±0.07	178.11±0.07	0.51±0.07	50.40±0.07	115.78±0.03
4	60	5	100	0.35±0.06	0.95±0.09	179.77±0.01	0.57±0.05	50.32±0.031	113.97±0.07
5	90	7	100	0.28±0.07	0.91±0.05	183.27±0.07	0.63±0.032	50.28±0.03	112.91±0.037
6	30	3	100	0.32±0.05	0.98±0.03	181.00±0.033	0.58±0.05	50.45±0.11	116.11±0.035
7	90	3	60	0.48±0.03	1.29±0.035	177.75	0.50±0.11	50.31±0.18.	113.89
8	60	7	80	0.36±0.07	1.18	178.90±0.03	0.53	50.37±0.11	116.21±0.07
9	90	7	60	0.45±0.07	1.23±0.033	179.00	0.49±0.05	50.33±0.71	112.73
10	30	3	60	0.53±0.012	1.31±0.13	178.21±0.033	0.48±0.11	50.39	114.89±0.07
11	60	3	80	0.42±0.011	1.24	178.76	0.54±0.035	50.37	114.60
12	60	5	60	0.46	1.21±0.11	177.90±0.11	0.49±0.13	50.30±0.035	114.31±0.11
13	90	5	80	0.43±0.035	1.08±0.13	178.57	0.55	50.34±0.51	113.46
14	90	3	100	0.27±0.13	1.24	181.75	0.59±0.033	50.32	113.92±0.11
15	30	7	60	0.49±0.13	1.26±0.035	178.12±0.11	0.50	50.38±0.15	113.94±0.035

Effect of Blanching Time and Ultrasound Time on oxalate anti -nutrient.

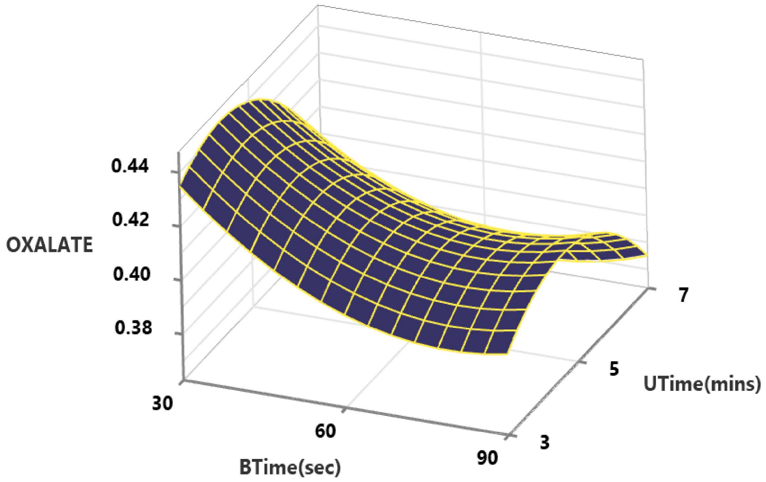

Figure. 1.2 Response surface graph for effect of Blanching Time (BTime) and Ultrasound Time (UTime) on Oxalate**.**

From the graph of Figure 1.2, it is observed that there is significant effect of both ultrasound time and blanching time on Oxalate. It is observed that the Oxalate level experienced a significant increase between Ultrasound time of (3 – 5 mins) and a decline was observed from blanching time of (5-7 mins). From this, it shows that, increase in Ultrasound time above 5 mins will lead to decrease in Oxalate level with Blanching time (BTime). This is in line with the work done by Ikrang and Umani 2019. From the graph, it is observed that there is a decline in Oxalate level as the Blanching time increases with Ultrasound time (UTime).

Effect of Blanching Time (BTime) and Ultrasound Time (UTime) on Phytate.

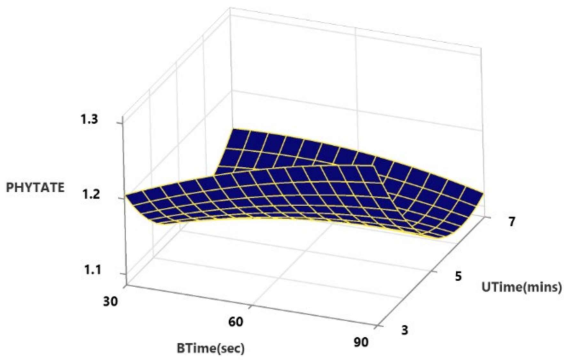

Figure. 1.3 Response surface graph for

From the graph, Figure1.3 it is observed that there is significant effect of both ultrasound time and blanching time when combined together on Phytate. It is observed that the phytate level experienced a significant increase as blanching time increased. From this, it shows that, increase in Blanching time leads to increase in phytate level with Ultrasound time (UTime). From the graph, it is observed that there is a decline in phytate level as the Ultrasound time increases with Blanching time (BTime). From the graph, it showed that, with increase in Ultrasound time (UTime), phytate dropped from highest point to the mid-point of 5 mins and then increase again.

Effect of Blanching Time (BTime) and Ultrasound Time (UTime) on Potassium.

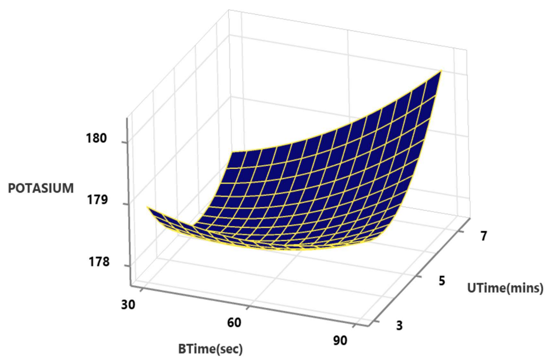

Figure. 1.4 Response surface graph for effect of Blanching Time (BTime) and Ultrasound Time (UTime) on Potassium.

