VACUUM FRYING PROCESSING TECHNOLOGY IMPROVES QUALITY ATTRIBUTES OF FRIED SWEETPOTATO CHIPS

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Transforming potato & sweetpotato value chains for food and nutrition security

9th Triennial Conference

Introduction

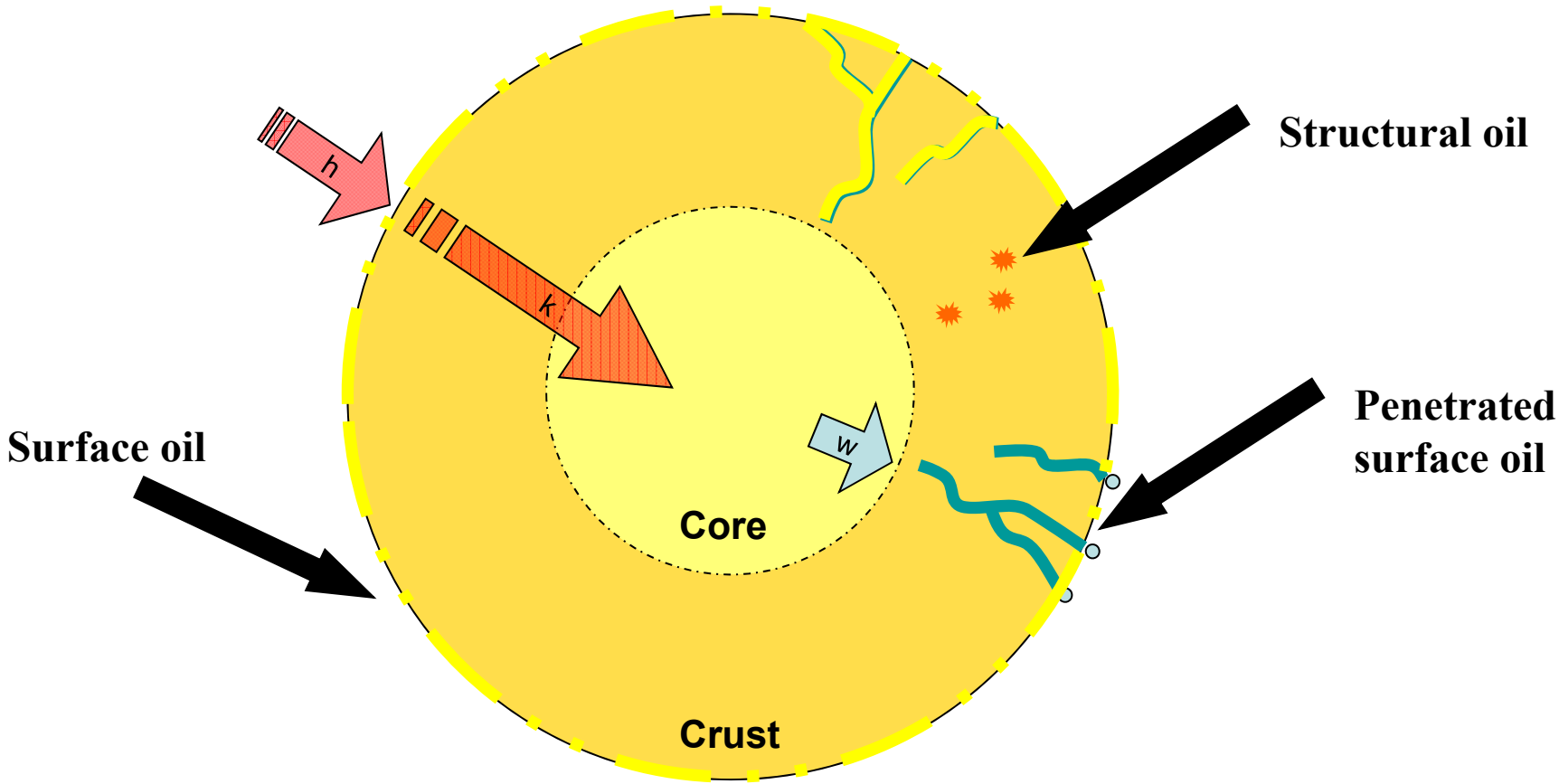
- Sweetpotato (***Ipomoea batatas***) is a dicotyledonous plant that belongs to the family Convolvulaceae

- The yellow flesh varieties is high in carbohydrates, vitamin A, and produces more edible energy per hectare per day than wheat, rice or cassava.

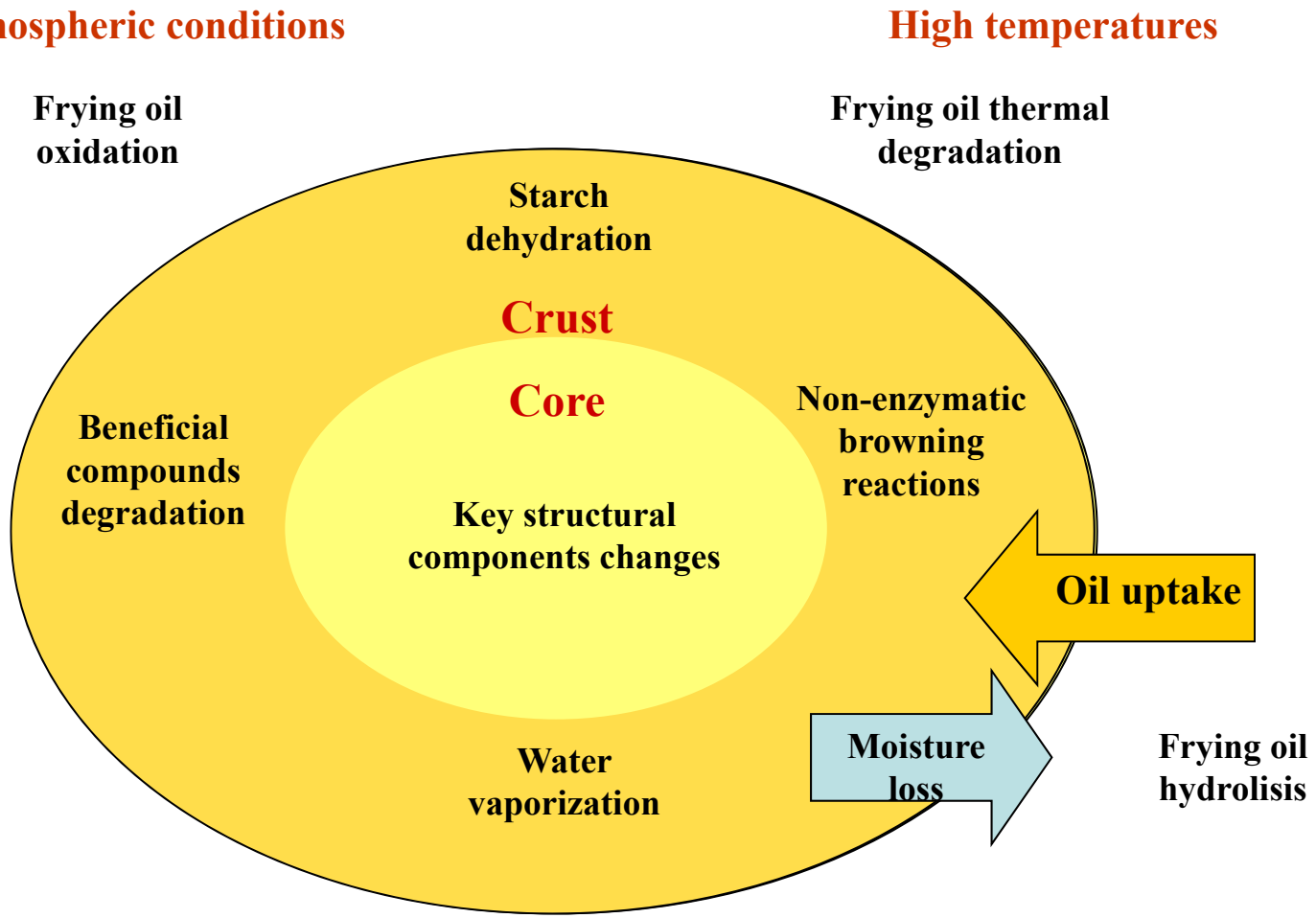
- Snack foods especially the fried foods is enjoying an ever increasing popularity world-wide (SFA, 1997; Brinkmann, 2000);

