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Optimization of frying time and temperature for the development of quality chips from varieties of sweet potato (*Ipomoea batatas* L.Lam)

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Abstract

Consumers seek low-fat fried products with appealing color, texture, and taste to avoid health issues like obesity and cardiovascular disease associated with high-oil-content foods. Frying conditions, including time and temperature, greatly affect the moisture, texture, oil content, and color of fried foods. The objective of this study was to optimize frying time and temperature to obtain quality fried chips from three varieties of orange-fleshed sweet potato roots. The study examined how frying temperature (ranging from 140 to 180°C) and time (2 to 6 mins) affect the quality of fried chips, assessing attributes like moisture content, oil content, color, and texture. Significant impacts of frying time and temperature on chip quality were found across all varieties using central composite design tests and mathematical models ($p<0.05$). Optimal frying conditions were determined through response surface methodology analysis, which was 154.8°C for 3.82 mins, 160.1°C for 3.66 mins, and 162.65°C for 3.04 mins for Kabode, Dilla, and Kulfo varieties, respectively, guiding sweet potato fried chip producers to achieve satisfactory results economically and efficiently.

1. Introduction

Sweet potato fried chips are widely enjoyed snacks found in both food service establishments and households, offering a simple yet effective method for creating healthy and delectable snacks from sweet potatoes (Maity *et al.*, 2012; Zhang *et al.*, 2021). Deep fat frying stands as one of the most prevalent and significant techniques in global food processing, relying on the interaction between oil and food at temperatures surpassing the boiling point of water. This interaction triggers a series of transformations in the product, including starch gelatinization, coloration, and oil absorption, resulting in a distinct appearance, texture, and taste characterized by a unique crispy crust (Ananey-Obiri *et al.,* 2018; Vaitkevičienė *et al.*, 2022). Despite the substantial transfer of fat during frying, achieving optimal sensory qualities in chips hinges on the efficient transfer of heat from the heated oil to the sweet potato slices. During frying, heat is transferred via convection and conduction, moving from the frying medium to the surface of the sweet potato slices and eventually penetrating the interior. Simultaneously, moisture evaporates and diffuses from the interior to the surface of the slices before migrating through the frying medium (Ananey-Obiri *et al.,* 2018; Vaitkevičienė *et al.*, 2022). Consumers increasingly prioritize healthy fried products with low fat content, appealing color, texture, and taste to mitigate health risks associated with high-fat consumption (Cruz *et al.*, 2018; Oke *et al.*, 2018; Tzompa-Sosa *et al.*, 2022; Vaitkevičienė *et al.*, 2022). Parameters such as frying time and temperature significantly influence the texture, oil content, and color of fried food products, with color and texture particularly reliant on sufficient frying time and temperature to prevent premature darkening of the chips (Nasir *et al.*, 2019; Liu *et al.*, 2021). The primary objective of this study was to investigate the impact of frying time and temperature on various quality attributes of fried chips derived from three varieties of orange-fleshed sweet potatoes. Additionally, the study aimed to determine the

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optimal frying conditions and conduct proximate and sensory analyses of the optimized fried chips to provide valuable insights for both commercial production and household preparation of lighter and more appealing sweet potato fried chips.

2. Materials and methods

2.1 Materials

Three orange-fleshed sweet potato (OFSP) varieties, namely Kulfo (LO-323), Ukr × Eju-13 (Dilla), and Kabode, were obtained from the Hawassa Agricultural Research Center, Hawassa, Ethiopia. Ten (10) kilograms of each variety were transported to the Chemical Engineering Department, Addis Abeba Science and Technology University, Ethiopia, in plastic net bags and kept at room temperature until used. Sunflower oil, slicer and fryer (AS-90, Guangdong, and China) collected from Ethiopia's local market.

2.2 Sample preparation and pre-treatments of the sweet potato slices

Sweet potato roots were soaked and cleansed with tap water to remove soil particles, then sorted and sliced into 1.2 mm thick slices using an adjustable stainless steel hand slicer. The sliced sweet potatoes were rinsed in distilled water to remove excess starch and control browning, followed by blanching at 90°C for 4 mins and drying at 70°C for 30 mins in a tray dryer. Finally, the pretreated slices were deep-fried at 160°C for 3.5 mins in sunflower oil until reaching a moisture content of 60% on a wet basis.

2.3 Frying process

The blanched and dried sweet potato slices were deep-fried at three levels of temperature (160, 170 and 180°C) in sunflower oil for different times (1, 3 and 5 mins) using a deep fat fryer (AS-90, Guangdong, China). The oil was heated to frying temperature before adding the sliced chips. The fried chips were drained in a sieve and then spread out on paper towel layers to absorb the excess oil. After that, the sweet potato chips were packed into low-density polyethylene (LDPE) bags to be stored for quality control.

