

CHEMICAL COMPOSITION AND SENSORY QUALITY OF SWEETPOTATO CRISPS AS AFFECTED BY VARIETY AND FRYING CONDITIONS

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ABSTRACT

The effect of frying temperatures ranging from 150-180 °C and frying time of 3-12 mins on the composition and sensory quality of sweetpotato crisps from white-fleshed and yellow-fleshed varieties were investigated in this study. Chemical composition, sensory properties and overall acceptability of the crisps were determined using standard methods. Results obtained showed moisture content (2.37-7.50%), fat (9.77-16.22%), total sugar (1.52-4.44%), carotenoids (31.65-55.29 µg/100 g), free fatty acid (0.11-0.44%) and peroxide values (2.95-12.30 mEq/kg). Each of the chemical components and sensory attributes of the crisps were significantly ($p < 0.001$) affected by the individual and combined effects of variety, frying temperatures and frying duration (time) in minutes. The highest overall acceptability scores were 8.46 for yellow-fleshed crisps fried at 170 °C/5 min and 7.84 for white-fleshed crisps fried at 180 °C/5 min.

Keywords: Sweetpotato, variety, frying, crisps, food quality

INTRODUCTION

Sweetpotato [*Ipomoea batatas* L. (Lam.)] is among the world's most important, versatile and under-exploited food crops. Nigeria is the leading producer of sweetpotato (SP) in Africa with an estimated average production (1993-2013) of 3.45 million metric tonnes (FAOSTAT, 2013). A large number of SP varieties exist, and they differ from one another in the colour of flesh, and root skin amongst other attributes (Woolfe, 1992; Aina *et al.*, 2009). In Nigeria, the two common local varieties are the purple skin-white fleshed and the yellow skin-yellow fleshed. However, improved varieties including or-

ange-fleshed varieties, with varying genetic and agronomic characteristics are being developed in Nigerian research institutions and released to farmers (Afuape, 2013).

SP has been recognised as having an important role to play in improving household and national food security, health and livelihoods of poor families in sub-Saharan Africa (CIP, 2013). This may be due to its wide range of agronomic and nutritional advantages such as high yield even in marginal soil conditions, wide ecological adaptability, low input requirements, and shorter growing period than other root crops (Horton, *et al.*,

1989). SP produces the highest amount of edible energy per hectare per day (Horton *et al.*, 1989). Despite its high carbohydrate content, it has a low glycemic index, indicating low digestibility of the starch (ILSI, 2008). It is the only starchy staple, which contains appreciable amounts of β -carotene (especially the orange-fleshed varieties), ascorbic acid and amino acid lysine that is deficient in cereal-based diets like rice (Bradbury and Holloway, 1988).

Fried products have been found to be among the sweetpotato products that are not only capable of increasing the utilization of sweetpotato, but also have high commercial potential (Onumah *et al.*, 2012). A recent study was conducted in Nigeria to generate evidence on the desirability and feasibility of investing in development of sweetpotato value chains for fresh root marketing and processed products in the major producing areas and markets. The report indicated that the fresh root market shows the greatest prospects for rapid growth in the short to medium term, particularly because it services a growing number of street-food vendors, selling fried sweetpotato chips targeting school children and urban workers. The authors further emphasized that the other top two value chains with good prospects for uptake of sweetpotato are the emerging sweetpotato crisps industry and marketing of sweetpotato fries by the fast food outlets (Onumah *et al.*, 2012).

Deep-fat frying is an established process of food preparation worldwide. It is a simultaneous heat and mass transfer process where moisture leaves the food in the form of vapour bubbles, while oil is absorbed simultaneously (Lui-ping *et al.*, 2005). This method of food processing results in modification of the physical, chemical and sensory char-

acteristics of the food (Patterson *et al.*, 2004). While extensive work has been reported on deep frying of potatoes (Sahin 2000, Krokida *et al.*, 2001, Kita 2002, Pedreschi *et al.*, 2005), studies on deep frying of sweetpotato to produce crisps is limited (Fetuga *et al.*, 2013, 2014a, b, Ali *et al.*, 2012, Singh *et al.*, 2003). Potatoes are fried following either the French fry model or the crisp (or chip) model. The former has a significant internal volume, external surface and good crust differentiation, while the latter is without a significant internal volume but with a large external surface area, similar to an all-crust, no-centre product (Blumethal 1991). One major commercial advantage of crisps over French-fries is its potential longer shelf stability.