- The frying technology is important to many sectors of the food industry: suppliers of oil and ingredients; food service operators; the food industries, and manufacturers of equipment;

Heat and mass transfer during atmospheric deep-fat frying



Microstructural changes during atmospheric deep fat frying



What is the problem?

Temperature and oxygen affects the quality of atmospheric fried products and oil

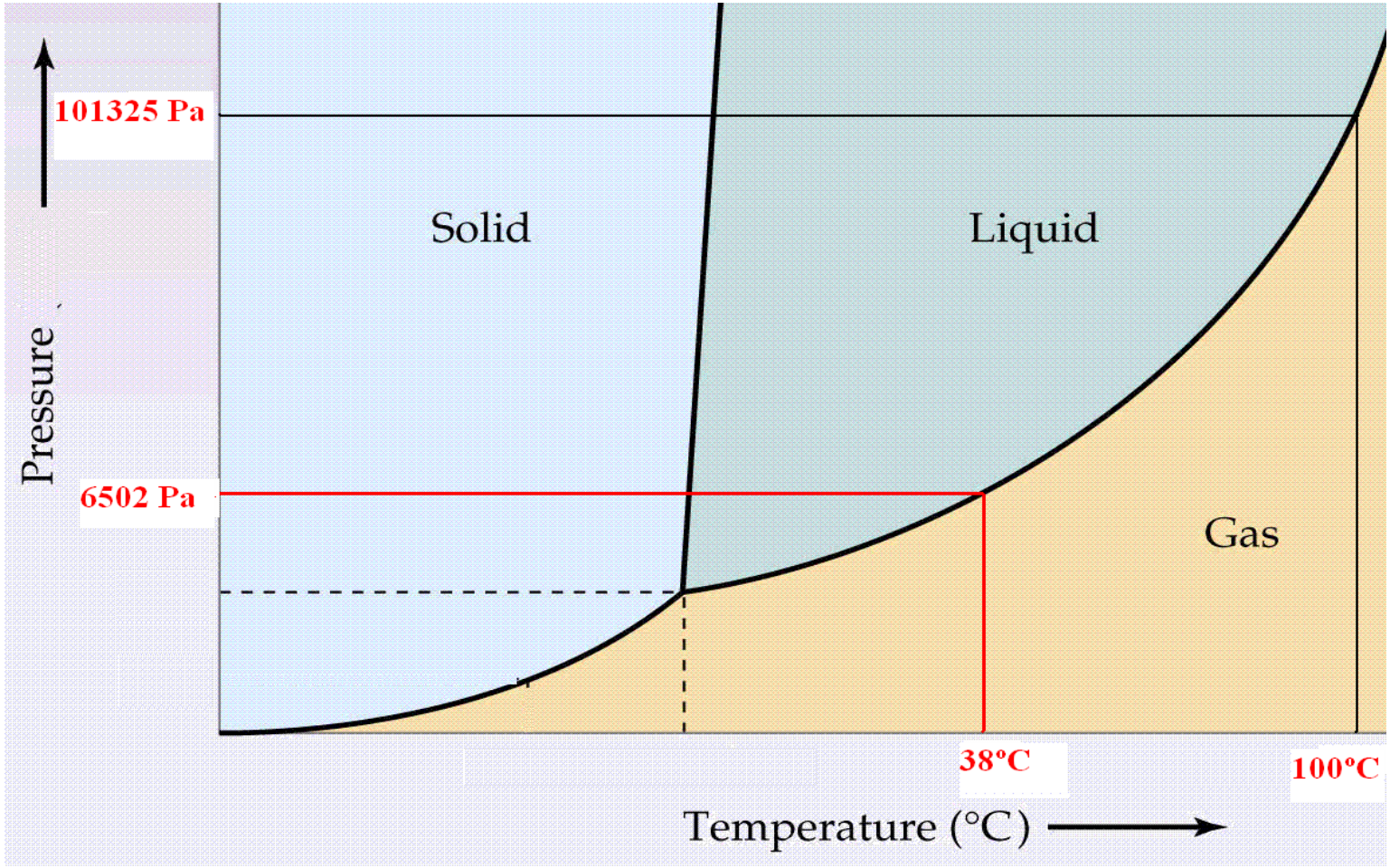
Solution

Vacuum frying (VF) to design novel snacks

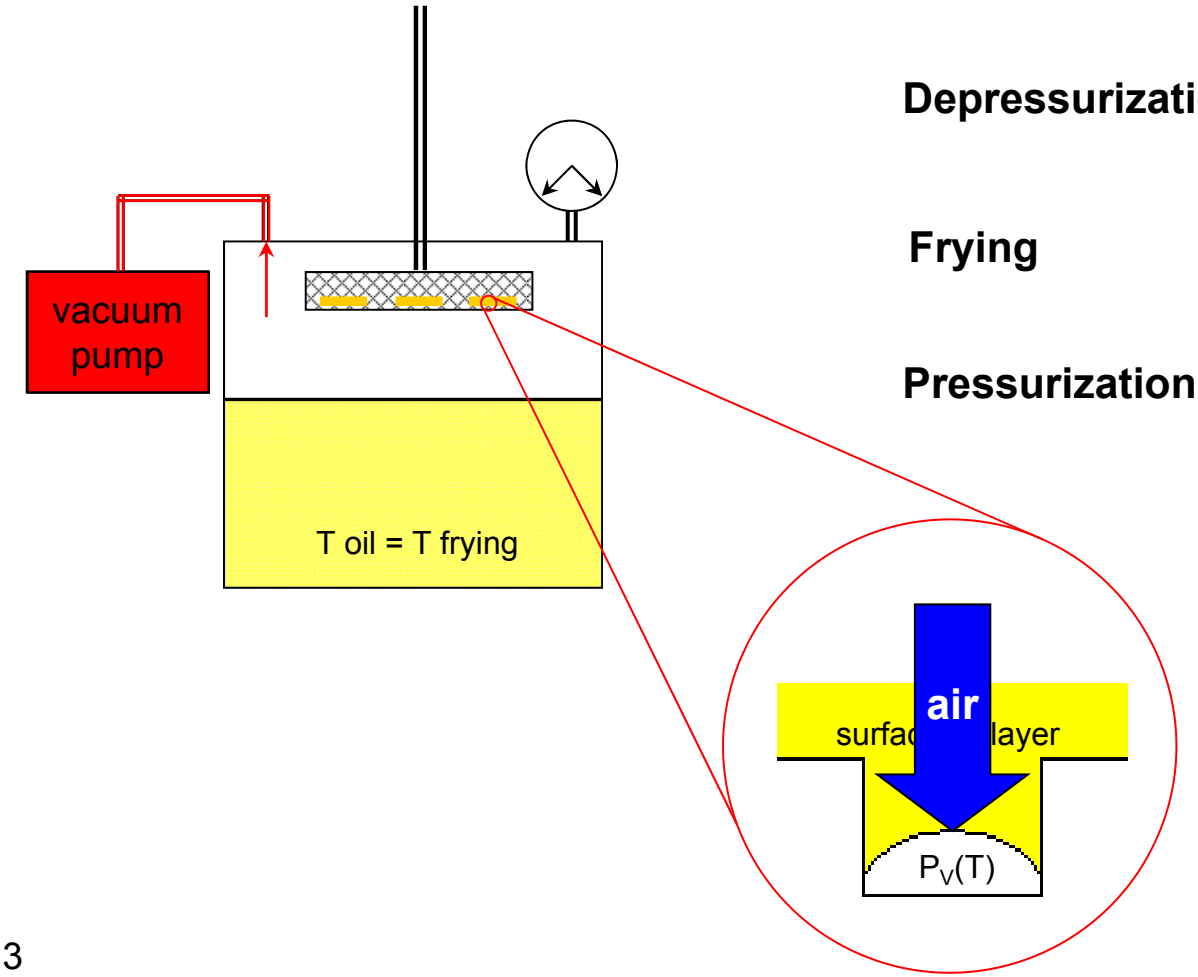
What do we need?

Development of a vacuum frying system

New processing technology: Vacuum inclusion



Vacuum frying operations



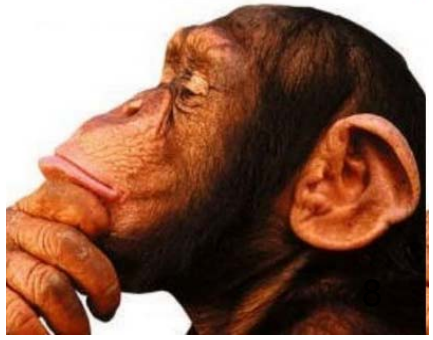
Depressurization: $P_{atm} \rightarrow P_{vac}$

Frying

Pressurization: $P_{vac} \rightarrow P_{atm}$

Hypothesis

