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RESEARCH ARTICLE

Influence of Blanching, Frying and Storage on the Physicochemical Properties and Shelf Life of Fried Taro (*Colocasia Esculenta*) Chip

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Abstract

Taro (*Colocasia esculanta)* tubers have the great importance of functional foods. Taro tubers are important sources of carbohydrates as an energy source. Taro tubers provide a number of desirable nutritional and health benefits such as anticancer activity, phenolic acid and phytochemicals. Taro deteriorates rapidly as a result of its high moisture. The high perishability of taro during storage remains a major constraint. It is widely cooked by deep frying and consumed in forms of French fries and chips. The major challenge for the food industry is to produce low fat fried product with desirable texture, color and flavor. This research has been focused on different parameters of blanching, drying for minimum oil absorption and sensory palatability while maintaining the most phytochemical components such as total phenolic, total flavonoid and anthocyanin; extending product shelf life during packaging and preservation. Results revealed that blanching 95^{o}C in 30 seconds with ascorbic acid of 0.15 g/100g taro, frying 2.0 cm of taro chip in soybean oil heating at 155^{o}C in 2 minutes was appropriated. Fried taro chip could be preserved for 12 weeks under vaccum at 4^{o}C. Moisture and oil content, as well as colour and texture are important quality attributes of fried taro products. Frying of taro chips is carried out to convert the tubers to value added products. Frying method brings out unique flavor and texture to the products that improve their overall acceptability.

Keywords: *Taro chip, Blanching, Frying, Shelf life, Anthocyanin, flavonoid.*

Introduction

Colocasia esculenta, commonly known as taro, is an important food staple of developing countries. Taro corms may be considered as a good source of carbohydrates and potassium. It is largely produced for its underground corms containing 70 to 80% starch [1].

It contains small granules which are highly digestible. Taro is also a good source of thiamin, riboflavin, iron, phosphorus and zinc and a very good source of vitamin B6, vitamin C, niacin, potassium, copper and manganese [2].

Phytochemical analysis of revealed the presence of alkaloids, glycosides, flavonoids, terpenoids, saponins and phenols [3]. Taro tubers are rich in starch and the corms contain the anthocyanins, cyanidin 3-glucoside, pelargonidin 3- glucoside, and cyaniding 3-rhamnoside [4].

Taro foods are useful to persons allergic to cereals and can be consumed by infants/children who are sensitive to milk.1 The taro promoted increase in the testicles parameters and hormones [5].

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Taro contains anti-nutrient factors such as: oxalate, phytate and tannin. They could be destroyed by heating. The frying process results in unique flavor, colour and texture attributes which are the main drivers of consumer acceptability of the products [6, 7]. Consumer preference for low-fat food products has been the driving force for the food industry to produce good quality fried potatoes with reduced oil uptake [8]. Too much oil content in a fried product endows it with an oily taste while too little oil content deprives it of the typical appealing taste and odour of the fried product.

Oil uptake in fried potato products has generally been related to the amount of moisture, starch and dry matter content of the raw potato as well as temperature of the frying oil [9, 10]. There were some studies mentioned to taro (*Colocasia Esculenta Schott*) frying. The effects of a water blanching pretreatment (BP, 85°C for 3 min), sample thickness (1 and 2 mm), oil temperature (180 and 200°C), and frying time (1 and 3 min) on the oil uptake (OU) behavior during the deep-fat frying of pre-dried (oven dried at 70°C for 20 min) taro (*Colocasia esculenta*) chips were investigated [11]. The effect of pre-frying drying on mass transfer kinetics (moisture loss and oil uptake) of taro slices during frying was investigated [12]. Influence of a blanching pretreatment on color, oil uptake and water activity of potato sticks, and its optimization was examined [13]. Storage stability and sensory evaluation of taro chips fried in palm oil, palm olein oil, groundnut oil, soybean oil and their blends were observed [14]. It is important to investigate blanching and frying conditions for use by potential small scale processors while ensuring acceptable quality of taro chip. Hence, the objective of this study was to determine the effect of blanching, frying temperature and time, thickness of taro chip on the composition and sensory properties of fried taro chip.

Material & Method

Material

Taro tubers (*Colocasia Esculenta Schott)* were collected in Soc Trang province, Vietnam. After harvesting, it must be temporarily preserved in dry cool place. In laboratory, it was thoroughly washed to remove dirt and foreign matter. Taro would be chopped into bars with different thickness depth. The oil tank was filled with 10 liters of soybean oil and preheated. Once the oil temperature reached the target value, the frying basket with 1kg of chopped taro chip was placed in the frying vessel and the lid was closed. After frying, the fried taro chips were removed from the basket, allowed to cool to ambient temperature for 20 minutes, and then be packed in metalized polyethylene pouches.