Moisture and oil content, as well as colour and texture are important quality attributes of fried sweetpotato products (Fetuga *et al.*, 2013, 2014a, Brigatto Fontes *et al.*, 2011, Singh *et al.*, 2003, Sahin, 2000). The limited literature available on these products have shown that these quality attributes are influenced by frying conditions such as frying temperature, duration of frying, slice thickness and oil type among other factors. Fetuga *et al.* (2013) investigated the effect of some pre-frying treatments on composition and sensory quality of sweetpotato crisps, the authors reported that drying pre-treatment resulted in crisps with the least moisture and fat contents which in turn gave the most acceptable products. Fetuga *et al.*, 2014a reported that sweetpotato crisps produced from a yellow-fleshed variety at 150-170 °C at 3-8 min were generally acceptable. Sahin 2000 studied the effects of frying time and temperature on the colour kinetics of French-fried potatoes during frying; the author developed a multiple regression equation for total colour change as a function of time and temperature. The equation showed

that increase in time and temperature increased total colour change. In the light of global trend to consume healthy products with low calories, Brigatto Fontes *et al.*, 2011 developed optimized conditions for processing of sweetpotato chips in different oil types. The conditions for palm olein were 160 °C for 3 min 30 sec for chips with moisture content of 7.43% and oil content of 14.46%, while that for palm stearin were the same time, but at 180 °C for chips with moisture content 3.47% and oil content of 13.1%. Singh *et al.*, (2003) also developed models capable of predicting the quality of sweetpotato chips (crisps) using response surface methodology as an optimization tool; the model had optimum conditions of 174.7 °C as frying temperature, 26 s as frying time and varying concentrations of a mixture of chemical salts. These conditions and in particular the very short frying time may not be feasible for the budding micro to small scale producers of sweetpotato crisps in Nigeria considering the limited sophistication of equipment. The use of a mixture of chemicals and safety concerns by consumers may also not allow for easy adoption of such models as developed. In Nigeria, varieties of sweetpotato roots commonly consumed are identified by the skin colour (red/purple or yellow), flesh colour (white or yellow) or ethnicity of cultivation area (Yoruba or Hausa types). Varietal differences in raw material with respect to chemical composition have been reported to result in products with varying characteristics, particularly sensory, which consequently influence consumer preference (Kita, 2002; Rodiguez-Saona and Wrolstad, 1997). Product quality is also influenced by the interaction between varieties and processing conditions (Fetuga *et al.*, 2014c). The present study is expected to guide in selecting appropriate sweetpotato variety

and matching frying conditions that will produce consumer-acceptable crisps. Hence, the objective of this study was to determine the effect of frying temperature and frying time on the composition and sensory properties of sweetpotato crisps from white- and yellow-fleshed varieties.

MATERIALS AND METHODS

White-fleshed and yellow-fleshed sweetpotato roots were bought from Ketu market in Lagos. The roots were thoroughly washed under running potable water and peeled manually with a stainless steel kitchen knife. The peeled roots were sliced into discs of 1.2 mm thickness using a plantain slicer (Model No. 714.216 Mother's Choice, Houston, Texas). The slices were blanched in 1% w/v NaCl for 2 min, drained and fried in refined, bleached and deodorized vegetable oil (Turkey brand, Malaysia) using a deep fat fryer (Model: Platinum PL-DF-2.5L, China). Frying was done at four different temperatures (150, 160, 170 and 180 °C) and at four different times (3, 5, 8 and 12 mins). The oil was preheated to the frying temperature prior to frying. The fried crisps were drained in a sieve and thereafter spread on layers of paper towel to absorb excess oil. The sweetpotato crisps were allowed to air cool to ambient temperature (30 ± 2 °C) and then packaged in high density polyethylene bags (0.06 mm) to prevent moisture loss before quality analysis.

