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Studies on the Characteristics of Deep Fried Pretreated Cocoyam Slices (*Xanthosoma sagittifolium*)

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ABSTRACT

The deep fat frying of cocoyam slices was investigated to determine the effect of pretreatments on the characteristics of deep fried cocoyam slices. Three pretreatments were used; 40% w/w sucrose solution for 4 hours, 20% w/w sodium chloride solution for 4 hours and blanching in hot water at 100^0C for 1 minute. The slices were then fried at 170^0C in a deep fat fryer for 7minutes. Sensory analysis, shrinkage, total sugar, moisture content and oil uptake of the fried slices were determined. Results obtained showed that the oil uptake and moisture content of the pretreated slices were reduced. The percentage shrinkage followed the same trend with the blanched samples shrinking least. Sensory analysis results showed that the crispiness and sweetness showed significant difference ($P<0.05$) while the crispiness, crunchiness and appearance showed no significant difference *($P<0.05$)*. It can be concluded that osmodehydration as a pretreatment to frying has a desirable effect on the product with salt or sugar.

Keywords: Cocoyam, Pretreatment, Blanching, Osmodehydration, Shrinkage, Oil uptake,

Introduction

The popularity of potato chips suggests that suitable substitutes might be found among tropical roots, tubers and plantains, and the market for this kind of product has increased over recent years in tropical and northern hemisphere countries[1]. In Nigeria, as in most developing countries, there are many food items prepared traditionally by immersion frying but information about process variables, product properties and optimal processing conditions are difficult to find in literature[2]. The application of frying to starchy food materials has mainly been studied for potatoes and yam slices with very scarce publications till date concerning the frying behavior of cocoyam slices. Cocoyam is a tuber crop used mainly for human food. Nigeria is the world's largest producer of cocoyam. The average production figure for Nigeria is 5,068,000 million tonnes which accounts for about 37% of total world output of cocoyam[3]. The main type of cocoyam grown in Nigeria is *Colocasia exculenta* (L) scholt, a member of Araceae family otherwise known as taro. Taro (*Colocasia* spp) is grown throughout the southern belt of Nigeria for its edible corms, cornels and leaves as well as for its traditional ceremonial uses. It is believed to have originated from India and other parts of South East Asia[4]. Literatures also have it that they have nutritional advantages over other root and tuber crops[5]. It has more crude protein and its starch is highly digestible because of the small size of its granules. It has a reasonable amount of calcium, phosphorus and vitamins A and B[6]. Cocoyam can be processed in different forms; boiled, roasted or processed to fried slices (chips) which are available in the market[7]. Cocoyam chips are so much delighted by children and youths as school snacks. Similarly, several confectionaries such as biscuits, chinchin, flakes and balls have been produced from flours of cocoyam through various value addition technologies.

Deep-fat frying is an established process of food preparation and a process of cooking foods by immersing them in edible oils and fats at elevated temperatures to induce fast dehydration. It is a simultaneous heat and mass transfer process where moisture leaves the food in the form of vapor bubbles, while oil is absorbed simultaneously[8, 9]. It is often selected as a method of choice for creating unique flavors and texture in processed foods[10] (Patterson *et al.,* 2004) and results in modification of the physical, chemical and sensory characteristics of the food. One of the most important quality changes during the process is the amount of oil retained inside the product, which is incompatible with current health trends. Several studies have shown that oil is mainly retained in the crust region[11,12,13,14] which mostly penetrates during the post-frying cooling period[12,15,16,17,18]. Research has demonstrated that during frying the vigorous escape of water vapor and related inner pressure precludes oil migration into the crust and therefore, oil penetration is limited during most of the immersion period. As a result, oil absorption would be essentially a surface-related phenomenon, which is determined by the equilibrium between surface drainage and suction during post-frying cooling[15]. Despite its importance as a dehydration process and the desire to lower the oil content of fried products while still retaining other quality attributes, very little detailed information is available on deep-fat frying of cocoyam slices. Pretreatments have a great effect particularly on the sensory properties and oil contents of fried products[19]. Blanching inactivates enzymes, improves the colour and texture of food products and reduces deterioration such as development of off flavour[20]. Osmodehydration has also been reported to reduce changes in the physical, chemical properties and contributing to an improvement in quality[2, 21, 22, 23]. Different works have been carried out on fried tuber crops like potatoes and yam[2, 23, 24] but no much work has been done on the effect of pretreatment of cocoyam before frying, hence this work is aimed at investigating the effect of pretreatments on the characteristics of deep fried cocoyam slices.