By reducing the frying pressure, (vacuum deep-fat frying), it is possible to remove product moisture in a low-oxygen environment at a low temperature (due to water boiling-point depression), allowing to produce low fat and nutritious novel snacks, such as SP chips, while keeping unique characteristics of regular fried snacks.



Main objective

Study the effect of vacuum inclusion in a traditional deep-fat frying operation, in order to understand its impact in the developed microstructure and associated transport phenomena, particularly oil uptake, as well as in the main quality parameters of fried SP chips.

MATERIALS

- Three varieties of YFSP were procured from local market in Abeokuta, Nigeria:
  - EX-OYUNGA
  - 442016
  - SPK004

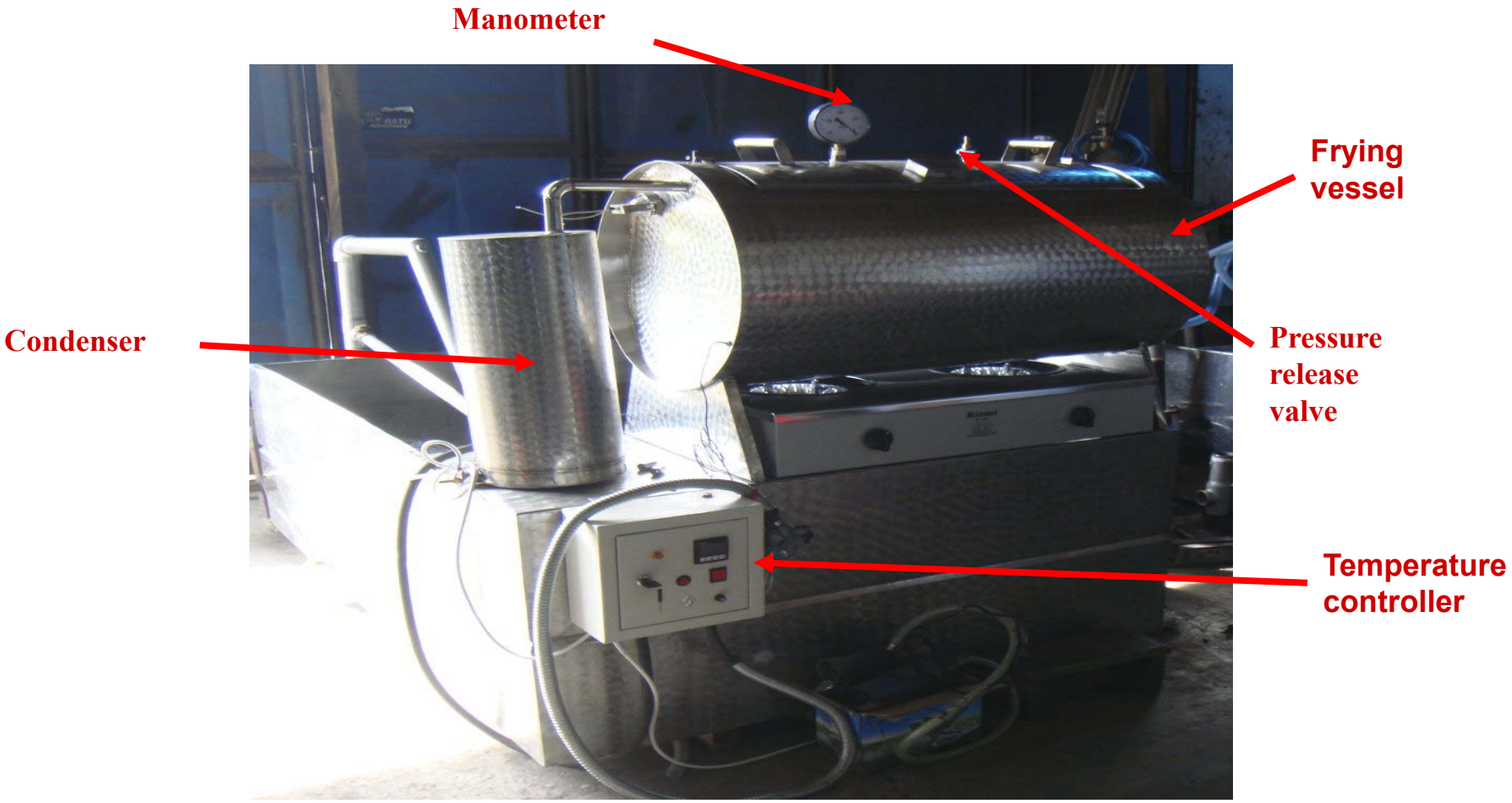
- Three different types of frying oils normally used for frying were purchased from a local market in Abeokuta:
  - Refined bleached deodorized oil (RBDO)
  - Palm oil (PO)
  - Groundnut oil (GO)