Compositional analysis

Moisture content of sweetpotato crisps was determined by the oven-drying AOAC Method 934.01, procedure 4.1.03, (AOAC, 2000). Crude protein was determined by using Kjeldahl technique (AOAC Method 955.04, 2.4.03) for determination of the total nitrogen in the sample, followed by multiplication of the nitrogen value by 6.25 (AOAC,

2000). Oil content was determined as the crude fat using Method 920.39, 4.5.01 (AOAC, 2000). Ash was determined by Method 900.02 (AOAC, 2000). Crude fibre was determined as the acid –detergent fibre using procedure 4.6.03, method 973.18 of the AOAC. 1.0 g of flour made from the sweetpotato crisps was refluxed with an acid-detergent solution; the residue was washed successively with water followed by acetone. The residue was dried at 105 °C in a hot air oven, cooled in a dessicator and weighed (AOAC, 2000). Total carbohydrate was calculated by difference according to James (1995).

Sensory evaluation

A 10-member semi-trained panel evaluated the sweetpotato crisps for attributes of taste, colour, flavour and crispness using a '9-point hedonic scale' (9-like extremely, 8-like very much, 7-like moderately, 6-like slightly, 5-neither like nor dislike, 4-dislike slightly, 3-dislike moderately, 2-dislike very much, 1-dislike extremely) (Watts *et al.*, 1989). A total of 16 samples were evaluated. The coded samples were presented to the panelists in batches of eight. Overall acceptability test was also conducted by an in-house consumer panel comprising of 50 untrained undergraduate students who were regular consumers of sweetpotato, using the same hedonic scale (Lyon *et al.*, 1992).

Statistical analysis

The compositional and sensory data are presented as means of duplicate analysis. The data were subjected to descriptive analysis and the minimum, maximum, mean, and standard deviation were computed. One-way 'analysis of variance' (ANOVA) test was conducted to determine if the samples were significantly different ($p < 0.05$) from one another. Least Significant Differ-

ence (LSD) and Duncan Multiple Range Test (DMRT) were employed as post hoc tests to separate the means where significant difference existed. A multivariate General Linear Model (GLM) analysis was performed to determine the individual and interactive effects of the treatments (variety, frying temperature and time) on the attributes measured. Significant effects were established at $p < 0.05$, 0.01 and 0.001 levels. Pearson's correlation coefficient was computed to determine significant ($p < 0.05$) relationship between composition and sensory attributes of sweetpotato crisps. The correlation between individual sensory attributes and overall consumer acceptability was also calculated in order to determine the attributes that were important to consumers. Statistical packages used were Microsoft Excel and SPSS Version 16.0 (SPSS Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

Sweetpotato crisps differ significantly ($p < 0.05$) in proximate composition (Table 1). The range of moisture content (2.37-7.50%) was higher than reported in earlier studies (Fetuga *et al.*, 2013, 2014a, b). This could be as a result of varietal differences or influenced by time of harvest (rainy or dry season). The values were however within the range reported by Singh *et al.* (2003). Low moisture content is required for shelf stability. Sweetpotato crisps from yellow-fleshed (YF) variety had lower moisture content than crisps from white-fleshed (WF) variety. At each temperature, moisture content reduced with increase in frying time. One of the characteristics of a frying process is the movement of water in the form of vapour from the product into the oil. The highest moisture content was 7.51% for WF crisps and 6.87% for YF crisps fried at 150 °C for 3 min. Crisps fried at 180 °C for 12 min had the lowest moisture contents.

The sweetpotato crisps had protein content of between 1.68% and 5.49%. These values were higher than in earlier reports (Fetuga *et al.*, 2013, 2014a) but within the range reported for French-fried sweetpotato chips (Odenigbo *et al.*, 2012). At each of the frying temperatures, protein values of crisps fried at 8-12 mins were generally higher than at 3-5 mins.

Earlier studies (Fetuga *et al.*, 2013, 2014a) have reported positive significant ($p < 0.05$) correlations between protein and colour scores of sweetpotato crisps. Although sweetpotato root is normally not a major source of protein; however, the protein value could be improved upon by the use of improved varieties with increased protein quantity and quality (ILSI, 2008). In the present study, crisps from YF variety had higher protein content than those from WF variety.

The fat content of sweetpotato crisps in particular and fried products in general, is an important quality factor from the perspective of storage and health considerations (Fetuga *et al.*, 2014b, Brigatto Fontes *et al.*, 2011, Gunstone 2008). The fat content of the sweetpotato crisps was between 9.77% and 16.22%. These values were lower than reported by Fetuga *et al.*, 2013, 2014a). There was significant ($p < 0.05$) in-

crease in fat content with increase in frying time at each of the frying temperatures. Mass transfer involved in frying process includes movement of oil into the product in addition to movement of water in the form of vapour into the oil (Singh *et al.*, 2003).