From the graph, Figure 1.4 it is observed that there is significant effect of both ultrasound time and blanching time on Potassium. It is observed that the potassium level experienced a significant increase as Ultrasound time increases. From this, it could be seen that, increase in Ultrasound time leads to increase in Potassium level. Also, it is observed that there is a decline in Potassium level as the Blanching time increases from 3- 7mins with Ultrasound time (UTime). This finding is similar to the work done by Ekanem et.,al., 2020. From the work, it showed that, increase in Blanching time (BTime) leads to a decline in potassium level with Ultrasound Time (UTime).

Effect of Blanching Time (BTime) and Ultrasound Time (UTime) on Iron.

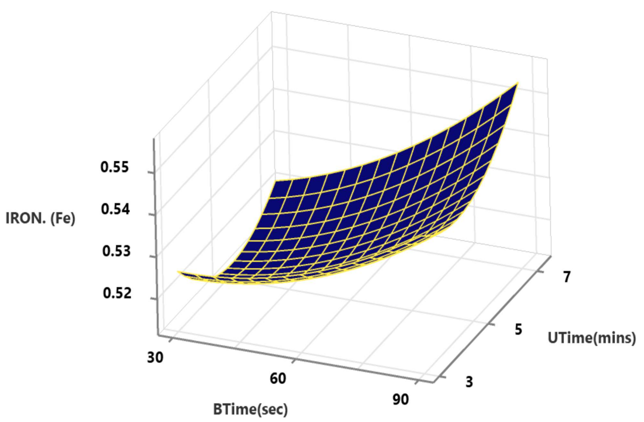

Figure. 1.5. Response surface graph for effect of Blanching Time (BTime) and Ultrasound Time (UTime) on Iron.

From the graph, Figure 1.5 it is observed that there is significant effect of both ultrasound time and blanching time when combined together on Iron. It is observed that the Iron content experienced a significant increase as blanching time increase from 30 sec- 90 sec. From this, it concludes that, increase in blanching time leads to increase in Iron level with ultrasound time **(UTime**). From the graph, it is observed that there is an increase in Iron level as the Ultrasound time increases from 3- 7mins with Blanching time **(BTime).** This observation is in line with the work carried by Fakayode and Ajav 2016. From this, it showed that, increase in Ultrasound time **(UTime)** leads to a significant increase in Iron level with Blanching Time **(BTime).**

Effect of Blanching Time (BTime) and Ultrasound Time (UTime) on Vitamin C.

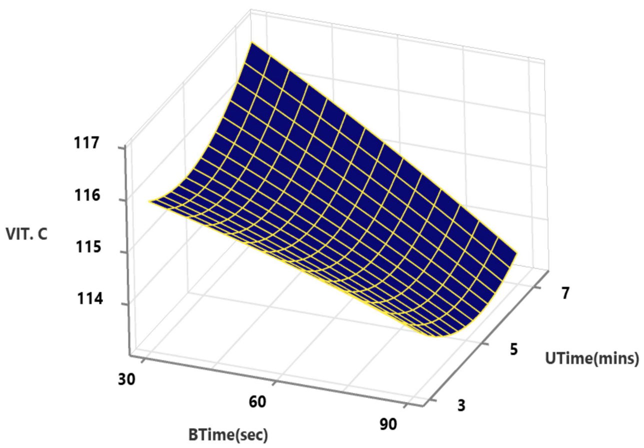

Figure. 1.6 Response surface graph for effect of Blanching Time (BTime) and Ultrasound Time (UTime) on Vitamin C.

From the graph, Figure 1.8 it is observed that there is significant effect of both ultrasound time and blanching time when combined together on Vitamin C. It is observed that the Vitamin C level experienced a significant decrease as blanching time increase from 30 sec- 90 sec. From this, it could be observed that, increase in Blanching time leads to decrease in Vitamin C level with Ultrasound time **(UTime**). This finding is in line with the observations by Ossom et al., 2020. From the graph, it is observed that there is a decline in Vitamin C level as the Ultrasound time increases from 3- 5mins and Vitamin C content experienced an increase as Ultrasound time increased from 5-7min with Blanching time **(BTime).**

Conclusion

The Paw-paw fruit thin layer slices were dried using Microwave Oven at 60^{0}C. Effects of the drying method on the nutritional and anti-nutritional properties of Paw-paw *(carica papaya)* sing response surface methodology was analyzed in this research study. Based on the results, the following conclusions were made:

. From the result of the work, it shows that, increase in Ultrasound time above 5 mins will lead to decrease in Oxalate level with Blanching time (BTime). It was also observed that there is a decline in Oxalate level as the Blanching time increased. Moreover, it was observed that there is a decline in phytate level as the Ultrasound time increases with Blanching time (BTime). It also showed that, with increase in Ultrasound time (UTime), phytate dropped from highest point to the mid-point and then increased again.

After pretreatment and subsequent drying, of samples in the micro wave oven the nutrients and anti-nutrients content were affected when compared to the control. From the work potassium level experienced a significant increase as Ultrasound time increases. also, there is a decline in Potassium level as the Blanching time increased. It was observed that there is an increase in Iron content as the Ultrasound time increased. Furthermore, it was observed that the Vitamin C level experienced a significant decrease as blanching time increased.

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