Continuous Frying Improves the Longevity of Palm Olein for Processing of Extruded Product

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Presentation outline



Background of frying



Oils for frying



Study case



Design of experiments



Research outcomes

Conclusions

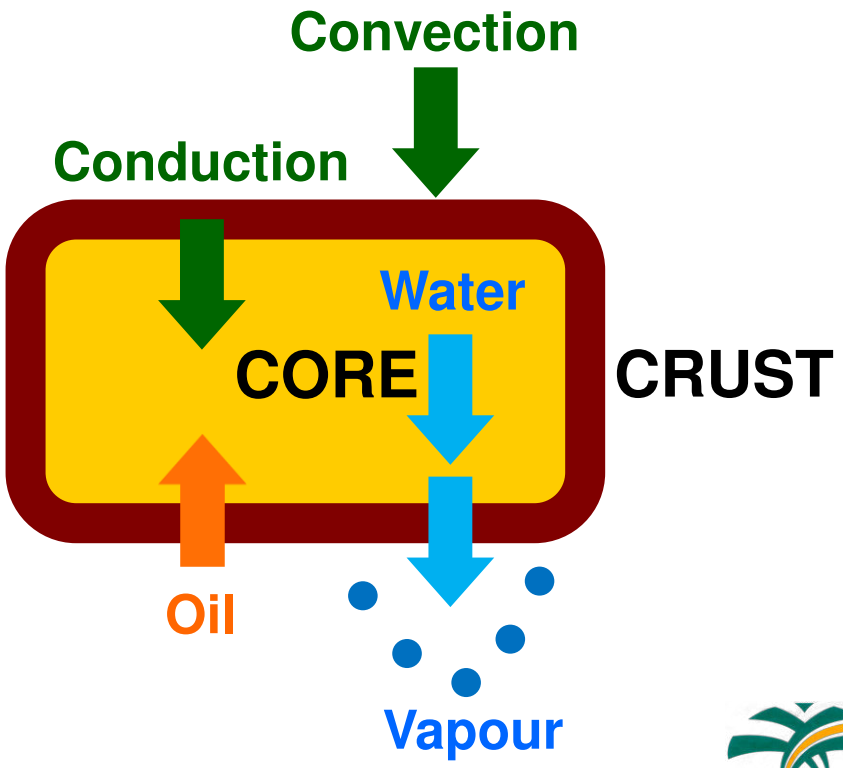
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Principle of frying

More than 20 million tonnes of edible oil production is utilised in frying sectors

Frying is a dehydration process when product is immersed in hot oil

Simplicity in frying operation, convenience and economic feasibility that contributes to extensive sales of fried food.



Roles of frying


Heat transfer media


Modify food texture


Remove water


Make food palatable


Unique sensory properties



Source of vitamins


Impart of fried food


Essential fatty acids


Provide high energy


Acts as lubricant

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How much oil in your favourite snacks?



Potato chips
30 - 40%



Tortilla chips
22 - 26%



Frozen French fries
4 - 7%



French fries
12 - 15%



Breaded products
13 - 20%



Battered products
14 - 17%



Instant noodles
18 - 21%



Doughnuts
22 - 26%

Consumers perspective…

"...As significant amount of frying oil is becoming part of the fried food, oil quality and stability is of major concern to consumers..."