Materials and Method

Materials

Fresh red cocoyam (Colocasia esculenta) variety procured from a local market in Abeokuta, South West Nigeria, was used for the research. Tubers weighing between 1.01 and 1.50 kg were selected from the lots, washed, graded into weight classes. The tubers were then stored at about 10^0C, 80–90% relative humidity before use. This method had earlier been used earlier by[25] to reduce variability in selection of raw materials for processing. Refined, bleached and deodorized palm olein oil supplied by Ngo Chew Hong Ltd. (Singapore) was used for frying experiments.

Preparation of Yam Slices

The cocoyam tuber was peeled using a hand peeler and sliced into 5mm obtained from the most central parts using a multipurpose slicer. The slices were rinsed immediately to remove surface starch using method of[26].

Pretreatments

The following treatments were used.

a. Control slices were without osmodehydration
b. Slices blanched in hot water of 100°C for 1minute
c. Osmodehydration using sucrose solution of 40% w/w for 4 hours
d. Osmodehydration using 20% w/w solution of sodium chloride for 4 hours, modified methods of[26, 27,28].

Frying Operation

A deep-fat fryer (model S-516, M/S Assudamal & Asons (HK) LTD, Hong Kong, China) with temperature control of 1^0C was used. The fryer holds 1.5 L of oil and is equipped with a 2 kW electric heater. Isothermal condition was observed during frying by keeping the yam-to-oil weight ratio as low as possible[27, 29] and monitored using a digital thermometer (Comak Instruments Inc., Huntsville, AL). Frying temperature was set at 170^{0}C for 7mins slice thickness 5mm using tubers of initial dry matter 0.152 kg/kg. The frying temperature was set at 170^{0}C and the frying time was kept at 7 minutes[26, 27]. The experiments were carried out in triplicate hence results presented are the mean values. Excess oil was shaken off from the chips after removal from the fryer after the preset frying time for about 50s[1, 18, 25, 30].

Analytical Methods

Moisture Content

Moisture contents and initial dry matter of samples was determined using standard gravimetric method. The samples were weighed into flasks and dried at 105^{0}C for 5 hrs, cooled in desiccators and weighed again according to the method number 32.082 of[31]. Same samples were used for oil analysis. Oil content was determined by soxhlet extraction according to the method of[32]. The dried samples were ground in a blender and extracted with petroleum ether (bp40–60^{0}C) for 4hrs. Petroleum ether was removed under vacuum at 60^{0}C using a rotary evaporator. The recovered oil was left for 24hrs in a vacuum oven at 70^{0}C and weighed. Analysis was conducted in triplicate and results presented are the average of the values obtained.

Shrinkage

Sample dimension before and after frying was measured with a ruler; measurements were made randomly using 10 samples. Shrinkage was expressed as the percentage using modified method of[33, 34].

$$S = \frac{(do - d(t))}{do} \times 100$$

do = Initial diameter of the sample

d(t) = Diameter of sample after frying at time (t).

Degree of shrinkage in volume (S_v) was evaluated by

$$S_V = \frac{100\left(V_0 - V_{(t)}\right)}{V_0}$$

Vo = Original volume of the sample

$V_{(t)}$ = Volume of the sample at time
(t) = time of frying
Where;
V = Volume of a cylinder
$V = \pi r^2 h$,
H = Thickness

Sensory Evaluation

A multiple comparison test was done by a 9 member semi trained panelist, using a 5 point hedonic scale by the method of[25,27]. The following chips characteristics were accessed, crispiness, crunchiness, colour, sweetness and appearance.

Statistical Analysis

The statistical analysis of the data was conducted using SPSS 10.0 version (SPSS Inc., Chicago, IL) and significance expressed at the $P < 0.05$ level.