Figure 1: Taro (*Colocasia Esculenta Schott)*

Research Method

Effect of Blanching Temperature and Time on Physicochemical and Sensory Properties of Fried Taro Chip

Four levels of blanching temperature (^{o}C) namely (i) 85^{o}C in 60 seconds (ii) 90^{o}C in 45 seconds (iii) 95^{o}C in 30 seconds (iv) 100^{o}C in 15 seconds were carried out. During blanching, all samples were treated with ascorbic acid of 0.15 g/100g taro. The best blanching temperature and time was selected based on the values of moisture (g/kg) and oil (g/kg) content; total phenolic (mg GAE/ g), total flavonoid (mg QE/g), anthocyanin (mg/ 100g); sensory score of fried taro chip.

Effect of Frying Temperature and Time on Physicochemical and Sensory Properties of Fried Taro Chip

Four levels of frying temperature (°C) namely (i) 145°C in 3.0 minutes (ii) 150°C in 2.5 minutes (iii) 155°C in 2.0 minutes (iv) 160°C in 1.5 minute were carried out. The best frying temperature and time was selected based on the values of moisture (g/kg) and oil (g/kg) content; total phenolic (mg GAE/ g), total flavonoid (mg QE/g), anthocyanin (mg/ 100g); sensory score of fried taro chip.

Effect of Thickness of Taro Chip on Physicochemical and Sensory Properties of Fried Taro Chip

Thickness of taro chip was examined in four different size levels (1.0 cm, 1.5 cm, 2.0 cm, 3.0 cm). The best thickness of taro chip was selected based on the values of moisture (g/kg) and oil (g/kg) content; total phenolic (mg GAE/ g), total flavonoid (mg QE/g), anthocyanin (mg/ 100g); sensory score of fried taro chip.

Effect of Packaging and Storage Temperature on Shelf Life of Fried Taro Chip

Fried taro chip would be packed by two different bags (zipper and vaccum) and stored in two different temperatures (4°C and 28°C) during 12 weeks of storage. Shelf life of fried taro chip was based on the changes in thiobarbituric acid (TBARs) (mg malonaldehyde/ kg).

Physico-chemical and Statistical Analysis

Moisture (g/kg) content of fried taro chips was determined in triplicate according to the AOAC method (AOAC, 2000) using a hot air oven. Oil (g/kg) content of fried taro chips was determined in triplicate by petroleum ether extraction using the Soxhlet extraction unit. Total phenolic (mg GAE/ g) content was determined by the method based on oxidation–reduction reaction by Folin–Ciocalteu reagent using gallic acid as a standard. Total flavonoids (mg QE/g) content was determined by colorimetric method [15].

Total anthocyanin content (TAC) was determined by following the procedures of Mancinelli, Hoff, and Cottrell (1988) with few modifications [16]. Sensory score was based on 9-point hedonic scale. The thiobarbituric acid (TBARs) (mg malonaldehyde/ kg) of fried taro chips was determined in triplicate by a distillation method [17]. Data were statistically summarized by Statgraphics Centurion XVI.

Result & Discussion

Effect of Blanching Temperature and Time on Physicochemical and Sensory Properties of Fried Taro Chip

Blanching is essential to producing fries of good quality in terms of both color and texture [18]. Blanching inactivates enzymes, leads to leaching out of sugars, gelatinizes starch and causes cell separation [19, 22]. Blanching temperature and frying time had a greater impact on texture and appearance of fried chips than blanching time [23].

Table 1: Effect of blanching temperature and time on physicochemical and sensory properties of fried taro chip

Blanching	Moisture (g/kg)	Oil (g/ kg)	Total phenolic (mg GAE/ g)	Total flavonoid (mg QE/g)	Anthocyanin (mg/100g)	Sensory score
85°C in 60 seconds	0.50±0.01^{a}	1.62±0.02^{a}	1.55±0.00^{b}	0.70±0.00^{b}	15.36±0.01^{b}	7.41±0.00^{ab}
90°C in 45 seconds	0.49±0.03^{ab}	1.60±0.00^{ab}	1.57±0.01^{ab}	0.72±0.01^{ab}	15.53±0.01^{ab}	7.58±0.02^{ab}
95°C in 30 seconds	**0.49±0.02^{ab}**	**1.60±0.03^{ab}**	**1.60**±0.03^{a}	**0.74**±0.03^{a}	**15.74**±0.01^{a}	**7.69±0.01^{a}**
100°C in 15 seconds	0.48±0.01^{b}	1.58±0.02^{b}	1.56±0.02^{ab}	0.71±0.02^{ab}	15.44±0.03^{ab}	7.13±0.01^{b}