The range of crude fibre and ash contents of sweetpotato crisps were (0.15-0.50%) and (0.28-0.96%) respectively. These values were lower than those reported in earlier studies (Fetuga *et al.*, 2014a). At each frying temperature, crude fibre and ash contents increased significantly ($p < 0.05$) with increase in frying time; this agrees with the report of Fetuga *et al.*, 2014a. Crisps from yellow-fleshed variety had higher crude fibre and ash values than crisps from white-fleshed variety. Sweetpotato is a rich source of soluble fibre (Woolfe, 1992; Yoshimoto, 2010). The ash content is a measure of the mineral content of foods.

The sweetpotato crisps had carbohydrate contents of 71.27-80.70%; these values were higher than figures reported by Fetuga *et al.*, 2014a. Sweetpotato is a major source of carbohydrates and energy; hence the crisps could be marketed as an energy-providing snack. There was a decrease in carbohydrate content with increase in frying time at each frying temperature; this is in contrast with the report of Fetuga *et al.*, 2014a.

Table 1: Proximate composition of sweetpotato crisps as influenced by variety, frying temperature and time

Temperature (°C)	Time (min)	Moisture (%)	Protein (%)		Fat (%)		Crude Fibre (%)		Ash (%)	Carbohydrate (%)	
		WF	YF	WF	YF	WF	YF	WF	YF	WF	YF
150	3	7.50m	6.87l	2.37de	2.49a	10.30c	10.36a	0.18abc	0.21b	0.28a	0.46a
	5	7.20jk	6.74k	2.06bc	2.65b	11.12d	11.21b	0.20abc	0.34e	0.36cd	0.43a
	8	6.62g	5.72h	4.32h	3.63d	11.68e	12.20c	0.36ef	0.17a	0.87h	0.51b
	12	6.57g	3.26f	5.20j	5.41hi	15.75k	16.22n	0.37ef	0.47gh	0.86h	0.94g
160	3	7.28l	6.54j	1.68a	4.91e	9.93b	15.00h	0.15a	0.28cd	0.26a	0.60c
	5	7.14j	6.37i	2.19cd	5.21fg	11.04d	15.42i	0.17ab	0.44fg	0.30ab	0.90fg
	8	4.34e	3.08d	2.42e	5.12f	12.26f	15.68k	0.38f	0.41f	0.31abc	0.89f
	12	3.27c	2.90b	4.81i	5.31gh	15.37j	15.82l	0.36ef	0.42f	0.96i	0.89f
170	3	7.23kl	4.89g	2.29de	2.70b	9.77a	11.19b	0.22bc	0.24bc	0.37d	0.44a
	5	6.20f	3.21ef	2.89f	3.10c	14.74g	13.32d	0.28d	0.25c	0.64f	0.50b
	8	2.91b	3.20e	3.73g	3.58d	14.90h	14.92g	0.28d	0.30de	0.71g	0.88f
	12	2.91b	3.00c	3.81g	5.49i	14.96h	16.12m	0.33e	0.50h	0.70g	0.67de
180	3	7.08i	3.17e	1.91b	2.49a	9.87b	14.00e	0.19abc	0.26cd	0.30ab	0.64d
	5	6.91 h	2.87b	2.03bc	2.78b	11.08d	14.85f	0.22bc	0.30de	0.35bcd	0.67de
	8	4.17d	2.81a	2.89f	3.20c	15.06i	14.87fg	0.23c	0.34e	0.58e	0.70e
	12	2.37a	2.80a	5.27j	5.08f	15.67k	15.58j	0.32de	0.33e	0.90h	0.92fg
Minimum		2.37	2.80	1.68	2.49	9.77	10.36	0.15	0.17	0.28	0.43
Maximum		7.50	6.87	5.27	5.49	15.75	16.22	0.38	0.50	0.96	0.94
Mean		5.60	4.21	3.11	3.11	12.72	14.17	0.26	0.32	0.54	0.69
SD		1.87	1.62	1.21	1.21	2.33	1.89	0.08	0.10	0.25	0.19
LSD		0.000	0.010	0.005	0.005	0.030	0.020	0.000	0.000	0.000	0.020
Effects											
V		***	***	***	***	***	***	***	***	***	***
FTp		***	***	***	***	***	***	***	***	***	***
FTm		***	***	***	***	***	***	***	***	***	***
V x Tp		***	***	***	***	***	***	***	***	***	***
V x Tm		***	***	***	***	***	***	***	***	***	***
Tp x Tm		***	***	***	***	***	***	***	***	***	***
V x Tp x Tm		***	***	***	***	***	***	***	***	***	***