Frying Operations

Table1: The coded values of the independent variables for vacuum frying of cassava roots

	Codes		
Variable	-1	0	+1
X_1	EX-OYUNGA	440216	SPK004
X_2	RBDO	PO	GO
X_3 (^oC)	108	122	136
X_4 (cmHg)	4.91	9.91	19.91
X_5 (min)	3	6	9

X_1, X_2, X_3, X_4 and X_5 are SP variety, types of oil, frying temperature, vacuum pressure and frying time, respectively



Vacuum frying machine donated by International Foundation for Science (IFS)

Sample Analysis

- Oil and moisture contents of fried SP chips (AOAC, 2003)
- Colour parameters – (Glories, 1984)
- Carotenoid content of raw and fried YFC chips (AOAC, 2005)
- Texture (Garaya and Moreira, 2002)

RESULTS AND DISCUSSION

Table 1. Response surface Analysis result of responses as a function of the independent variables

Experimental Run	Oil (%)	Moisture (%)	β-Carotene (ppm)	Texture (N)	Lightness	Redness	Yellowness
1	16.38	2.10	53.37	6.9	26.58	0.84	71.88
2	13.72	1.76	4.89	5.75	**1.04**	**74.25**	23.88
3	17.07	2.12	82.74	9.50	32.53	10.87	56.33
4	17.10	4.27	60.79	14.00	2.02	69.57	27.96
5	11.33	2.45	48.32	8.65	27.96	1.37	69.86
6	17.83	1.85	62.21	5.05	26.58	31.23	41.96
7	9.93	3.07	54.79	3.25	26.33	1.26	71.54
8	16.99	**1.66**	**1.89**	**3.15**	1.96	71.37	25.97
9	7.51	2.85	68.21	**20.55**	31.24	42.37	25.65
10	**19.32**	1.87	80.69	4.90	19.93	22.71	56.78
11	10.85	2.14	75.48	9.45	28.12	1.45	70.03
12	17.34	1.94	86.06	7.10	25.91	1.16	72.62
13	6.93	2.94	71.85	8.60	41.27	35.96	**21.95**
14	7.10	1.97	87.95	4.90	**62.60**	7.19	29.87
15	10.92	2.07	75.32	15.00	34.95	3.02	61.66
16	18.30	2.17	104.69	5.60	38.26	2.96	57.97
17	16.16	2.07	69.00	5.90	39.64	1.87	57.94
18	17.00	1.83	72.16	7.80	4.52	67.84	27.48
19	17.29	1.77	94.58	12.20	1.76	71.27	25.56
20	18.60	2.13	103.27	10.40	1.84	38.74	58.63
21	17.58	1.68	96.64	6.35	26.30	**0.64**	72.83
22	**5.36**	**7.25**	66.16	5.15	58.31	9.86	31.14
23	10.41	2.05	82.89	6.60	26.05	1.04	72.74
24	15.20	1.94	107.85	9.45	1.78	39.86	58.33
25	17.83	2.38	**109.90**	4.45	23.86	11.26	63.96
26	8.17	5.84	71.37		1.87	72.40	24.96
27	15.00	1.93	8.53	3.65	1.74	73.84	23.96
28	15.80	2.25	72.48	12.85	26.09	0.91	**72.97**

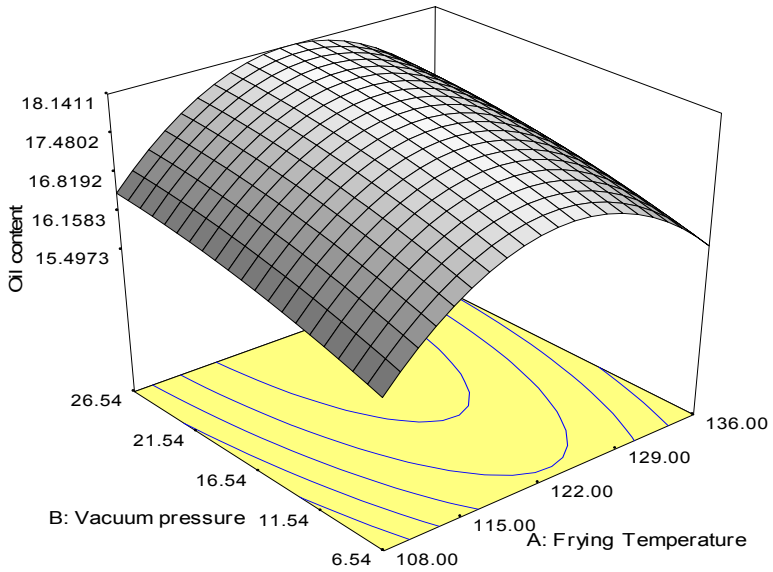
Values are means of duplicate

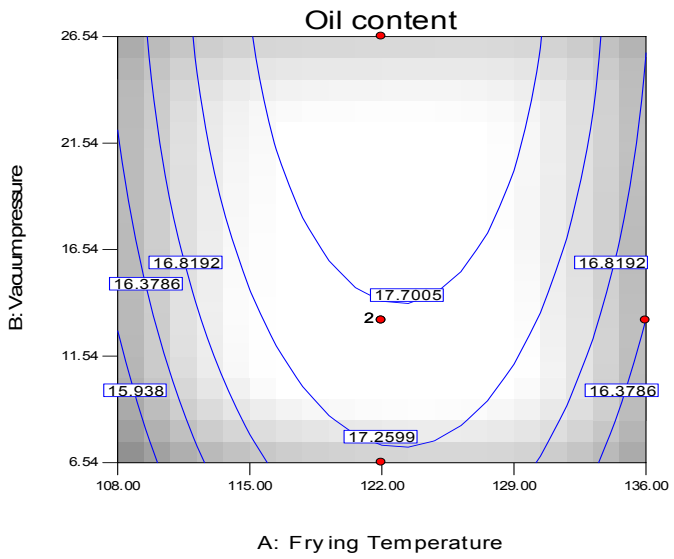
Table 4. Regression coefficients for the quadratic models for all the responses