Data are expressed as mean ± SD values (n = 3). Mean value with different superscript in each column differs signifcantly (p<0.05)

The effects of a water blanching pretreatment (BP, 85°C for 3 min), sample thickness (1 and 2 mm), oil temperature (180 and 200°C), and frying time (1 and 3 min) on the oil uptake (OU) behavior during the deep-fat frying of pre-dried (oven dried at 70°C for 20 min) taro (*Colocasia esculenta*) chips were investigated. Results demonstrated that using short frying times and high oil temperatures causes OU to decrease in both blanched and non-blanched samples ($p < 0.01$). In addition, higher product thicknesses were found to increase OU in non-blanched taro chips, while the opposite trend was found for the blanched slices ($p < 0.01$). BP also affected the OU, yielding lower fat contents (up to 80% of OU reduction) ($p < 0.05$), thus allowing the development of a fried taro product with reduced fat content (less than 30% fat

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content in dry basis) [11]. Influence of a blanching pretreatment on color, oil uptake and water activity of potato sticks, and its optimization was examined. The blanching optimum conditions were as follows: a concentration of ascorbic acid of 0.2 g/100g potato, a time of 5.5 min and a temperature of 69°C.

Regarding oil uptake, some of the blanched sticks absorbed 31% less oil than the control. Regarding A_w, all blanched samples presented lower values than the control, suggesting that blanching increases the shelf life of fried potatoes [13].

Effect of Frying Temperature and Time on Physicochemical and Sensory Properties of Fried Taro Chip

Frying is a process of simultaneous heat and mass transfer in which heat is transferred from the oil to the food that leads to moisture transfer in the form of vapors and the fat is absorbed by the food. The process remains a complex operation because of the two mass transfers in opposite directions within the material being fried.

A number of physical and chemical changes occur during frying starting with dehydration to cooking, starch gelatinization, protein denaturation, aromatizing, and coloring via Maillard reactions and fnally oil uptake.[12] Nutritional analysis showed that moisture content is (56.8%), ash content (1.22%), carbohydrate (3000 mg/100gm), protein (824 mg/100gm) and starch (2700 mg/100gm) in dry tubers [3].

Table 2: Effect of frying temperature and time on physicochemical and sensory properties of fried taro chip

Frying	Moisture (g/kg)	Oil (g/ kg)	Total phenolic (mg GAE/ g)	Total flavonoid (mg QE/g)	Anthocyanin (mg/100g)	Sensory score
145°C in 3.0 minutes	0.49±0.02^{a}	1.60±0.03^{a}	1.60±0.02^{a}	0.74±0.01^{ab}	15.74±0.01^{b}	7.69±0.01^{ab}
150°C in 2.5 minutes	0.48±0.00^{a}	1.59±0.01^{a}	1.62±0.01^{ab}	0.76±0.00^{ab}	15.77±0.03^{ab}	7.61±0.00^{ab}
155°C in 2.0 minutes	**0.47±0.01^{a}**	**1.58±0.01^{a}**	**1.64**±0.00^{a}	**0.78**±0.01^{a}	**15.79**±0.02^{a}	**7.73±0.01^{a}**
160°C in 1.5 minute	0.47±0.02^{a}	1.58±0.01^{a}	1.57±0.02^{ab}	0.71±0.03^{c}	15.75±0.01^{b}	7.17±0.03^{b}

Data are expressed as mean ± SD values (n = 3). Mean value with different superscript in each column differs signifcantly (p<0.05)

Table 2, the taro chip should be fried at 150°C in 2 minutes to achieve the best physicochemical and sensory properties of finished products. Frying is a simultaneous heat and mass transfer process where moisture leaves the food in the form of vapour bubbles, while oil is absorbed simultaneously.

The frying process results in unique flavor, color and texture attributes which are the main drivers of consumer acceptability of the products. Moisture and oil content, as well as colour and texture are important quality attributes of fried taro. The effect of pre-frying drying on mass transfer kinetics (moisture loss and oil uptake) of taro slices during frying was investigated.