Values are means of duplicate determinations. Values followed by different alphabets are significantly (p<0.05) different. SD-standard deviation

LSD-least significant difference

***Significant effect at p< 0.001

YF-yellow-fleshed V-variety FTp-frying temperature FTm-frying time Tp-temperature Tm-time

WF-white fleshed

Table 2 shows the chemical composition of sweetpotato crisps as influenced by variety, frying temperature and frying time. There were significant ($p < 0.05$) differences among the samples in all the chemical components. Total sugar ranged between 1.52 and 4.44% while the range for glucose and fructose were 0.60-1.65% and 0.48-1.45% respectively. Fetuga *et al.*, 2013 reported reducing sugar of 22.42-35.25 mg/100 g for sweetpotato crisps. Total sugar, glucose and fructose content of sweetpotato crisps are not available in literature. Crisps from yellow-fleshed variety had higher sugar contents than those of white-fleshed variety. Sugar content of products is expected to contribute to taste (sweetness) and colour (non-enzymatic Maillard browning) of foods. Reducing sugar is a primary factor that contributes to Maillard reaction when food is cooked. Maillard reaction has played an important role in improving the appearance and taste of foods. It influences food properties like colour, aroma, taste and nutritional value (Martins *et al.*, 2001).

Carotenoids content of sweetpotato crisps from white-fleshed variety was 31.65-51.27 $\mu\text{g}/100\text{ g}$ and 34.29-55.29 $\mu\text{g}/100\text{ g}$ for yellow-fleshed variety. Sweetpotato with coloured flesh, particularly the yellow-fleshed and orange-fleshed, are rich source of carotenoids. The amount of carotenoids increases with increased intensity of these colours. Carotenoids are pigments responsible for the yellow and orange colours of sweetpotato and other vegetables and fruits. In addition, carotenoids, particularly β -carotene has high vitamin A activity (deMan, 1999).

acids of storage oil in plant foods, is a frequent cause of poor shelf life and off flavours in processed foods (de Mann, 1999).

Peroxide value is an indication of deterioration of fats and is used to estimate oxidation. During deep-fat frying, vegetable oils can undergo oxidation, cyclization, polymerization, degradation to volatile compounds, and hydrolysis. A combination of these chemical changes causes off-flavours, rancid aromas, greasy mouth feel, and impaired nutritional value in fried foods (Ory *et al.*, 1985). In the present study, there was a significant ($p < 0.01$) correlation (0.91) between free fatty acid and peroxide value of sweetpotato crisps.

The sensory scores for attributes of sweetpotato crisps as influenced by variety, frying temperature and frying time is presented in table 3. The crisps differ significantly ($p < 0.05$) in sensory attributes. At each frying temperature, the taste, colour and crispness scores were higher at 3-5 mins than at 8-12 mins. The highest scores for taste were for crisps fried at 160 °C/ 3 min for white-fleshed (7.35) and yellow-fleshed (8.29). The highest scores for crispiness were for crisps fried at 180 °C/3 mins for white-fleshed (8.52) and yellow-fleshed (8.25). The highest scores for colour were white-fleshed (8.54) fried at 160 °C/5 mins and yellow-fleshed (8.45) fried at 170 °C/5 mins. The highest overall acceptability scores were 8.46 for yellow-fleshed crisps fried at 170 °C/5 mins and 7.84 for white-fleshed crisps fried at 180 °C/5 mins (Fig. 1). Crisps fried at 180 °C for 8-12 mins had the lowest overall acceptability scores (1.32-3.88). Sweetpotato crisps fried at 150-180 °C for 3-5 mins were generally acceptable (5.60-8.46), except for crisps from white-fleshed fried at 150 °C/3 mins (4.27).