2.4 Proximate composition and color measurement

The moisture, oil, ash, protein, fiber and carbohydrate content of fried chips were determined by the method of the Association of Official Analytical Chemists as reported by Liang *et al.* (2019). For each sample, three measurements were taken, and the average value was calculated. The color of sweet potato chips was measured using a colorimeter (NR110, 3NH technology com., Ltd). The Hunter Lab color value of L* (lightness, 0 = black to 100 = white) was recorded and evaluated. Three measurements were taken for each sample, and the result was expressed as the mean value.

2.5 Central composite design test and texture measurement

As shown in Table 1 central composite experimental design of response surface methodology (RSM) with two independent variables was established. Each variable has three levels of four responses (moisture (%), oil content (%), color and texture (N)). The factors are set as frying temperature (A) and frying time (B). For each variety, eleven (11) experimental runs were generated to study the effects of these variables on the responses using design expert software (version 12). The texture of the chips was measured using a texture analyzer (TA1, Ametek Lloyd Instruments Ltd., USA) measurement method. Three measurements were conducted for each sample, and the result was expressed as the mean value.

2.6 Sensory analysis

Sensory evaluation of the crisps made from three varieties of sweet potato was carried out to predict consumer acceptance and preference using ten untrained sensory panelists from the Food Process Engineering Department. Sensory qualities like color, flavor, crispness, and overall acceptability of the product were evaluated using a seven-point hedonic scale (one and seven, representing dislike very much and like very much, respectively).

2.7 Statistical data analyses and modeling

For optimization purposes, regression analysis was conducted by fitting a second - order quadratic equation to the data to obtain a response equation using design expert (Version 12) statistical package software. Data obtained from physicochemical analysis of sweet potato chips were statistically analyzed using analysis of variance (ANOVA) and significantly expressed at the $p<0.05$ level using SAS software package (version 9.4). The modeling, statistical analysis, and optimization procedures were conducted separately on data from each variety of sweet potatoes. The mathematical regression equations developed for the quality attributes of sweet potato fried chips were reported as follows;

$$Y = \beta_0 + \beta_1 (A) + \beta_2 (B) + \beta_{12} (AB) + \beta_{11} (A^2) + \beta_{22} (B^2) \quad (1)$$

Where Y = response for frying conditions, β_0= intercept, A= frying temperature, B = frying time, $\beta_1$and β_2 are coefficients for each factor at first - order term, β_{12} = coefficients for interaction factor; β_{11} and β_{22} = coefficients for each factor at second - order term.

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2.8 Response variables of fried chips from three varieties of sweet potato under different frying conditions

The experimental results for four response variables (moisture content, oil content, texture and color (L*) of fried chips from three varieties of sweet potato under different frying conditions are presented in Table 1. A quadratic model was used to describe the effect of frying time and temperature on moisture content, oil content, texture and color (L*) of fried chips from three different varieties of sweet potato. As a result, in the subsequent optimization process, a quadratic model was chosen to generate the regression equation.

2.9 A quadratic regression model of all responses for different varieties of sweet potatoes

Table 2 reveals the significance of the quadratic regression model for all responses across sweet potato varieties, with a very low probability value (P<0.0001) indicating significance. Frying temperature (A), frying time (B), interaction (AB), and A_2 were significant for all responses, while B^2 was significant for certain quality attributes across varieties. The R_2 and adjusted R_2 values for all responses were above 95%, indicating strong model fit and good agreement between predicted and actual data. Additionally, the coefficient determination values were close to 1 (100%), suggesting that the response variables were well explained by the models. The adequate precision values for all response variables were greater than four, indicating good model discrimination, consistent with findings by other researchers.

2.10 Regression equation for optimization of frying conditions

Equation 1 was used to represent the estimated coefficients of the fitted regression equation for the responses of different varieties of sweet potato chips. The final regression equation in terms of coded factors for moisture, oil content, texture and color of sweet potato chips is presented in equations 2 – 13.

Coded factors for the Kabode variety of sweet potato chips;

$$\text{Moisture content} = 1.96 - 2.2A - 0.82B + 0.5\,AB + 1.2A^2 - 7.9\times10^3B^2 \quad (2)$$

$$\text{Oil content} = +37.01 + 3.89A + 1.36B - 1.25\,AB - 2.16A^2 - 0.099B^2 \quad (3)$$

$$\text{Texture} = +12.85 + 1.45A + 1.03B - 2\,AB - 6.68A^2 + 0.068B^2 \quad (4)$$

$$\text{Color} = +63.97 - 0.4A + 0.5B - 3.2\,AB - 6.48A^2 - 1.78B^2 \quad (5)$$

Coded factors for the Dilla variety of sweet potato chips;

$$\text{Moisture content} = 3.14 - 2.18 - 0.8B + 0.46\,AB + 1.51A^2 + 0.061B^2 \quad (6)$$

