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Feasibility of Producing Acceptable Carotene and Energy Rich Taro Crisps with Deep Palm-Oil Frying in Nigeria

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Abstract: Corms of a high yielding taro genotype (NCe006) were used to assess the feasibility of producing acceptable pro vitamin A and energy rich taro crisps after deep oil frying with crude red palm oil. Frying with refined palm oil was used as control. Results showed that the taro crisps produced with the crude palm oil had 44 µg/g carotene content while the crisps fried with refined palm oil had only 0.77 µg/g carotene content. Sensory evaluation scores by semi trained organoleptic panelists showed that the high energy (1.8 MJ/100 g) pro-vitamin A rich crisps were generally acceptable to them. The pro-vitamin A rich crisps can be used as a tool (snack food) against vitamin A deficiency (VAD) syndrome amongst children and reproductive women in Nigeria.

Key words: Taro, crisps, crude palm oil, frying, pro vitamin A

INTRODUCTION

Taro (*Colocasia esculenta*) is a tropical starchy tuber crop that serves as a food staple in Nigeria and some other tropical countries that cultivate the crop (Kolchar, 2006). In Nigeria, Taro and Tannia (*Xanthosoma sagittifolium*), which are both aroids are collectively known as cocoyam. Crisps made with taro have been found to be as good as potato (*Solanum tuberosum*) crisps in Nigeria as snacks (Ukpabi *et al*., 2007). From the end of the 1980's, National Root Crops Research Institute (NRCRI), Umudike, Abia State, Nigeria has been producing cocoyam (*C. esculenta* and *X. sagittifolium*) crisps with cormels from low itching cocoyam varieties and treated corms of some of them (Akomas *et al*., 1989; Ukpabi and Ejidoh, 1989).The quality of these crisps, especially the salted ones made with Taro cormels (of *Cocoindia* cultivar) were highly accepted by the local consumers (Ukpabi *et al*., 2007).

In the past few years, NRCRI had also gone a step further by producing crisps with treated corms of high yielding Taro varieties such as NCe 006 cultivar (also known as Ghana cultivar). Locally, NCe 006 cultivar is considered both high yielding in corms as well as non-seasonal in certain niches like hydromorphic soils. Presently non-fortified food products from Taro are known to be energy rich (mostly carbohydrate) but low in carotene or pro-vitamin A that is required in combating vitamin A deficiency (VAD) syndrome among resource poor children and women in certain parts of sub-Saharan Africa (SSA) including Nigeria. Taro corms and cormels especially those from the local high yielding NCe006 cultivar, could therefore be considered a good food security material in Nigeria when energy requirement is in focus. The acrid nature of the corm can be eliminated through adequate processing techniques or treatment (Akomas *et al*., 1989).

Crude palm oil which is the world's richest plant source of carotenes in terms of retinol equivalent (Tan, 1989) is abundantly produced in many southern states of Nigeria. This study was therefore aimed at evaluating the feasibility of producing consumer acceptable high energy pro-vitamin A rich Taro crisps using the carotene rich fresh crude palm-oil in the deep oil frying unit operation of the crisps production. This food product has children and young women as target consumers.

MATERIALS AND METHODS

Source of the materials: The experimental Taro (*Colocassia esculenta* cv. NCe 006) corms were randomly harvested from the experimental plots of the Cocoyam Programme, NRCRI, Umudike, Abia State, Nigeria. Fresh crude red palm oil made from local oil palm (*Elaeis guineensis* var. tenera) and table salt (Dangote brand) were purchased from the Main market, Umuahia, Abia State, Nigeria. Refined palm-oil (Turkey brand) was produced and imported from Malaysia.

Production of the crisps: The unit and subunit operations used in the production of two types of crisps from the cocoyam (taro) corms are as shown in Fig. 1.

The peeled washed corms were chipped with a chipping machine (Kenwood model) while brining was done with 1% sodium chloride solution (for 10 min). After the brining operation, the natural mucilaginous materials on the treated corm chippings were removed by manual washing with clean water. Frying was done with a kerosene stove (Butterfly model).