Table 2: Chemical composition of sweetpotato crisps as influenced by variety, frying temperature and time

Temperature (°C)	Time (min)	Total sugar (%)		Glucose (%)		Fructose (%)		Carotenoids µg/100 g		FFA (%)		PV mEq/kg	
		WF	YF	WF	YF	WF	YF	WF	YF	WF	YF	WF	YF
150	3	1.66b	2.35c	0.73b	1.02c	0.64d	0.83cd	32.17c	34.29a	0.62k	0.42g	13.25n	12.30g
	5	2.02d	2.51d	0.81c	1.16d	0.62c	1.05f	32.83e	36.28c	0.52gh	0.38f	12.41k	11.87g
	8	4.34k	1.93b	1.32g	0.88b	1.23i	0.71b	35.02h	36.46d	0.22c	0.26cd	5.24g	6.13d
	12	3.93i	3.97i	1.39h	1.58g	1.30j	1.45hi	49.26m	53.14i	0.20c	0.18ab	3.13b	3.57a
160	3	1.52a	4.44i	0.60a	1.67hi	0.48a	1.44hi	31.65a	53.27m	0.57ij	0.26cd	12.64i	8.79e
	5	1.62b	4.00ij	0.63a	1.31e	0.53b	1.23g	31.95b	48.59j	0.60jk	0.44g	13.41o	12.23g
	8	4.29k	4.10k	1.40h	1.65ghi	1.30j	1.46hi	49.74n	54.75n	0.11a	0.16a	3.78d	3.64b
	12	2.15e	4.04jk	1.05e	1.61gh	0.84e	1.41h	33.63f	52.67k	0.50fg	0.22bc	9.90j	4.58bc
170	3	2.57g	3.89h	1.31g	1.38ef	1.17h	1.27g	42.79j	39.65e	0.39e	0.37f	7.87h	10.63f
	5	2.16e	1.67a	0.96d	0.77a	0.80e	0.60a	34.77g	35.93b	0.46f	0.38f	9.78i	12.00g
	8	2.91h	3.99ij	1.21f	1.70i	1.08g	1.51i	46.34k	55.29o	0.27d	0.24c	4.79f	4.32b
	12	2.87h	2.91g	0.95d	1.06c	0.82e	0.81c	41.24i	43.77g	0.19bc	0.30de	3.31c	5.12c
180	3	1.92c	2.80f	0.71b	1.21d	0.57bc	1.09f	32.57d	45.27i	0.54hi	0.24c	12.57i	3.20a
	5	1.60b	3.88h	0.70b	1.41f	0.57bc	1.31g	31.87b	52.67k	0.59jk	0.32e	12.80m	4.21b
	8	4.17j	2.78ef	1.45i	1.20d	1.34j	0.94e	51.27o	42.97f	0.15ab	0.17a	2.95a	3.15a
	12	2.37f	2.72e	1.04e	1.17d	0.95f	0.91de	46.57l	44.21h	0.15ab	0.22bc	3.91e	3.40a
Minimum		1.52	1.67	0.60	0.77	0.48	0.60	31.65	34.29	0.11	0.16	2.95	3.15
Maximum		4.29	4.44	1.45	1.65	1.34	1.45	51.27	55.29	0.62	0.44	13.41	12.30
Mean		2.63	3.25	1.01	0.89	0.89	1.12	38.98	45.57	0.38	0.29	8.23	7.19
SD		1.00	0.87	0.29	0.30	0.30	0.30	7.38	7.37	0.19	0.09	4.18	3.91
LSD		0.005	0.005	0.005	0.005	0.000	0.000	0.010	0.085	0.005	0.000	0.000	0.075
Effects		***	***	***	***	***	***	***	***	***	***	***	***
V		***	***	***	***	***	***	***	***	***	***	***	***
FTp		***	***	***	***	***	***	***	***	***	***	***	***
FTm		***	***	***	***	***	***	***	***	***	***	***	***
V x Tp		***	***	***	***	***	***	***	***	***	***	***	***
V x Tm		***	***	***	***	***	***	***	***	***	***	***	***
Tp x Tm		***	***	***	***	***	***	***	***	***	***	***	***
V x Tp x Tm		***	***	***	***	***	***	***	***	***	***	***	***

Values are means of duplicate determinations. Values followed by different alphabets are significantly (p<0.05) different SD-standard deviation