$$\text{Oil content} = 37.12 + 3.33A + 1.13B - 1.25\,AB - 1.56A^2 + 1.95B^2 \quad (7)$$

$$\text{Texture} = 9.93 + 2.43A + 0.22B - 2.75\,AB - 3.82A^2 + 0.33B^2 \quad (8)$$

$$\text{Color} = 61.39 + 1.08A - 0.5B - 4.47\,AB - 6.09A^2 + 0.26B^2 \quad (9)$$

Coded Factors for the Kulfo variety of sweet potato chips;

$$\text{Moisture content} = 5.02 - 4.98 - 1.82B + 1.58\,AB + 2.66A^2 + 0.26B^2 \quad (10)$$

$$\text{Oil content} = 38.58 + 3.40A + 1.33B - 0.90\,AB - 1.08A^2 + 0.21B^2 \quad (11)$$

$$\text{Texture} = 9.10 + 1.70A + 0.63B - 1.51\,AB - 2.24A^2 - 0.048B^2 \quad (12)$$

$$\text{Color} = 58.04 + 3.87A + 0.90B - 2.33\,AB - 2.74A^2 - 0.34B^2 \quad (13)$$

Table 1. Central composite experimental design (CCD) for frying variables and the experimental results of moisture content, oil content, color (L*) and texture

Run Order	Frying temperature (°C)	Frying time (min)	Moisture (%)			Oil content (%)			Texture (N)			Color (L*)		
			a	b	c	a	b	c	a	b	c	a	b	c
1	140	6	3.80	5.5	9.5	33.70	36.5	36.4	7.60	7.00	7.50	57.80	58.40	54.30
2	160	2	2.50	4.0	7.0	36.02	38.5	37.5	10.90	9.80	8.50	61.30	62.10	56.90
3	160	6	1.60	2.6	3.6	37.80	40.3	40.3	14.50	10.50	9.35	63.00	61.20	59.20
4	180	6	0.50	2.12	2.6	39.0	40.7	41.5	6.40	6.30	7.76	50.30	51.70	56.80
5	180	4	1.10	2.5	2.8	38.71	39.2	40.9	7.50	8.50	8.50	55.20	56.30	60.10
6	160	4	1.90	2.9	5.0	37.01	36.9	38.5	13.50	10.00	9.20	63.60	61.40	57.80
7	140	4	5.50	7.0	12.6	31.00	32.6	34.3	4.40	3.50	4.90	55.70	54.30	51.20
8	180	2	1.40	2.9	3.2	38.31	40.7	40.7	9.10	11.50	9.30	56.20	61.70	59.90
9	160	4	1.90	3.4	5.0	37.01	36.9	38.5	13.00	10.00	9.20	64.20	61.40	57.80
10	140	2	6.90	8.1	16.4	28.00	31.5	32.0	2.30	1.20	2.99	50.60	50.50	48.10
11	160	4	1.90	2.9	5.0	37.01	36.9	38.5	13.00	10.00	9.20	64.20	61.40	57.80

a: Kabode variety, b: Dilla variety, c: Kulfo variety of sweet potato.

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Table 2. Response surface quadratic model of Kabode, Dilla and Kulfo variety chips on moisture content, oil content, texture and color.

Coefficients	Moisture			Oil content			Texture			Color		
	a	b	c	a	b	c	a	b	c	a	b	c
STD	0.30	0.24	0.11	0.36	0.42	0.16	0.65	0.17	0.27	0.37	0.08	0.63
R^2	0.988	0.993	0.999	0.995	0.992	0.999	0.987	0.999	0.992	0.998	0.998	0.985
Adjusted R^2	0.976	0.986	0.999	0.989	0.981	0.997	0.973	0.997	0.984	0.995	0.999	0.971
Predicated R^2	0.880	0.970	0.997	0.942	0.931	0.989	0.867	0.988	0.926	0.981	0.998	0.870
PRESS	4.66	1.22	0.68	7.01	6.63	1.00	21.10	1.23	3.16	5.12	0.30	18.19
Adequate precision	26.93	34.22	161.50	39.10	29.46	81.20	25.47	82.70	34.00	49.91	208.00	26.50
P-Value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

a: Kabode variety, b: Dilla variety, c: Kulfo variety of sweet potato, PRESS: prediction residual sum of squares, STD: Standard deviation, R^2: Regression coefficient.