Strategies to improve oil stability



Naturally stable oils



Breeding



Hydrogenation



Blending

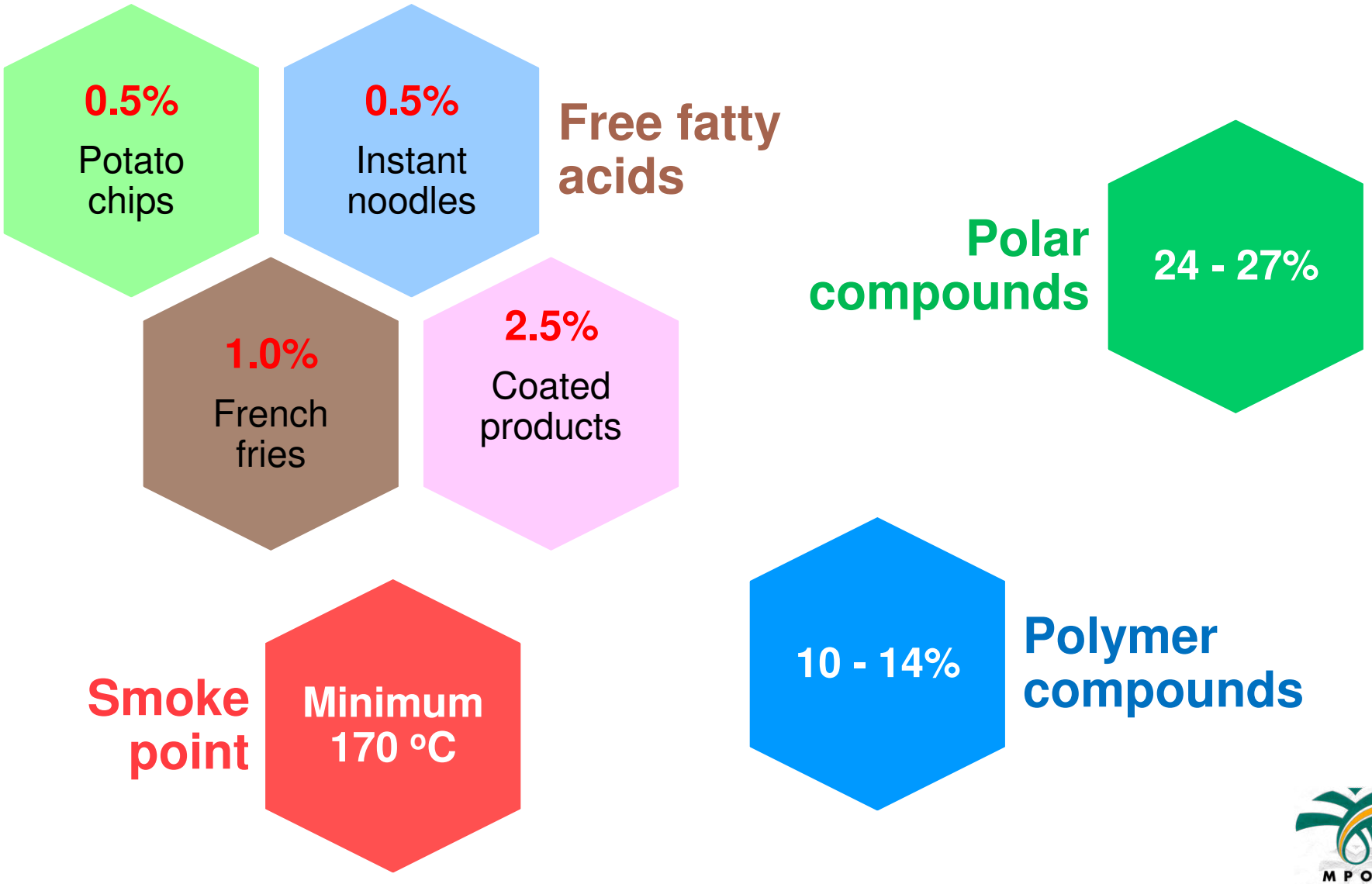


Additives



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Thresholds for used oil



Past studies…



"…Frying performance of palm olein has been discussed in many publications…"



"…Most of studies published are related to batch or intermittent frying…"



"…More than 80% reports on potato products such as potato chips and French fries…"



"…Limited publications on continuous frying is likely due to trade secret of the industry…"

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Literature on industrial (continuous) frying

Authors	Oils	Products
Sebedio and others (1996)	Sunflower oil	Potato chips Pre-fried French fries
du Plessis and Meredith (1999)	Palm olein	Potato chips
Kristott (2002)	Palm olein Sunflower oil High oleic sunflower oil	Potato chips
Ismail (2005)	Palm olein Palm oil	Potato chips Pre-fried French fries
Ahmad Tarmizi and Ismail (2008)	Standard palm olein Special Quality palm olein	Potato chips
Ahmad Tarmizi and others (2008)	High oleic sunflower oil	Potato chips
Ahmad Tarmizi and Ismail (2014)	Palm olein + sunflower oil Palm olein + canola oil Palm olein + cottonseed oil	Potato chips
Ahmad Tarmizi and Ahmad (Under review)	Palm olein	Extruded product

Therefore…

Objectives

- Compare the stability of palm olein during intermittent and continuous frying of extruded product;
- Conduct storage stability test for the product obtained under continuous frying conditions

Expected benefits

- Expose cottage industry on proper oil management during frying;
- Technical support to cottage industry on mass production using continuous fryer;
- Increase the yield of cottage industry

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Intermittent *versus* continuous frying

- Lower production of fried food
- Food is fried in discrete batches at predetermined intervals
- Oil is heated directly or using external heaters
- Non-automatic operation in which the oil is subjected to severe frying conditions
- Commonly used by fast food outlets, mass catering, cottage and medium industries, others

Intermittent frying



- Mass production of fried food
- Product flows continuously into the frying system
- Oil is heated using gas or heat exchangers
- Oil is continuously compensated, filtered and circulated through heat exchangers during frying
- Fully-automated operation where the oil is subjected to less severe frying conditions

Continuous frying



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Dough formulation

Ingredient	Amount (%)
Chickpea flour	44.47
Water	32.39
Tapioca flour	13.38
Palm olein	5.03
Chicken powder	2.01
Icing sugar	1.51
Salt	0.91
Chilli powder	0.30

Frying conditions

Variables	Intermittent frying	Continuous frying
Oil temperature	155 ± 5 °C	
Frying interval	20 min	Continuous
Frying time	2.5 min	2 min
Fryer capacity	11.5 L	200 L
Replenishment	Next day of frying	Continuous
Filtration	End of frying day	Continuous
Frying operation	40 h (8 h daily for 5 days)	
Production rate	0.2 kg h^{-1}	60 kg h^{-1}
Oil sampling	End of frying day	Hourly basis