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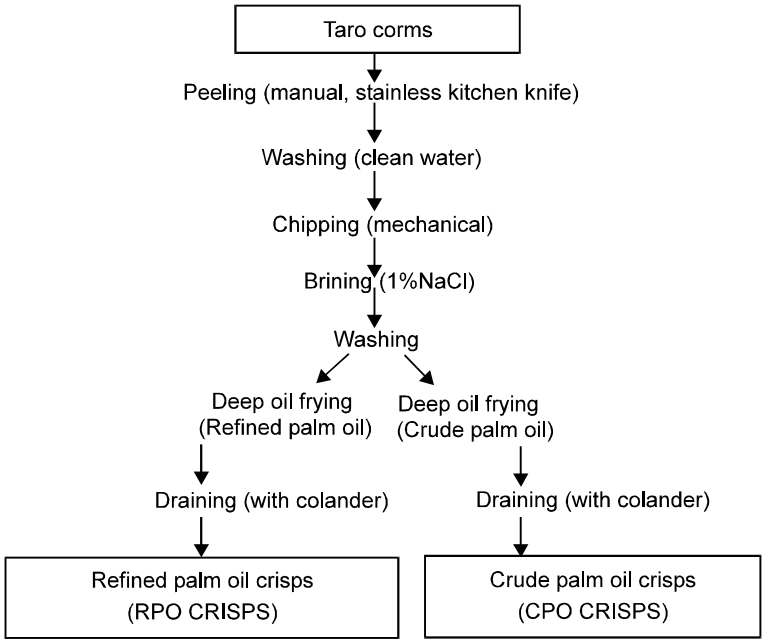

Fig. 1: Flow chart for the production of the experimental taro crisps samples

Food processing data: Hand peeling (with stainless kitchen knife) was used to determine peeling loss of the corms prior to chipping. A rule was used to determine the thickness of the fried crisps. The colour of the experimental samples (corm flesh/fried crisps) was determined visually by the researchers, while a thermocouple thermometer was used to record the frying temperature.

Chemical analysis: Relevant chemical analyses of the experimental corms (crude fiber, ash, crude protein, ether extract, carbohydrate, calorific value) were done in triplicates with standard AOAC methods (AOAC, 1990). The total carotenoid content of the taro corm and crisps were determined spectrophotometrically in triplicates with the HarvestPlus method (Rodriguez-Amaya and Kimura, 2004).

Sensory evaluation: A panel of semi-trained assessors made up of 30 randomly selected young women was used to evaluate the organoleptic characteristics of the fried crisps samples using a seven-point (0-6) hedonic scale (Iwe, 2002). The parameters evaluated were colour, taste, crispness and overall acceptability. In the scoring, 6 = "like extremely", 3 = "neither like nor dislike" and 0 = "dislike extremely". The panelists were also asked to comment freely about the taro crisps samples.

Statistical analysis: The statistical analyses in the study were done with the SAS software version 8 originally licensed to International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria (site 0022206002).

RESULTS AND DISCUSSION

Table 1 shows that the variegated coloured (pink/white) fresh flesh of the experimental corms had high dry matter content (36%) and low carotenoid content (0.56 µg/g). More efficient peeling method needs to be employed in order to reduce the recorded peeling loss of 20.19% (Table 1). The observed peeling loss of the corm is however similar to the values earlier recorded in NRCRI, Umudike, Nigeria (Ukpabi *et al*., 2006a,b) After the deep oil frying unit operation (at about 140°C), the obtained 1-2 mm thick crisps had beautiful reddish colour.

The result of the sensory evaluation of the experimental crisps showed an appreciable level of acceptance of the Refined Palm Oil (RPO) crisps and Crude Palm Oil (CPO) crisps; that is those respectively produced by deep oil frying in refined palm oil and crude palm oil (Table 2). Earlier work done by the authors of this study showed that blanching and boiling of the chipped corms (before frying) significantly ($p = 0.05$) lowered the level of overall acceptability of taro crisps (Ukpabi *et al*., 2006b). The bulk of the taste panelists remarked that the anti-acridity treatment (brining) used in the study successfully reduced the itching characteristics of the fresh taro corm.