3. Results and discussion

3.1 Effect of frying time-temperature on the quality of sweet potato fried chips

3.1.1 Effect of frying time-temperature on moisture content

Figure 1 illustrates the impact of frying time and temperature on the moisture content of sweet potato chips, showing varying moisture levels across different frying conditions and potato varieties. The moisture content ranged from 0.5% to 6.9% for Kabode, 2.12% to 8.1% for Dilla, and 2.6% to 16.4% for Kulfo varieties. Comparisons with previous studies revealed differences in moisture content, likely due to variations in frying parameters and potato types (Ağçam, 2022). At 140°C, the moisture content of Kabode decreased from 6.9% to 3.8% within a 6-min frying period. Similarly, at a constant frying temperature of 160°C, the moisture content of Kabode chips decreased from 2.5% to 1.6% over the same duration. Furthermore, at 180°C, the moisture content of Kabode chips decreased from 1.4% to 0.5% within the same 6-min frying period. Additionally, for the Dilla and Kulfo varieties, consistent temperatures of 140°C, 160°C, and 180°C resulted in a reduction in moisture content as the frying duration increased from 2 to 6 mins, as outlined in Table 1. Significant effects of frying time and temperature on moisture content were observed across all varieties, with

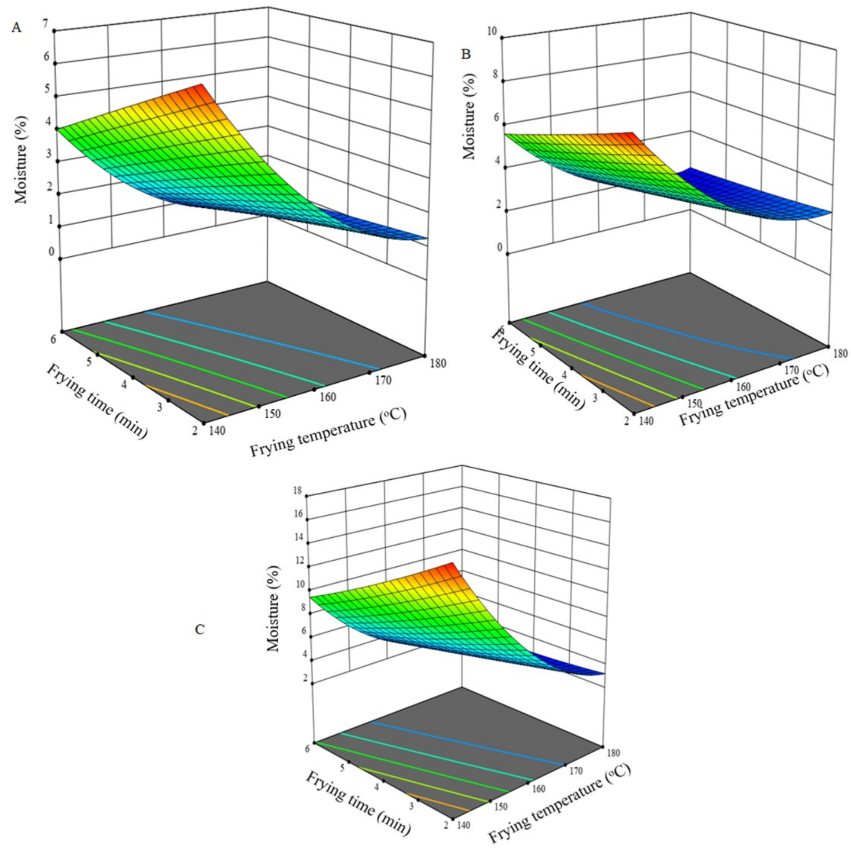

Figure 1. Response surface plot of moisture content of fried sweet potato chips as a function of frying time and temperature for (A) Kabode, (B) Dilla and (C) Kulfo varieties.

moisture decreasing as frying temperature increased or frying time extended. This reduction in moisture content was more pronounced at higher temperatures and longer frying durations, attributed to convection heat transfer causing water evaporation from the slices. Similar trends were noted in other fried chip varieties, including mango, potato, banana, and carrot chips, emphasizing the consistency of moisture reduction mechanisms during frying (Shyu and Sun, 2011; Akinpelu *et al.*, 2014; Shirazi *et al.*, 2022)

3.1.2 Effect of frying time-temperature on oil content

The oil content of the chips varied across different frying conditions, ranging from 28% (at 140°C for 2 mins) to 39% (at 180°C for 6 mins) for Kabode, 31.5% (at 140°C for 2 mins) to 40.7% (at 180°C for 6 min) for Dilla, and 32% (at 140°C for 2 mins) to 41.5% (at 180°C for 6 mins) for Kulfo varieties (Figure 2). Chips fried at higher temperatures and for longer durations exhibited higher oil content, with the lowest recorded at 140°C for 2 mins. These findings align with similar oil content ranges reported in potato fried chips, which typically fall between 30% and 45%, contributing to their desired texture and flavor (García-Segovia, 2016). Additionally, Figure 2 demonstrates a direct relationship between oil content and frying time/temperature, where oil content increased with prolonged frying duration and higher temperatures. This trend was consistent across all varieties tested. The increased frying temperature and duration facilitate greater oil transfer to the chips and contribute to water evaporation from the sweet potato slices, enhancing the two-way diffusion phenomenon. Similar patterns have been observed in various fried chip products, including sweet potato, yam, plantain, and banana chips, indicating a significant correlation between oil uptake and final moisture content during frying (Akinpelu *et al.*, 2014; Adeyanju *et al.*, 2016; Dodoo *et al.*, 2022; Tabtiang *et al.*, 2022). Moreover, factors such as variety also influence oil uptake during frying, as evidenced by the varying quantities of oil uptake observed among the different sweet potato varieties under identical frying conditions (Table 1). This variability may stem from differences in cellular structures and genetic traits affecting moisture flow rates within the tissue during frying (Okon *et al.*, 2022).