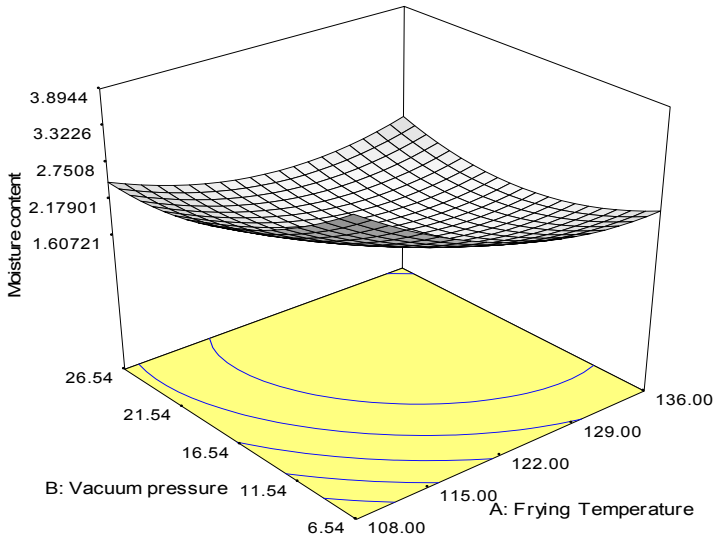
Parameters	Oil	Moisture	β-Carotene	Texture	Lightness	Redness	Yellowness
Intercept	9.85	1.78	81.68	7.15	23.23	14.69	61.66
A	-0.02	-0.50	**-15.68***	1.37	-11.38*	**20.04***	-9.63
B	0.23	-0.42	- 2.90	1.19	0.66	-11.25	10.56
C	0.85	-1.08	**-13.74***	**2.29***	**-11.57***	14.61	-2.90
D	0.77	-0.23	-4.47	**-1.73***	5.58	-7.91	2.43
E	1.07	0.01	3.58	**-2.08***	-4.65	2.06	2.48
A^2	-1.34	0.45	**-44.31***	**-4.70***	-2.07	**34.28***	**-32.28***
B^2	0.57	0.46	2.68	-0.85	2.23	-3.58	1.29
C^2	0.13	-0.33	11.62	0.04	-5.01	12.35	-7.56
D^2	0.15	0.27	17.99	2.02	-6.65	0.83	5.69
E^2	-2.89	0.17	-3.68	**4.22***	6.83	-17.17	10.55
AB	0.16	0.29	**11.57***	0.69	9.26	-2.60	-6.84
AC	-0.57	0.08	-4.30	-1.66	-0.61	4.56	-4.09
AD	1.01	0.40	**-13.46***	-0.30	-2.56	-0.65	3.15
AE	-0.46	0.54	3.84	**-3.27***	8.11	-9.91	1.69
BC	0.51	0.71	**16.45***	**-2.96***	0.27	3.20	-3.60
BD	-0.14	0.18	**-14.71***	-0.56	-1.08	-1.79	2.79
BE	-0.68	0.06	1.83	0.07	**9.16***	-11.99	2.79
CD	-1.34	0.50	**-11.28***	**-3.55***	**11.19***	-9.20	-2.13
CE	1.14	0.25	-8.32	**2.45***	1.05	-0.72	-0.56
DE	-0.44	-0.09	8.37	-0.03	6.06	-5.97	0.0012
R^2	0.76	0.72	0.95	0.95	0.89	0.91	0.875
PRESS	2209.46	1380.80	37000.23	3415.56	48307.68	200000	95030.57
F value	1.75	0.89	6.80	5.51	2.89	3.34	2.46

*Significant at 5% level

A, B, C, D and E are frying temperature, vacuum pressure, frying time, SP variety and type of frying oil







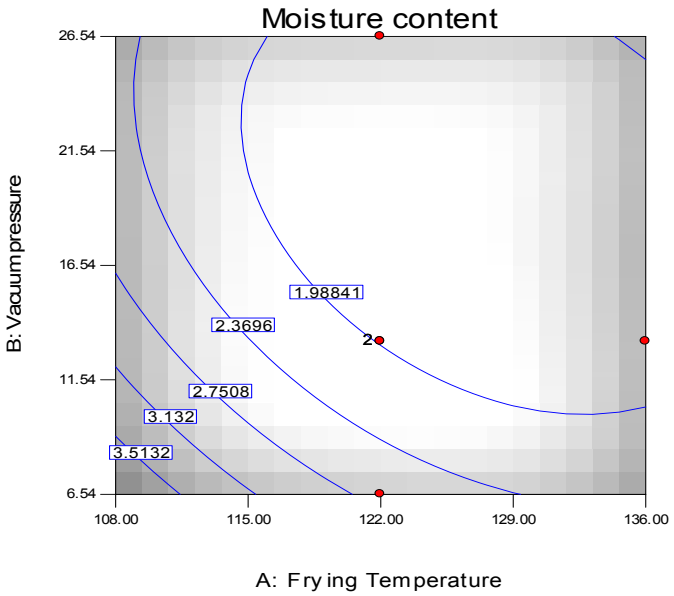
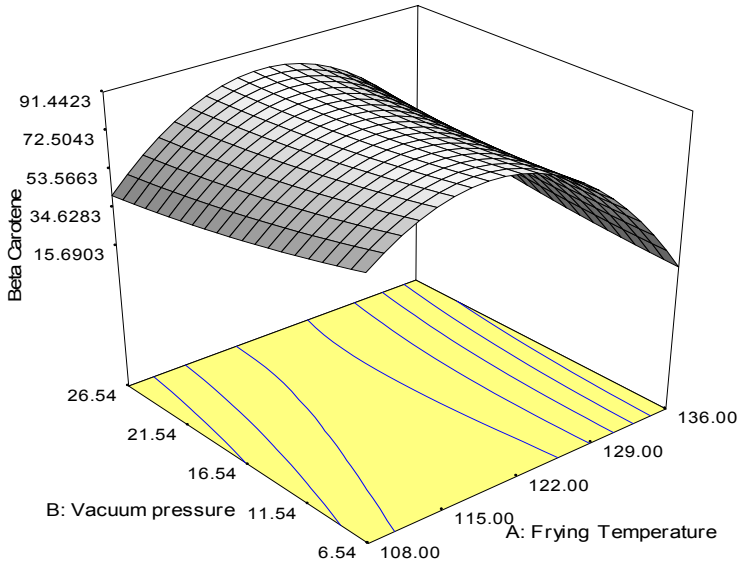
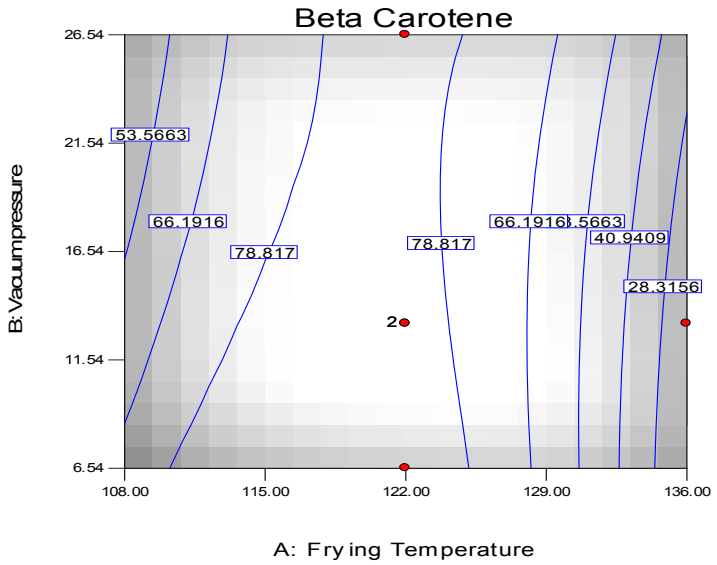
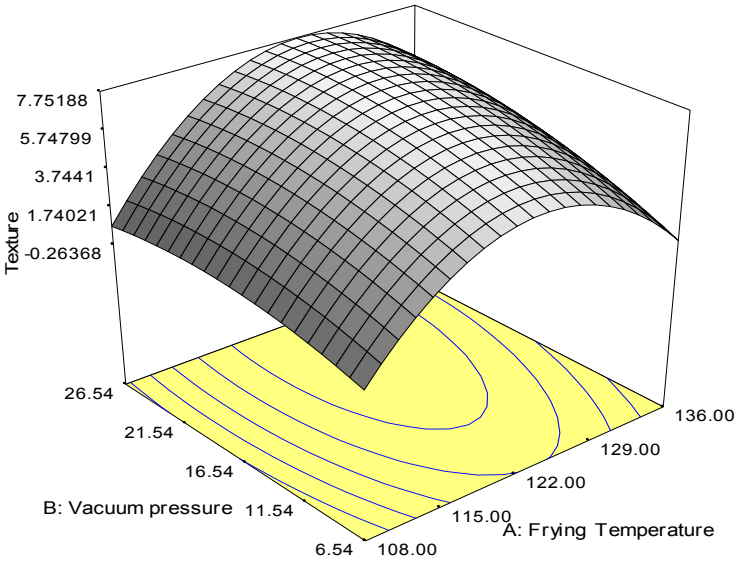


