OPTIMIZATION OF DEEP-FAT FRYING PROCESS FOR SWEETPOTATO CRISPS FROM DIFFERENT VARIETIES

By Sururah Nasir, Ganiyat Olatunde, Abdul Rasaq Adebowale, Isaac Ayelaagbe

Federal University of Agriculture, Abeokuta, Nigeria

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Sweet potato crisps could be marketed as highly nutritious snack foods, particularly the orange-fleshed varieties.

Orange fleshed sweetpotato are relatively new to the consumers.

Differences in texture and chemical composition associated with varieties influences process conditions.

It is important to determine the optimum frying conditions required for the production of sweetpotato crisps with high nutritional quality and consumer acceptable sensory properties.
MAIN OBJECTIVE

- To determine optimum deep fat frying conditions for sweetpotato crisps from different varieties

SPECIFIC OBJECTIVES

- To determine the effect of various combinations of oil temperature and frying time on selected quality (chemical and sensory) attributes of crisps from three varieties of sweetpotato roots
- To determine optimized frying conditions for each variety of sweetpotato crisps
- To determine the effect of two packaging materials on some chemical and microbial characteristics of optimized sweetpotato crisps stored under ambient temperature (30±2°C)
MATERIALS

- Three varieties of sweetpotato roots (two orange-fleshed, one yellow-fleshed)
- Refined deodorized vegetable oil

Experimental design

- Study based on hypotheses that colour, moisture content, oil content, crispness, and beta-carotene content of the product are functionally dependent on the temperature of the oil and the frying time

- Range of oil temperature and frying time determined from literature review followed by trial experiments conducted in the laboratory

- Central composite rotational design with two factors was used; 13 runs and five center points were generated
TABLE 1: Experimental design showing coded and actual values of oil temperature and frying time used in the experiment

<table>
<thead>
<tr>
<th>Trial</th>
<th>Variable codes</th>
<th>Actual values</th>
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Preparation of sample

Sweetpotato roots
- Washing
- Peeling
- Slicing
- Frying*
- Cooling
- Packaging**
- Storage***

* - Temp/Time combination as generated by CCRD/ Bush glass fryer
** - Two packaging materials (High Density Polyethylene and Laminated Aluminium foil)
*** Room Temperature (30±2°C)/ 6 weeks

Fig. 1. Flow chart for production of sweetpotato crisps (adapted from Fetuga et al., 2013)
ANALYSIS OF SAMPLES

- Chemical and physical properties of sweetpotato crisps {Moisture content, Oil content (AOAC, 2005), Total carotenoids (Kimura et. al., 2004), Colour (L*a*b*) – Konica Minolta Chroma meter}

- Sensory properties (crispiness, orange, yellow and brown colours (Descriptive method/ Intensity scoring)

- Analysis on optimized samples
  - Chemical properties: (Protein content, Crude fibre, Ash content)
  - Sensory analysis (Ranganna, 1999)
    - Product test – Descriptive method/ 10cm line intensity scale /10 trained panelists
    - Consumer test – Acceptance method /9-point Hedonic scale / 50 untrained in-house panelists

STORAGE STUDIES

2 packaging materials (high density polyethylene and laminated aluminum foil)
The products stored at ambient temperature (30±2°C) for 6 weeks
Storage Studies

- Microbial Analysis (FDA, 2013) (Total viable count, Total mould count, Salmonella count, Shigella count, Staphylococcus count)

- Chemical Analysis (Peroxide value, Free fatty acid, Saponification value, Total carotenoids, Carotenoid retention)
Statistical analysis

• Data generated for optimization was analyzed with Response surface methodology using Design Expert 6.0.8.

• The data generated from the analysis of the optimized products was analyzed with ANOVA using Statistical Analysis System

• Means were separated with Duncan Multiple Range Test (DMRT)

• Data was analyzed at p<0.05
RESULTS
Table 2: Effect of Oil temperature and frying time on chemical and colour properties of sweetpotato crisps on Mother’s delight variety

<table>
<thead>
<tr>
<th>Trial</th>
<th>Temperature (°C)</th>
<th>Time (min)</th>
<th>Moisture Content (%)</th>
<th>Oil Content (%)</th>
<th>Total Carotenoids (µg/100g)</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
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Values are means of replicate determinations. 
L* - lightness, a* - redness, b* - yellowness.
Table 3: Effect of Oil temperature and frying time on Sensory properties of sweetpotato crisps on Mother’s delight variety

<table>
<thead>
<tr>
<th>Trial</th>
<th>Temperature (°C)</th>
<th>Time (min)</th>
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Values are means of replicate determinations.
Figure 2: Contour plots showing the effect of temperature and time on L*, crispness, moisture content and oil content of optimized sweetpotato crisps from Mother’s delight variety.
Table 4: Chemical and colour properties of optimized SP crisps from three varieties of SP roots

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<th>Variety</th>
<th>Temp (°C)</th>
<th>Time (min)</th>
<th>†Moisture Content (%)</th>
<th>†Oil Content (%)</th>
<th>†Total Carotenoid (µg/100 g)</th>
<th>†L*</th>
<th>†a*</th>
<th>†b*</th>
<th>Crude protein (%)</th>
<th>Crude fibre (%)</th>
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<td>45.34</td>
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†values generated from software