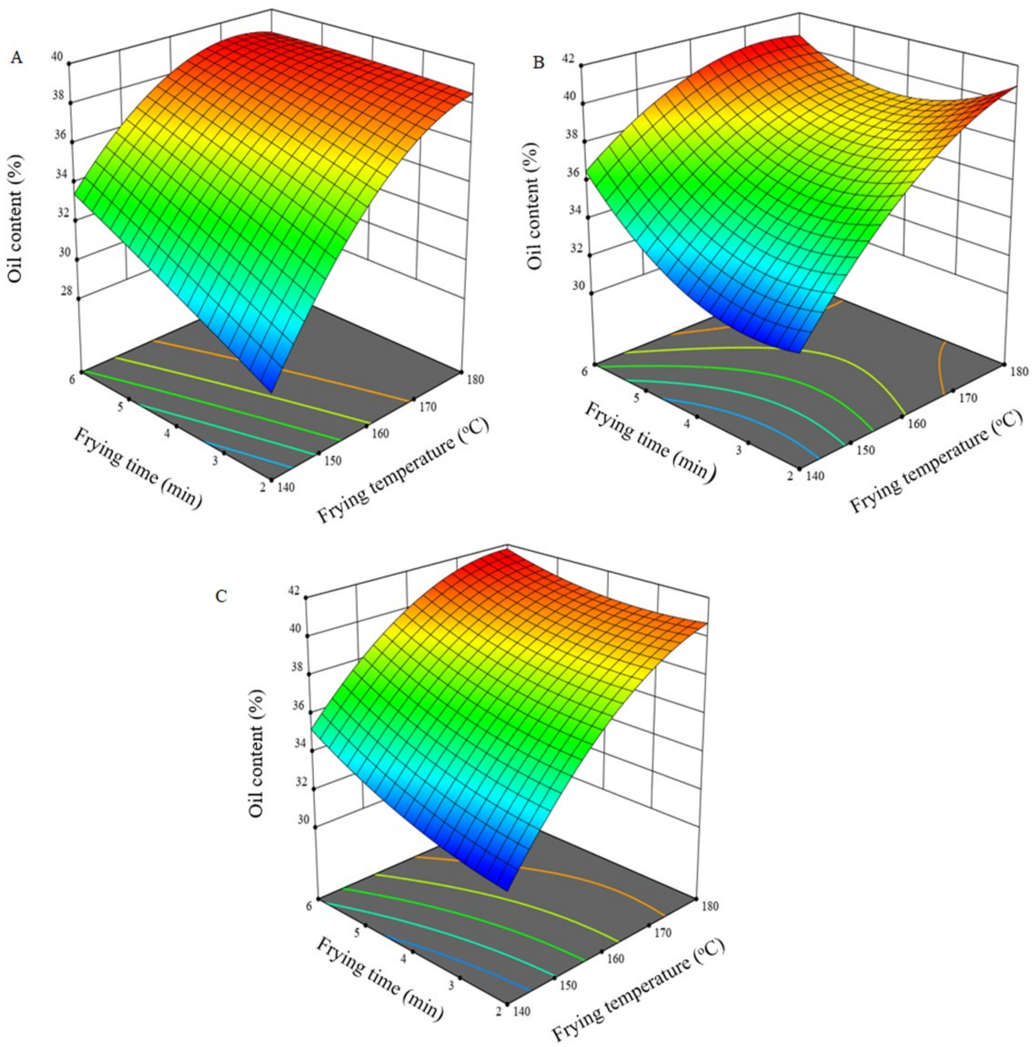

Figure 2. Response surface plot of oil content of fried sweet potato chips as a function of frying time and temperature for (A) Kabode, (B) Dilla and (C) Kulfo varieties.