Pre-frying drying time signifcantly reduced (P<0.05) the moisture content and oil uptake of fried taro slices [12].

Effect of Thickness of Taro Chip on Physicochemical and Sensory Properties of Fried Taro Chip

Mode of heat transfer from medium into the food pieces during initial heat-up stage was convection, subsequently when the temperature inside reached the boiling point, moisture started to evaporate during the constant rate stage. The last stage was falling rate, food surface became dry and crust, moisture was slowly removed by moisture diffusion mechanism [24, 25].

Table 3: Effect of thickness (cm) of taro chip on physicochemical and sensory properties of fried taro chip

Thickness (cm)	Moisture (g/kg)	Oil (g/ kg)	Total phenolic (mg GAE/ g)	Total flavonoid (mg QE/g)	Anthocyanin (mg/100g)	Sensory score
1.0	**0.47±0.01^{b}**	**1.58±0.01^{a}**	**1.64**±0.02^{b}	**0.78**±0.01^{b}	**15.79**±0.01^{b}	**7.73±0.01^{b}**
1.5	0.48±0.00^{ab}	1.56±0.03^{ab}	1.67±0.03^{ab}	0.79±0.02^{ab}	15.82±0.03^{ab}	7.75±0.00^{ab}
2.0	**0.50±0.01^{a}**	**1.55±0.00^{b}**	**1.69**±0.00^{a}	**0.82**±0.01^{a}	**15.84**±0.01^{a}	**7.82±0.01^{a}**
2.5	0.50±0.01^{a}	1.55±0.01^{b}	1.69±0.00^{a}	0.82±0.03^{a}	15.85±0.01^{a}	7.68±0.03^{c}

Data are expressed as mean ± SD values (n = 3). Mean value with different superscript in each column differs signifcantly (p<0.05)

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From table 3, the taro chip should be chopped into bars in 2.0 cm of thickness to achieve the best physicochemical and sensory properties of finished products during frying.

Effect of Packaging and Storage on Shelf Life of Fried Taro Chip

Shelf life is the time period in which a food product still retains its quality and safety and is acceptable to consumers. Shelf life evaluation of food stored under actual condition may take much longer time; hence an accelerated shelf life testing is often used for shelf life prediction [26]. Rancidity is often considered an unpleasant flavor in fried foods and can be indicated by the thiobarbituric acid (TBARs) value.

Table 4: Effect of packaging and storage on shelf life (thiobarbituric acid, mg malonaldehyde/ kg) of fried taro chip

Storage (weeks)	Packing bag		Storage temperature	
	Zipper	Vaccum	4°C	28°C
0	$0.51{\pm}0.02^{b}$	$0.51{\pm}0.02^{b}$	$0.51{\pm}0.02^{b}$	$0.51{\pm}0.02^{b}$
4	$0.53{\pm}0.04^{ab}$	$0.52{\pm}0.01^{ab}$	$0.53{\pm}0.01^{ab}$	$0.55{\pm}0.01^{ab}$
8	$0.54{\pm}0.02^{ab}$	$0.52{\pm}0.03^{ab}$	$0.54{\pm}0.00^{ab}$	$0.56{\pm}0.03^{ab}$
12	$0.57{\pm}0.01^{a}$	$0.53{\pm}0.02^{a}$	$0.57{\pm}0.02^{a}$	$0.58{\pm}0.00^{a}$

Data are expressed as mean ± SD values (n = 3). Mean value with different superscript in each column differs signifcantly ($p<0.05$)

From table 4, fried taro chip should be packed under vaccum and stored at 4°C to slow down the rancidity reaction. Storage stability and sensory evaluation of taro chips fried in palm oil, palm olein oil, groundnut oil, soybean oil and their blends were observed. The chip fried in palm oil and groundnut oil blend had the most desired flavour, taste and stability [14].

Conclusion

Colocasia esculenta (taro) is a tropical plant grown primarily for its edible corms, roots and vegetables Taro is one of such crops grown for various purposes. Taro tubers are used as staple foods in tropical and sub-tropical countries. Frying is one of the oldest processes of food preparation. Consumers have desired fried foods because of their unique combination of flavor and texture. Consumers are increasingly health conscious and trends are moving toward foods with low oil content.

The quality of the products from frying depends not only on the frying conditions, but also on the storage of fried taro chip. This study demonstrated that blanching, frying temperature and time; thickness of taro chip; packaging and storage temperature had signifcantly affected quality of fried taro chips.

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