Fig. 1. Response surface and contour plots for moisture and oil contents of fried sweetpotato chips







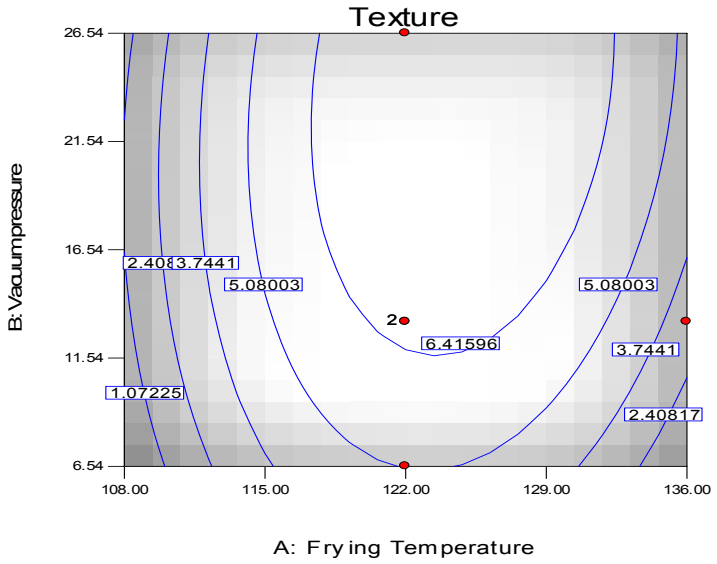


Fig. 2. Response surface and contour plots for Beta carotene and texture of fried sweetpotato chips