Table 1: Properties of the experimental fresh Taro (cv. NCe 006) corms

Parameters	Data
Flesh colour	Variegated (white/purple)
Dry matter content (%)	36.00±0.15
Starch content (%)	29.40±0.20
Total carotenoid (µg/g)	0.56±0.01
Peeling loss (%)	20.19±0.09

Table 2: Sensory Evaluation Scores*# of the Experimental Taro Crisps

Sample (+)	Colour	Taste	Crispness	Overall acceptability
RPO Crisps	4.93[a]	4.27[a]	4.87[a]	4.73[a]
CPO Crisps	4.67[b]	3.87[a]	4.53[a]	4.53[a]

*Values with the same letters in a column are not significant different (p=0.05)
#Where 0 = dislike extremely
3 = neither like not dislike
6 = like extremely
+ RPO crisps = Refined Palm oil fried crisps
CPO crisps = Crude palm oil fried crisps

Table 3: Total carotenoid content of the Taro crisps samples

Sample*	Carotenoid content
ROP crisps	0.77±0.02 µg/g
CPO crisps	44.00±0.22 µg/g

*Where RPO crisps = Refined palm oil fried crisps
CPO crisps = Crude palm oil fried crisps

Table 4: Proximate composition and calorific values of the crude palm oil fried crisps (on dry matter basis)

Parameter	Value
Crude fibre	0.72%±0.01
Ash	1.24%±0.02
Fat	8.11%±0.08
Crude protein	5.8%±0.04
Total carbohydrate	84.8%±0.12
Energy (Calorific value)	1.8 MJ/100 g±0.01

Table 3 showed that the use of palm oil in the production of taro crisps could enhance the pro-vitamin A content of the taro by more than 50 folds. Generally, crude palm oil, unlike refined palm oil, is considered a very good source of pro-vitamin A (Kings and Burgess, 1972; Benade, 2003) as crude red palm oil has high carotenoid content of 500-800 ppm or µg/g (Ng and Tan, 1988; Sundram *et al*., 2003). In nutritional studies, conversion rate of carotenoids to retinol equivalent depends on the carotene type (Solomon and Orosio, 2013) and Ng and Tan (1988) also reported that the carotenoid composition of crude palm oil is made up of mainly beta-carotene (slightly more than half of it) and alpha-carotene (about a third of it).

The proximate composition and calorific value of the experimental pro-vitamin rich crisps are shown in Table 4. These energy rich crisps (1.8MJ/100 g) were observed to have very low moisture content (2.00%). This means that the CPO crisps can serve as both dietary energy source and pro-vitamin A food material. Ukpabi *et al*. (2012) also reported that carotenes are usually absorbed more in fatty food products ($\geq$ 6% fat) by the body, thereby making the CPO crisps (with fat content of 8.11%) a good dietary source of pro-vitamin A especially amongst children and reproductive women in areas that are endemic to VAD syndrome. This is in line with the fact that Benade (2003) had earlier reported that consumption of red palm oil incorporated in sweet snacks or biscuits significantly improved plasma retinol concentration in lactating mothers and children in South Africa. We suggest detailed non-controversial clinical research on the effect of consumption of red palm oiled snacks on the plasma concentration of adult males. Interestingly, crude red palm oil also has 600-1000 ppm of the fat soluble vitamin E (30% tocopherol and 70% tocotrienols) which has the potentials of cholesterol lowering, anticancer effects and protection against atherosclerosis as health benefits in adult men and women (Chong and Ng, 1991; Sundram *et al*., 2003). By calculation only one teaspoon daily intake of red palm oil, providing about 530 RAE (retinol activity equivalent) of beta-carotene is enough to prevent childhood blindness from vitamin A deficiency. The obtained 8.11% fat content of the COP crisps makes packaging with transparent polyethylene films (presently used in packaging crisps in many rural areas in Nigeria) unsuitable (in terms of light induced isomerization and oxidation of the carotenes). There is therefore a need for further research work on appropriate packaging of the experimental taro crisps in order to enhance their shelf life and suitability as a snack food and nutriceutical in Nigeria.