LSD-least significant difference

WF-white fleshed

FFA-free fatty acids

YF-yellow-fleshed V-varietyFp-frying temperature

PV-peroxide value

***Significant effect at p < 0.001

FTm- frying time

Tp-temperature

Tm-time

Table 3: Sensory attributes of sweetpotato crisps as influenced by variety, frying temperature and time

Temperature (°C)	Time (min)	Taste		Colour		Crisp- ness	
		WF	YF	WF	YF	WF	YF
150	3	7.03j	6.59g	7.51i	6.24e	4.67e	6.72g
	5	7.27l	7.85k	8.48m	7.47h	6.53g	6.62g
	8	6.70h	8.14m	6.92g	8.22k	6.88j	7.22h
	12	5.43c	6.35e	5.75d	6.22e	7.23l	5.31e
160	3	7.35m	8.29o	7.41h	8.15j	4.38d	7.29h
	5	6.88i	8.23n	8.54n	8.16jk	6.75i	7.79i
	8	6.13f	7.25j	6.32f	7.55i	6.69h	7.35h
	12	5.89d	5.24d	4.77b	4.40d	7.53m	5.03d
170	3	7.35m	8.02l	8.23k	8.43l	5.86f	5.49e
	5	6.95i	8.12m	6.94g	8.45l	2.55b	8.13j
	8	6.48g	7.05i	6.34f	6.35f	6.93j	6.30f
	12	5.96e	2.18b	5.95e	2.55b	7.02k	2.44b
180	3	7.18k	6.45f	8.33l	6.36fg	8.52n	8.25j
	5	6.93i	6.72h	7.74j	6.42g	7.54m	7.25h
	8	2.60b	3.50c	5.44c	3.43c	3.52c	4.46c
	12	1.23a	1.35a	1.37a	1.75a	1.43a	1.89a
Minimum		1.23	1.35	1.37	1.75	1.43	1.89
Maximum		7.35	8.29	8.54	8.45	8.52	8.25
Mean		6.08	6.33	6.62	6.25	5.87	6.09
SD		1.71	2.15	1.78	2.11	1.96	1.87
LSD		0.000	0.025	0.020	0.010	0.010	0.030
Effects							
V			***		***		***
FTp			***		***		***
FTm			***		***		***
V x Tp			***		***		***
V x Tm			***		***		***
Tp x Tm			***		***		***
V x Tp x Tm			***		***		***

Values followed by different alphabets are significantly ($p < 0.05$) different SD-standard deviation

SD-least significant difference ***Significant effect at $p < 0.001$

WF-white fleshed YF-yellow-fleshed V-variety FTp-frying temperature

FTm- frying

time Tp-temperature

Tm-time

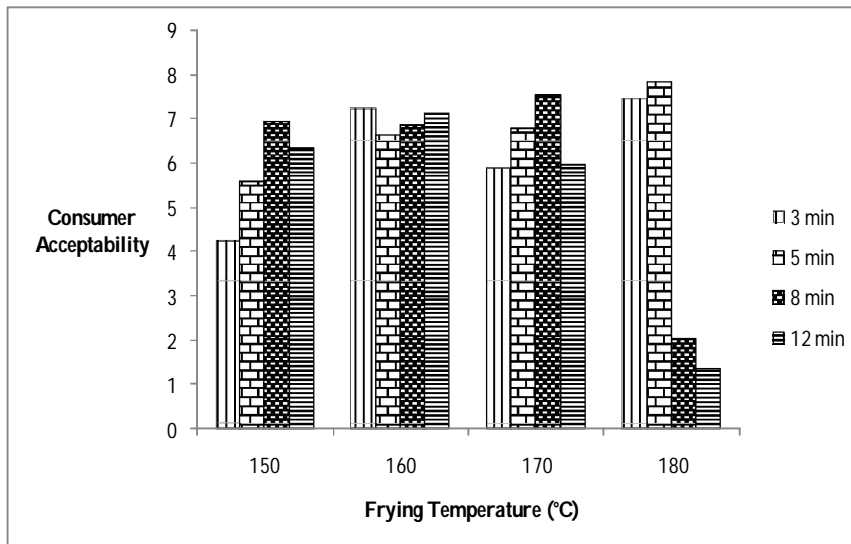


Figure 1a: Consumer acceptability of sweetpotato crisps from white-fleshed variety as influenced by frying temperature and time