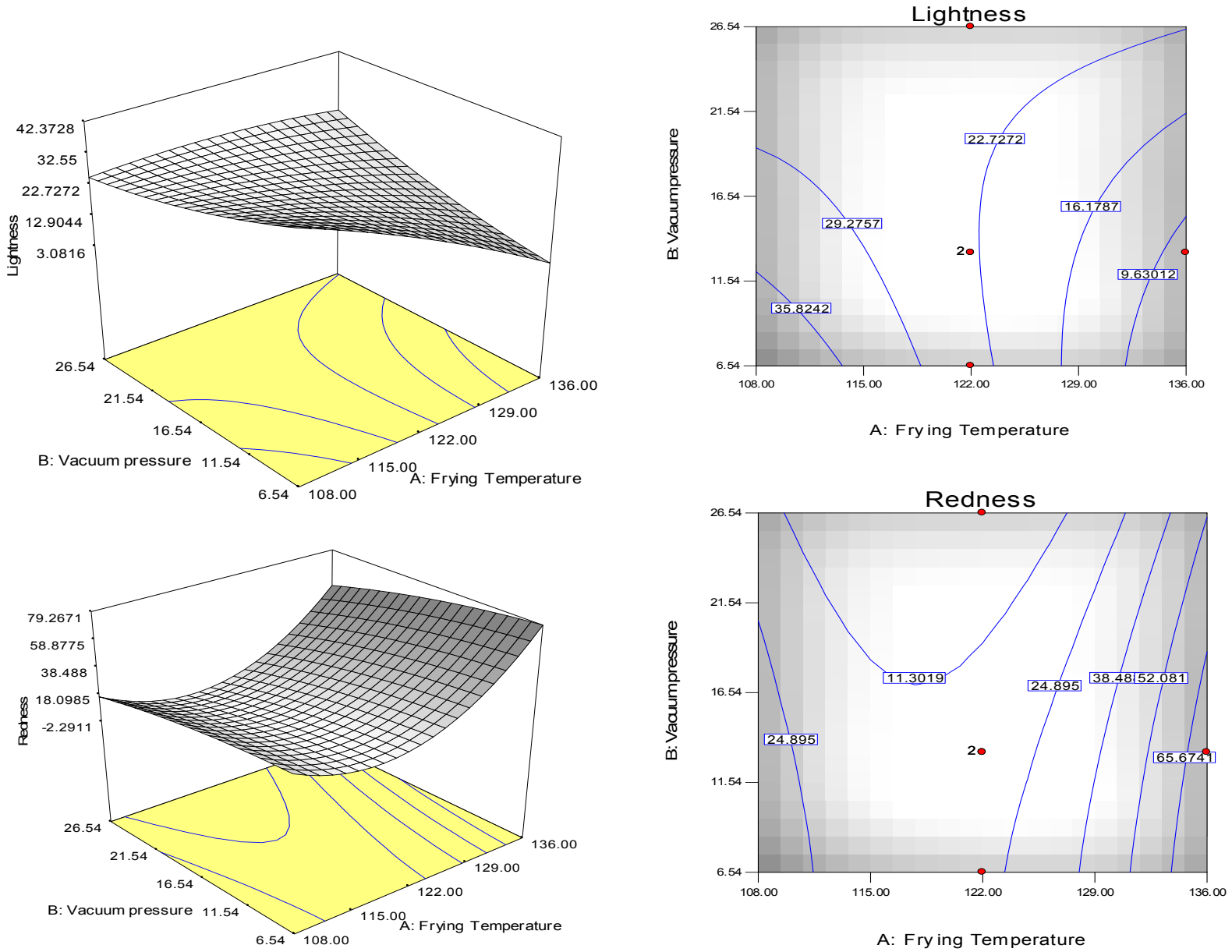


Fig. 3. Response surface and contour plots for Lightness and redness of fried sweetpotato chips

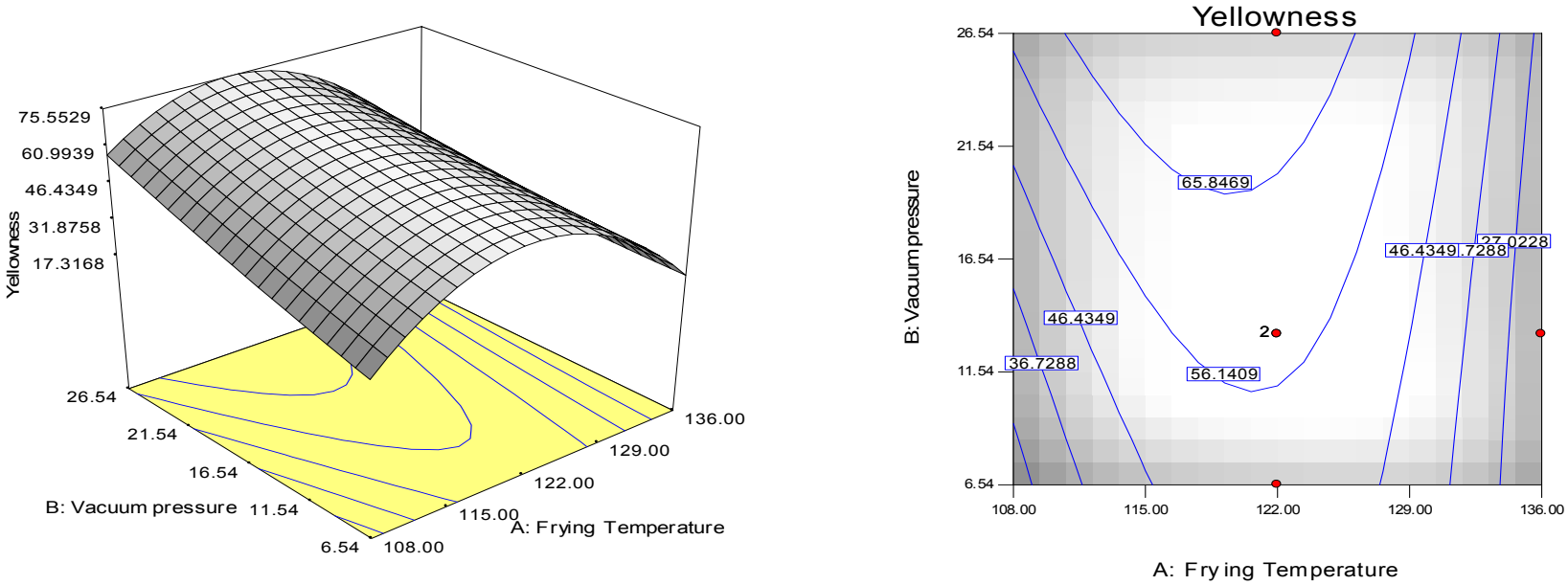
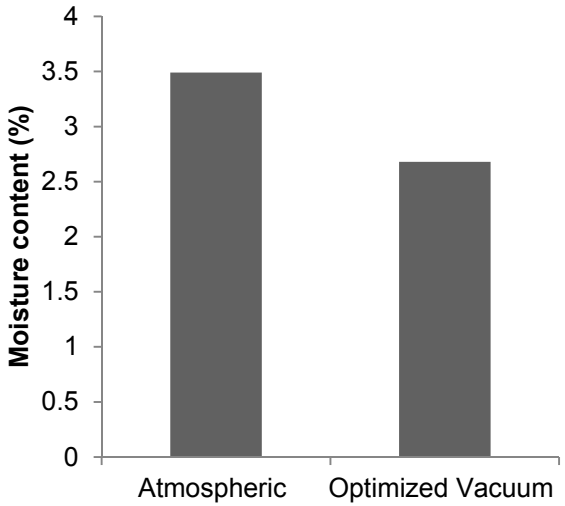
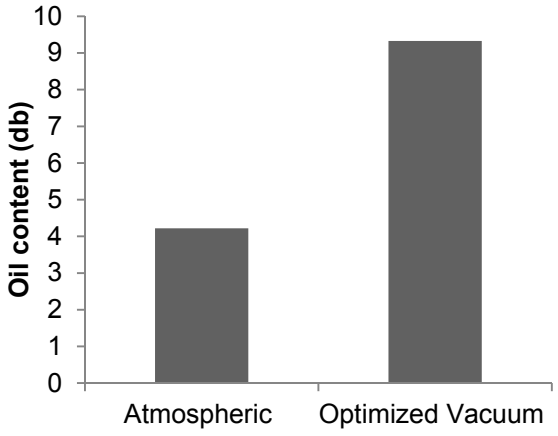
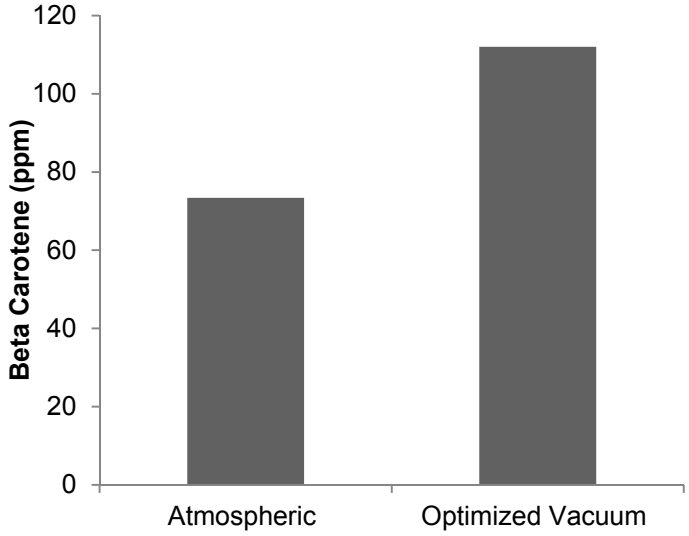