Conclusion: The experimental taro crisps produced in Nigeria with crude palm oil incorporation were found to be generally acceptable by local semi trained female sensory panelists. Therefore, children and reproductive women in areas with dietary vitamin A deficiency ought to be encouraged to eat the high energy pro-vitamin A rich taro crisps as snacks. The need for extensive research on appropriate cheap packaging materials for this product in Nigeria cannot be over emphasized. This pro-vitamin A rich snack food can also be used as a prophylactic treatment for children and lactating women in areas where VAD syndrome is endemic.

REFERENCES

Akomas, G.E.C., E.N.A. Mbanaso and O.E.U Akomas, 1989. Food forms of cocoyam for home and commercial use. In: Proceedings of the 1st National Workshop on Cocoyam, N.R.C.R.I., Umudike, Nigeria, August, 16-21, 1989.

AOAC, 1990. Official Methods of Analysis of Association of Official Analytical Chemists, AOAC, Washington, D.C.

Benade, A.J., 2003. A place for palm fruit oil to eliminate vitamin A deficiency. Asia Pac. J. Clin. Nutri., 12: 369-372.

Chong, Y.H and T.K. Ng, 1991. Effects of palm oil on cardiovascular risk. Med. J. Malaysia, 46: 41-50.

Iwe, M.O., 2002. Handbook of Sensory Methods and Analysis. Rejoint Communication Services Ltd., Enugu, Nigeria.

Kings, F.S. and A. Burges, 1972. Nutrition for Developing Countries (2nd edition). Oxford University Press, Oxford.

Kolchar, K., 2006. Economic Botany in the Tropics. Macmillan India, Bangalore.

Ng, J. and B. Tan, 1988. Analysis of palm oil Carotenoids by HPLC with diode-array Detection. J. Chromatogr. Sci., 26: 463-469.

Rodriguez-Amaya, D.B. and M. Kimura, 2004. HarvestPlus Handbook for Carotenoid Analysis. HarvestPlus Technical Monograph Series 2. IFPRI, Washington DC/CIAT, Cali.

Solomon, N.W. and M. Orosco, 2003. Alleviation of vitamin A deficiency with palm fruit and its products. Asia Pac. J. Clin. Nutr., 12: 373-384.

Sundram, K., R. Sambanthamurthi and Y. Tan, 2003. Palm fruit chemistry and nutrition. Asian Pac. J. Nutr., 12: 355-362.

Tan, B., 1989. Palm carotenoids, tocopherols and tocotrienols. J. Am. Oil Chem. Soc., 66: 770-776.

Ukpabi, U.J., E.N. Ekeledo and V.U. Ezigbo, 2012. Potential use of roots of orange fleshed sweet potato genotypes in the production of β-carotene rich chips in Nigeria. Afr. J. Food Sci., 6: 29-33.

Ukpabi, U.J., E. Oti and U. Chijioke, 2006a. Quality evaluation of cocoyam (Eddoe) crisps produced with an intermediate technology in Nigeria. In: Proceedings of 30th Annual Conference of Nigeria Institute of Food Science and Technology (Ebuehi, O.A.T. ed), Sheraton Hotel and Towers, Lagos, 23rd-27th October, 2006.

Ukpabi, U.J., E. Oti and U. Chijioke, 2007. Quality evaluation of cocoyam (Eddoe) crisps produced under a farm condition in Nigeria. Agri. J., 2: 658-661.

Ukpabi, U.J., E. Oti and U. Chijioke and E.N.A. Mbanaso, 2006b. Quality assessment of crisps produced with corms of cocoyam. NRCRI Annual Report, NRCRI, Umudike, Nigeria, pp: 229-303.

Ukpabi, U.J. and J.I. Ejidoh, 1989. Effects of frying on the oxalate content and degree of itching of cocoyam (*Xanthosoma* and *Colocasis* spp). 5th Annual Conference of Agric. Society of Nigeria, Federal University of Technology. Owerri, Nigeria. 3rd-5th September, 1989.