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3.1.3 Effect of frying time-temperature on the texture of the chips

Frying temperature and duration significantly influenced ($p<0.05$) the hardness of fried chips across all sweet potato varieties. As depicted in Figure 3, chip texture increased in hardness with longer frying times and higher temperatures, reaching peaks at 160°C/4mins, 180°C/2mins, and 160°C/6mins for Kabode, Dilla, and Kulfo varieties, respectively. The texture reached maximum hardness around the midpoint of frying time and temperature before experiencing a decline with further increases. This hardening phenomenon stemmed from crust formation due to microstructural changes in the fried product's tissue (Huang *et al*., 2022). However, at higher frying temperatures, the chips' breaking power diminished due to increased brittleness caused by sugar content caramelization during frying (Timalsina *et al*., 2019; Ergün, 2022). During frying, moisture reduction in sweet potato slices and subsequent crust formation contribute to increased chip hardness and crispiness. Thus, chip texture hardened as frying time and temperature rose until maximal hardening occurred, driven by rapid water evaporation from sweet potato slices (Akinpelu *et al*., 2014; Ergün, 2022). Previous research by Ergün (2022) indicated that water molecule evaporation induces volume reduction via microstructure dehydration, resulting in the formation of numerous holes, cracks, and crust, ultimately shaping the product's texture.

3.1.4 Effect of frying time-temperature on color of chips

The brightness (L*) of sweet potato fried chips serves as a vital quality indicator (Vaitkevičienė *et al*., 2022). Figure 4 illustrates how frying time and temperature affect the color brightness of chips from three sweet potato cultivars. The L* value of Kabode and Kulfo chips was significantly ($p<0.05$) influenced by both frying temperature and time, while Dilla chips showed a highly significant effect ($P<0.0001$) on chip hardness. With increased frying time and temperature, the L* value decreased, indicating a darker color, which was less preferred by consumers. This trend was observed for Kabode at 160°C/4 mins, Dilla at 160°C/2 mins, and Kulfo at 180°C/4 mins (Figure 4). However, further increases in frying time and temperature led to significant decreases in L* value due to excessive browning of potato slices, aligning with consumer preferences for lighter-colored chips. Similar findings have been reported for potato chip frying (Vaitkevičienė *et al*., 2022). The darkening of the sweet potato crust at higher frying temperatures and times is attributed to rapid sugar content caramelization (Kumar *et al*., 2006).

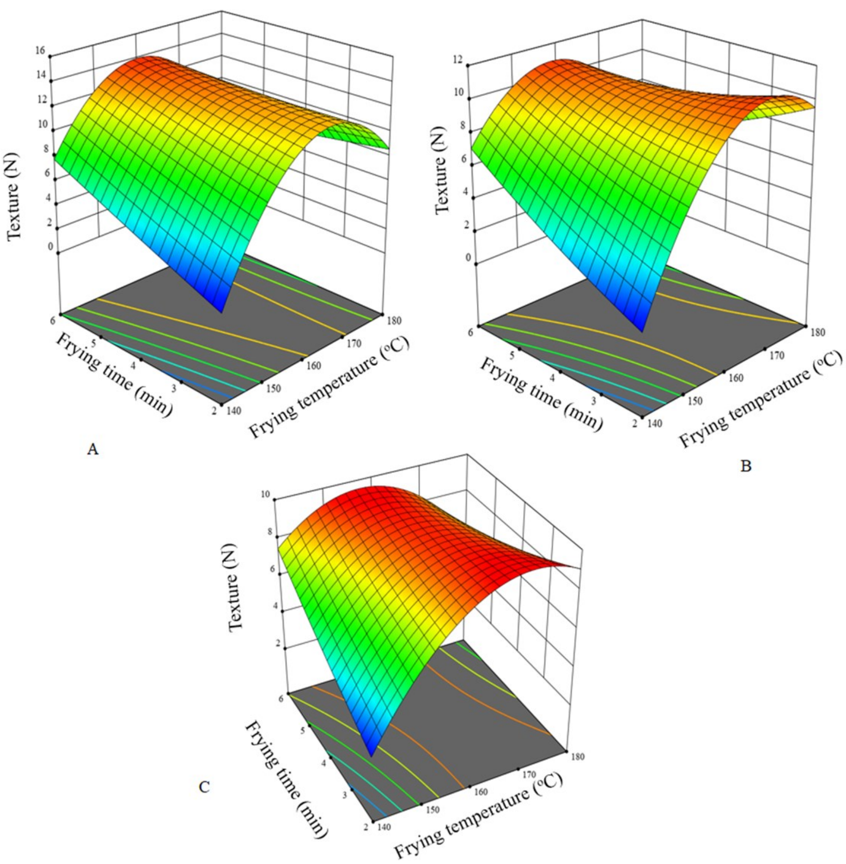

Figure 3. Response surface plots of texture of fried sweet potato chips as a function of frying time and temperature for (A) Kabode, (B) Dilla and (C) Kulfo varieties.