Fig. 4. Response surface and contour plots for yellowness of fried sweetpotato chips







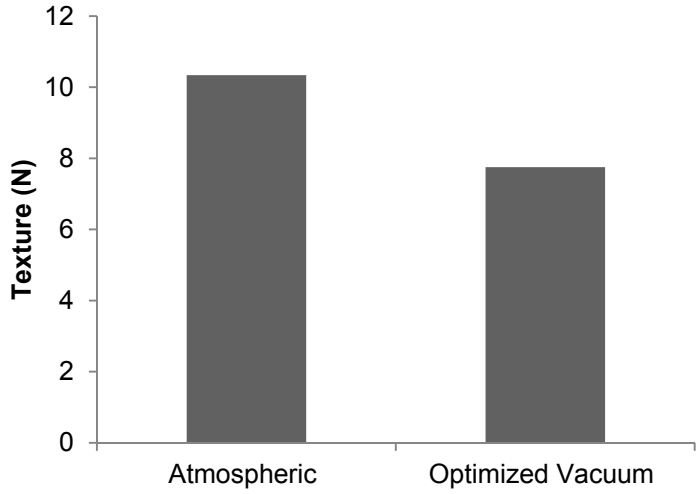


Fig. 5. Comparison of atmospheric and optimized vacuum fried SP chips

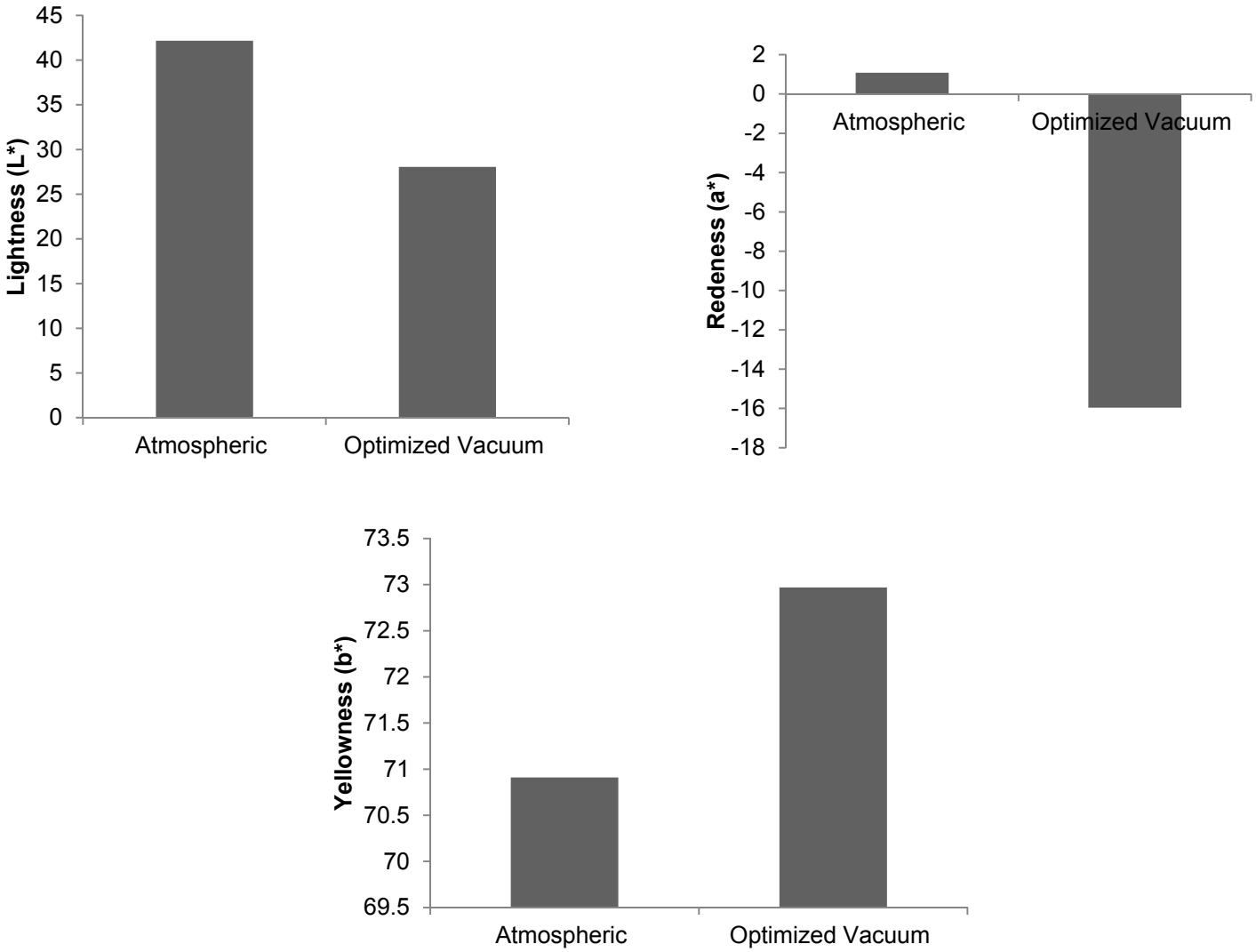


Fig. 6. Comparison of colour properties of atmospheric and optimized vacuum fried SP chips

Key findings

- In terms of the basic deep fat frying qualities:

- Vacuum fried SP chips retains more carotenoid than atmospheric fried samples after processing

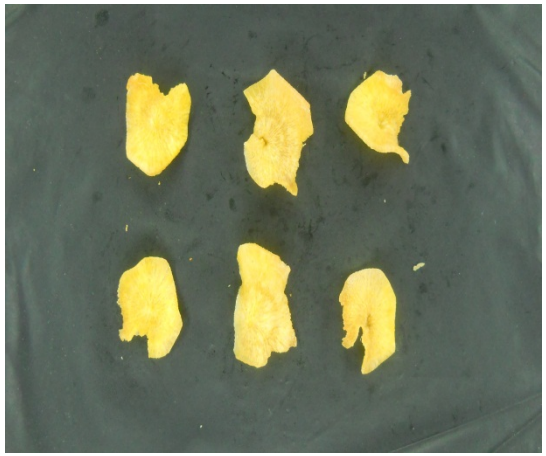
- Colour properties of vacuum fried samples are better than the atmospheric fried samples

- Vacuum fried samples are more crispier than atmospheric fried samples

Acknowledgement

- International Foundation for Science (IFS)

- K + S Kali GmbH for full sponsorship of the corresponding author to APA 2013



Optimized vacuum fried SP crisps

Atmospheric fried SP crisps

MANY THANKS FOR YOUR ATTENTION