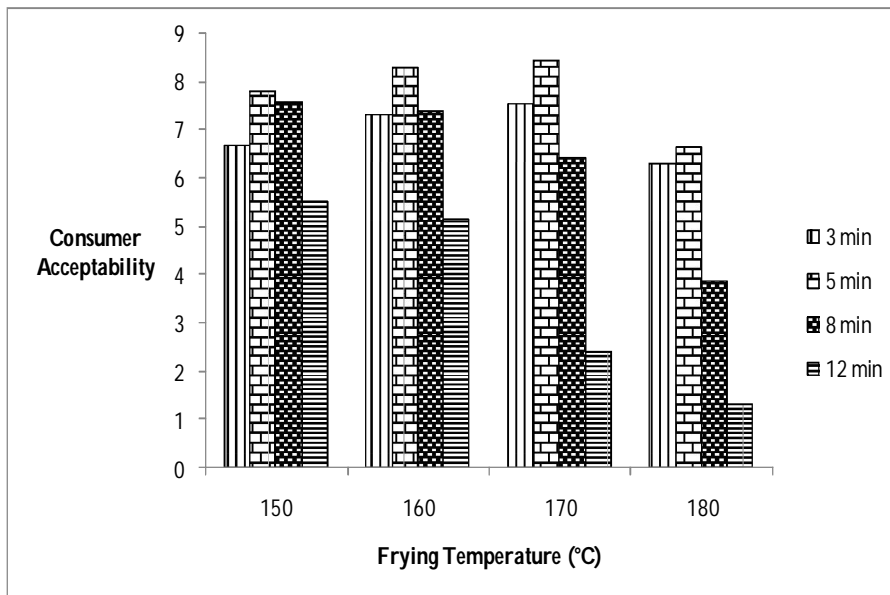


Figure 1b: Consumer acceptability of sweetpotato crisps from yellow-fleshed variety as influenced by frying temperature and time

Generally, each of the proximate and chemical composition as well as sensory attributes of the sweetpotato crisps was significantly affected ($p < 0.01$) by variety, frying temperature, frying time and by the combinations of these treatments (Tables 1-3).

The correlation coefficient between composition and sensory attributes of sweetpotato crisps were generally low (Table 4). Colour and taste of sweetpotato crisps showed sig-

nificant ($p < 0.01$) correlations with moisture, protein, fat, fibre and ash contents. The correlations with moisture were positive while those of protein, fat, fibre and ash were negative. Significant correlations exist between moisture, protein, fat and ash contents and overall acceptability of sweetpotato crisps. Similar correlations were reported by Fetuga *et al.* (2013, 2014a).

Table 4: Correlation coefficient between chemical composition and sensory attributes of sweetpotato crisps

	Taste	Colour	Crispiness	Overall acceptability
Moisture	0.53**	0.65**	0.24	0.39**
Protein	-0.39**	-0.53**	-0.23	-0.30*
Fat	-0.49**	-0.60**	-0.23*	-0.36**
Fibre	-0.33**	-0.49**	-0.15	-0.19
Ash	-0.39**	-0.56**	-0.17	-0.26*
Carbohydrate	0.24	0.34**	0.16	0.18
Total sugar	-0.07	-0.12	0.56	-0.04
Glucose	-0.08	-0.18	0.01	-0.07
Fructose	-0.03	-0.12	0.05	-0.03
Carotenoids	-0.25	-0.31*	-0.08	-0.22

*Correlation is significant at $p < 0.05$, **Correlation is significant at $p < 0.01$

CONCLUSION

All the proximate components of sweetpotato crisps except moisture and carbohydrate contents increased with increase in frying time at each frying temperature. Crisps from yellow-fleshed (YF) variety had lower values of moisture content than those from white-fleshed variety. Protein, fat, fibre and ash contents were higher for crisps from YF variety, while carbohydrate content was in the same range for both varie-

ties. Each of the proximate and chemical components as well as sensory attributes of the sweetpotato crisps were significantly affected ($p < 0.01$) by variety, frying temperature, frying time and by the combinations of these treatments. The highest overall acceptability score for white-fleshed was 7.84 for crisps fried at 180 °C/5 mins while value obtained for yellow-fleshed was 8.46 for crisps fried at 170 °C/5 mins.

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