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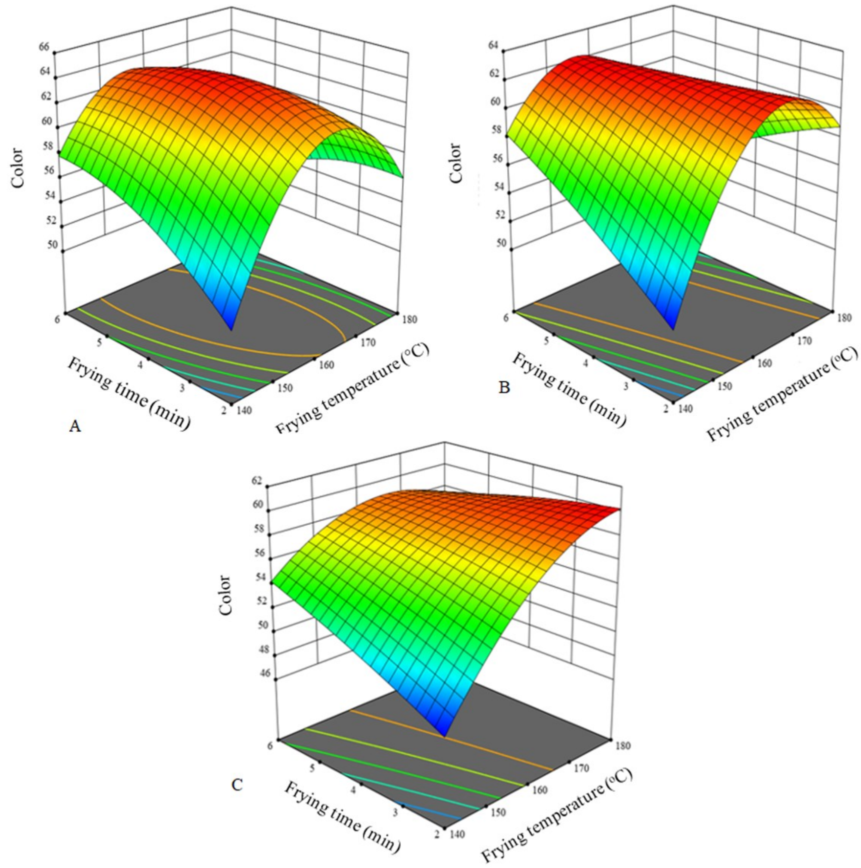

Figure 4. Response surface plots of color (L*) of fried sweet potato chips as a function of frying time and temperature for (A) Kabode, (B) Dilla and (C) Kulfo varieties.

3.1.5 Optimization of frying conditions and validation of the model

A numerical optimization technique employing desirability values was utilized to ascertain the optimal frying conditions concerning moisture content, oil content, color, and texture of sweet potato chips. The study aimed to minimize moisture and oil content while maximizing the L* value and texture of the chips. All independent variables (frying time and temperature) were kept within the range of process parameters. The solution yielding the highest desirability value was chosen as the optimal frying condition for producing satisfactory fried chips, with corresponding qualities (moisture, oil content, texture, and color) outlined in Table 3. Previous research has shown similar outcomes in minimizing oil incorporation and moisture content of sweet potato fried chips at 160°C for 3.30 mins (Fontes *et al.*, 2011). Although Nasir *et al.* (2019) reported different optimal frying temperature and time values for high-quality chips from the Mother Delight cultivar, a direct comparison with our study is challenging due to variations in cultivars and methodologies. To verify the correctness of the Response Surface Methodology (RSM) model results, a confirmation experiment was conducted under the predicted optimum process conditions. Moisture content, oil content, texture, and color values recorded for Kabode, Dilla, and Kulfo varieties closely matched the optimal results obtained from the RSM model (Table 3), validating its accuracy. Hence, the model played a crucial role in predicting quality parameters (moisture content, oil content, texture, and color) and determining optimum process parameters for sweet potato chip production.

3.1.6 Physicochemical composition of sweet potato chips

Table 4 reveals significant variations ($P < 0.05$) in moisture levels among chip varieties. The moisture content ranged from 2.5% (Kabode) to 5.84% (Kulfo), indicating distinct differences among chips from the three varieties. Comparable moisture content values for Kabode and Dilla varieties align with findings by Fetuga *et al.* (2014), reporting a moisture range of 0.49% to

Table 3. Optimized frying conditions and quality attributes (responses) of sweet potato chips

Variety	Frying T^{O} (°C)	Frying time (min)	Moisture Content (%)	Oil Content (%)	Texture (N)	Color (L*)	Desirability
Kabode	154.81	3.82	2.70503	35.7030	11.89000	63.37	0.617
Dilla	160.11	3.66	3.26203	37.0068	9.91468	61.50	0.714
Kulfo	162.65	3.04	5.23120	38.4758	9.06636	58.14	0.675