MD – Mother’s delight       KJ – King J       AF – Anoma Funfun
L* - lightness               a* - redness       b* - yellowness
Figure 3: Spider chart for sensory attributes of optimized sweetpotato crisps from three varieties

- MD – Mother’s delight (156.55°C, 3.51 min)
- KJ – King J (140°C, 6 min)
- AF – Anoma Funfun (150.68°C, 6 min)
Figure 4: Consumer sensory scores for optimized crisps from varieties of SP roots

MD – Mother’s delight, UMU (156.55°C, 3.51 min)
KJ – King J (140°C, 6 min)
AF – Anoma Funfun (150.68°C, 6 min)

Figure 4: Consumer sensory scores for optimized crisps from varieties of SP roots
Figure 5: Peroxide Values of SP crisps as influenced by variety and storage period

MDA – Mother’s Delight in Aluminium foil
MDH – Mother’s Delight in HDPE
KJA – King J in Aluminium foil
KJH – King J in HDPE
AFA – Anoma Funfun in Aluminium foil
AFH – Anoma Funfun in HDPE
Figure 6: Free Fatty Acid Values of SP crisps as influenced by variety and storage period

MDA – Mother’s Delight in Aluminium foil
MDH – Mother’s Delight in HDPE
KJA – King J in Aluminium foil
KJH – King J in HDPE
AFA – Anoma Funfun in Aluminium foil
AFH – Anoma Funfun in HDPE
Figure 7: Saponification Values of SP crisps as influenced by variety and storage period

MDA – Mother’s Delight in Aluminium foil
MDH – Mother’s Delight in HDPE
KJA – King J in Aluminium foil
KJH – King J in HDPE
AFA – Anoma Funfun in Aluminium foil
AFH – Anoma Funfun in HDPE
Figure 8: Total Carotenoid Values of SP crisps as influenced by variety and storage period

MDA – Mother’s Delight in Aluminium foil
MDH – Mother’s Delight in HDPE
KJA – King J in Aluminium foil
KJH – King J in HDPE
AFA – Anoma Funfun in Aluminium foil
AFH – Anoma Funfun in HDPE
### Table 5: Carotenoid Retention Values of SP crisps as influenced by variety and storage period

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<td>42.52&lt;sup&gt;e&lt;/sup&gt;</td>
<td>42.20&lt;sup&gt;e&lt;/sup&gt;</td>
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<tr>
<td>MDH</td>
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<td>39.40&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>34.94&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>34.29&lt;sup&gt;bc&lt;/sup&gt;</td>
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<td>13.81&lt;sup&gt;a&lt;/sup&gt;</td>
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</table>

Values in any column, with the same letter are not significantly different (P < 0.05)

MDA – Mother’s Delight in Aluminium foil
MDH – Mother’s Delight in HDPE
KJA – King J in Aluminium foil
KJH – King J in HDPE
AFA – Anoma Funfun in Aluminium foil
AFH – Anoma Funfun in HDPE
Results of microbial counts are averages of triplicate values with standard error obtained from colony forming unit on agar plate and converted to the standard log cfu/ml values at appropriate dilution factors for each medium.

- MDA – Mother’s Delight in Aluminium foil
- MDH – Mother’s Delight in HDPE
- KJA – King J in Aluminium foil
- KJH – King J in HDPE
- AFA – Anoma Funfun in Aluminium foil
- AFH – Anoma Funfun in HDPE

*Figure 9: Total Viable Count of SP crisps as influenced by variety and storage period*
Conclusion

The optimum frying conditions and corresponding qualities for each variety are:

- Mother's delight, UMU SP03 (156.55°C, 3.51 min) moisture content – 5.15%, oil content – 28.7%, total carotenoids – 3866.74 µg/100g, a* - 21.20, b* - 35..36, crude protein – 3.71%, crude fibre – 8.87%, crude ash – 1.27%, crispiness – 8.64, orange – 8.35, oiliness – 2.5

- King J, UMU SP01 (140°C, 6 min) moisture content – 2.48%, oil content – 24.66%, total carotenoids – 3530.52 µg/100g, a* - 3.99, b* - 29.1, crude protein – 5.77%, crude fibre – 9.14%, crude ash – 1.01%, crispiness – 8.92, orange – 4.9, oiliness – 7.61

- ‘Anoma Funfun’, UMU SP02 (150.68°C, 6 min) moisture content – 2.08%, oil content – 26.92%, total carotenoids – 1934.04 µg/100g, a* - 3.26, b* - 23..34, crude protein – 3.4%, crude fibre – 6.63%, crude ash – 1.65%, crispiness – 7.99, orange – 0, yellow – 9.15, oiliness – 3.39

- Aluminium foil showed a good barrier for oxidative and microbial rancidity and also better carotenoid retention ability
Recommendation

- The optimum frying conditions generated in this study should be validated in real time SME production of sweetpotato crisps from each variety
Selected references


- Oke, M.O., Workneh, T.S. 2013. A review on sweet potato postharvest processing and preservation technology. African Journal of Agricultural Research, 8 (40), 4990-5003


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