Results and Discussion

Table I shows the effect of pretreatments on chemical composition of cocoyam spp. The initial moisture content of the cocoyam slices dropped from about 61% in the fresh sample to below 10% in the sample osmodehydrated with sugar. This has been attributed to moisture losses during frying which was in agreement with the work of[16] reported, that during frying, the moisture content of fried products reduces with time of frying. The blanched slices had the least moisture content, among the pretreated samples, but generally the pretreated samples had low moisture contents, because pretreatments reduces the moisture content of fried products, thereby shrinking them as certain solids are infused into the product mature,[27]. As for the oil content as shown in table I, the oil uptake of pretreated samples were low, though the blanched samples was relatively high which is due to the hot water blanching which has disrupted the cells and tissues of plant hence allowing earlier uptake of oil. Also from table I, the oil content of the sugar osmodehydrated slices were the least, though those of the untreated and blanched were the highest, showing pretreatment has relatively reduced the oil uptake of the samples. The total sugars of the control sample were the least, while that of the untreated cocoyam slices was the highest. Caramelization was more obvious in the sugar osmodehydrated slices which can be attributed to the presence of sugar (sucrose), which was used.

Table I: Chemical Composition of Fried Pretreated Cocoyam Slices

Samples	Moisture Content %	Dry Matter %	Total Sugars %	Ether Extract %
Fresh	61 ± 0.17	39 ± 0.17	N. D.*	N.D.*
Control**	6.77 ± 0.03	93.23 ± 0.03	0.80 ± 0.00	9.50 ± 0.00
Untreated	6.73 ± 0.10	93.27 ± 0.10	1.03 ± 0.03	12.77 ± 0.10
Blanched	5.50 ± 0.07	94.50 ± 0.07	0.73 ± 0.03	12.17 ± 0.17
O.D*** (SALT)	6.50 ± 0.00	93.50 ± 0.00	0.93 ± 0.03	11.63 ± 0.17
O.D*** (SUGAR)	6.17 ± 0.03	93.83 ± 0.03	1.00 ± 0.00	8.37 ± 0.20

*** Not Done   **Control   ***Osmodehydrated**

Table 2 shows that the dimensions of the cocoyam slices (both the diameter and volume) reduced after frying. The percentage shrinkage of the samples followed a similar trend; with the untreated samples having the least value while the blanched samples were the highest with a considerable high amount of percentage shrinkage. The percentage shrinkage of the sugar osmodehydrated slices was more than those of the salt Osmodehydrated samples. The high content of the blanched slices could be attributed to the water uptake of the slices during the hot water blanching process, which has disrupted, inactivated the enzymes and swelled the tissues of the slices. The degree of shrinkage expressed in volume of the slices also followed the same trend as the percentage shrinkage.

Table 2: Degree of Shrinkage Fried Cocoyam Slices

Samples %	Percentage Shrinkage	Degree of Shrinkage
Untreated	1.52	2.49
Blanched	12.80	24.02
Osmodehydrated (Salt)	4.27	8.40
Osmodehydrated (Sugar)	7.01	13.02

Table 3 shows the result sensory properties of pretreated cocoyam samples, the sugar osmodehydrated slices were best preferred, while the blanched ones were least preferred. There was no significant difference in the crunchiness of the slices while the sugar osmodehydrated slices were considered most crunchy. There was no significant difference in the sweetness and colour of the slices, which may be due to the dark colour of cocoyam itself, making it impossible to observe a slight colour difference in the samples.

Table 3: Mean Sensory Scores on Pretreated Fried Cocoyam Slices

Parameters	Untreated	O.D* (Salt)	O.D* (Sugar)	Blanched
Crunchiness	2.55a	3.66a	3.66a	3.11a
Crispiness	2.78b	4.33a	4.56a	3.33a
Sweetness	3.11	3.44	4.33	3.11
Colour	3.77a	3.66a	4.44a	3.53
Appearance	3.44a	3.88a	4.44a	4.00

***Osmodehydrated. Means values with different superscript within the same column are significantly different at $p \leq 0.05$**

Conclusion

Results obtained from this study shows that deep-fat frying of cocoyam slices is a rapid drying method in which, the rate of moisture loss is significantly influenced by frying temperature and oil uptake was significantly affected by frying temperature and frying time pretreatment increases the various characteristics of slices ranging from crunchiness, crispiness, sweetness amidst others. Osmodehydration has been established to be the best pretreatment for fried cocoyam slices either with salt or sugar. However, more work is still needed to be done to establish the best concentration of salt and sugar.

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