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3.83% for yellow-fleshed sweet potato chips. Ash content showed no statistically significant differences (p > 0.05) among chip varieties, with values of 3.21% (Kabode), 2.93% (Dilla), and 2.17% (Kulfo). These findings corroborate those of Odenigbo *et al*. (2012), reporting ash content ranging from 2.07% to 3.42% for sweet potato fries. Significant variation (P <0.05) in crude protein content was observed, with values of 2.01% (Kabode), 1.32% (Dilla), and 0.72% (Kulfo). However, no statistical difference (p > 0.05) was noted between Dilla and Kulfo varieties. These results align with those of Fetuga *et al*. (2014), reporting crude protein content ranging from 0.1% to 1.42% for yellow-fleshed sweet potato chips. Oil content and crude fiber content exhibited no statistically significant differences (p > 0.05) among chip varieties. Mean oil content values were 34% (Kabode), 36.6% (Dilla), and 39.64% (Kulfo), consistent with fat content ranges (28-39%) reported for deep-fried sweet potato chips by Caetano *et al.* (2017). Crude fiber content ranged from 1.05% to 2.13%, in line with findings (0.44% to 1.99%) reported by Fetuga *et al*. (2014). Carbohydrate content varied among varieties, with values of 56.14% (Kabode), 53.8% (Dilla), and 50.58% (Kulfo), highlighting differences attributable to variety, pretreatment conditions, and frying methods across studies.

Table 4. Proximate composition and sensory characteristics of sweet potato chips.

Paraments	Varieties		
	Kabode	Dilla	Kulfo
Moisture (%)	2.5±0.57^{b}	3.73±0.4^{b}	5.84±0.25^{a}
Oil Content (%)	34.0±0.83^{a}	36.6±0.99^{a}	39.6±2.35^{a}
Fiber (%)	2.13±0.52^{a}	1.84±0.37^{a}	1.05±0.06^{a}
Protein (%)	2.01±0.10^{a}	1.32±0.16^{b}	0.72±0.17^{b}
Ash (%)	3.21±0.41^{a}	2.93±0.23^{a}	2.17±0.14^{a}
CHO (%)	56.14±1.4^{a}	53.58±0.6^{a}	50.58±2.5^{a}
Flavor	6.4±0.52^{a}	5.5±0.84^{b}	4.0±0.82^{c}
Color	6.0±0.82^{a}	5.4±0.53^{a}	4.5±0.53^{b}
Crispness	6.5±0.69^{a}	5.4±0.63^{b}	4.3±0.67^{c}
Overall Acceptability	6.2±0.63^{a}	5.9±0.74^{a}	4.2±0.73^{b}

Values are presented as mean±SD. Values with different superscript within the same row are statistically significantly different (p<0.05).

3.1.7 Sensory characteristics of fried chips

Table 4 displays the mean scores from ten panelists across seven hedonic scales evaluating fried chips derived from different sweet potato varieties. Kabode chips exhibited significantly better flavor than both Dilla and Kulfo chips (p<0.05), with a notable statistical difference observed between Dilla and Kulfo chips as well. Additionally, Kabode and Dilla chips received higher color scores compared to Kulfo chips, with no significant difference (p>0.05) between Kabode and Dilla varieties. Variations in chip crispness were significant (p<0.05) among varieties, with Kabode chips achieving the highest sensory score, potentially attributed to their higher starch content. This aligns with the notion that sweet potato roots with elevated starch content contribute significantly to chip crispness through starch gelatinization during frying (Nourian and Ramaswamy, 2003). Overall acceptability scores were significantly higher (p<0.05) for Kabode and Dilla chips compared to Kulfo chips, with the lowest overall acceptance observed for Kulfo chips. However, there was no statistical difference (p>0.05) in overall acceptance between Dilla and Kulfo cultivars. In summary, Kabode chips demonstrated superior flavor, color, crispness, and overall acceptability compared to the other two varieties, potentially due to their lower reducing sugar content, reduced moisture content, higher specific gravity, and elevated starch content.

4. Conclusion

The study revealed that as frying temperature and time increased, there was a higher rate of hot oil transfer to the chips, leading to water evaporation from sweet potato slices, while the rate of moisture loss decreased gradually. Moreover, factors such as variety influenced the amount of oil uptake during frying. The chips' texture became harder with increased frying time and temperature, reaching maximum hardness due to rapid water evaporation. Additionally, higher frying temperatures caused sweet potato crusts to darken and chip color to lighten due to quick sugar burning. Chips from the Kabode variety received the highest sensory scores for flavor, color, crispness, and overall acceptability compared to Dilla and Kulfo varieties. The response surface methodology model was instrumental in predicting quality parameters and obtaining optimal processing conditions for sweet potato chip production. These findings offer valuable insights for commercial chip manufacturers and home cooks aiming to produce lighter, more appealing chips at lower production costs.

Conflict of interests

The authors declare no conflict of interest.

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