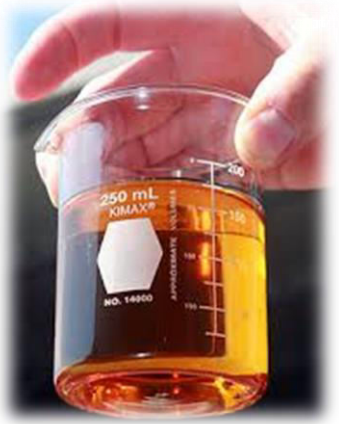



Quality indices

Frying oil
Free fatty acid
Smoke point
Peroxide value
p-anisidine value
Total oxidation (Totox) value
Colour
Induction period
Fatty acids composition
Vitamin E
Iodine value
Polar compounds
Polymer compounds

Product
Storage stability test
Sensory evaluation

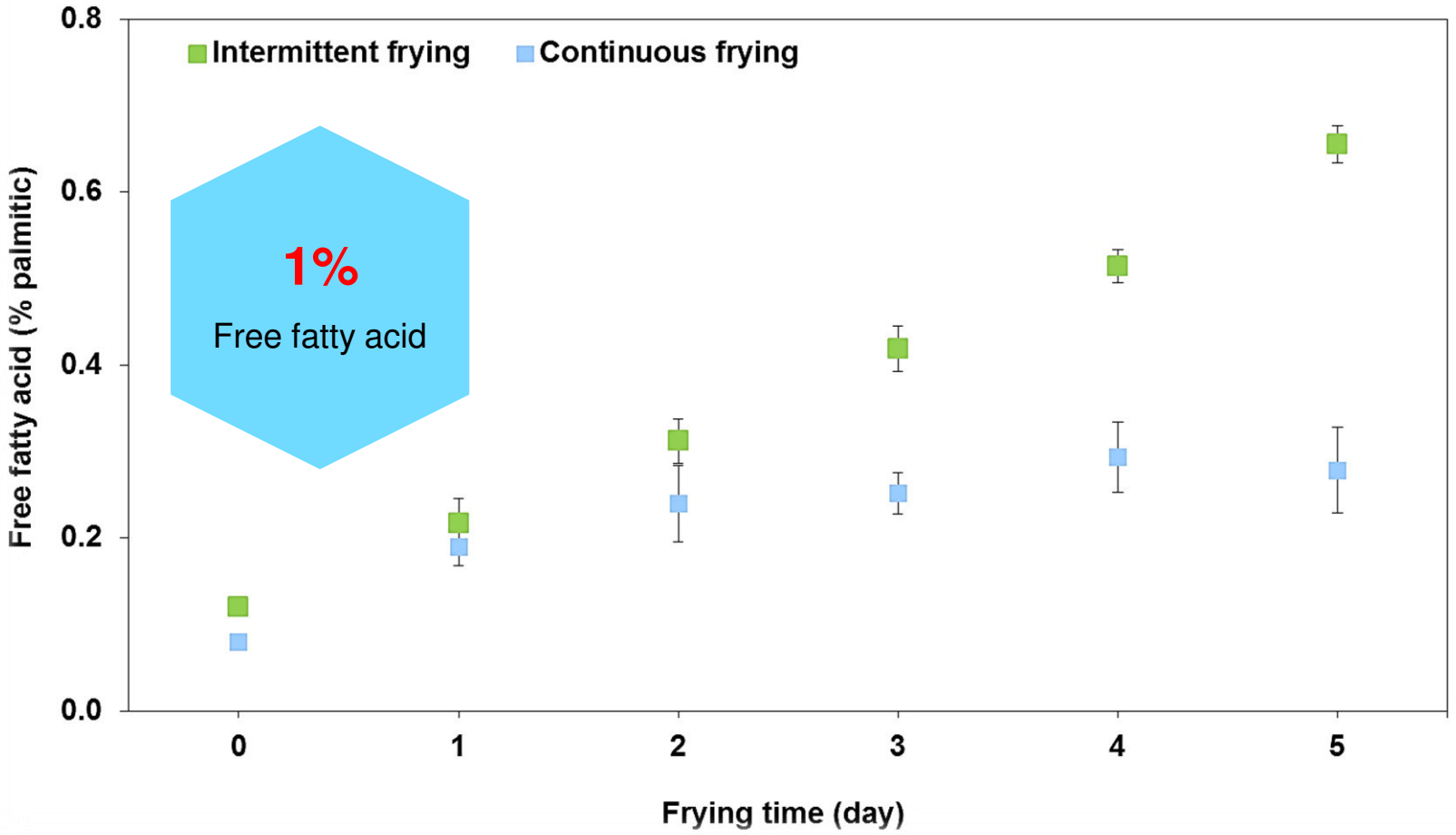




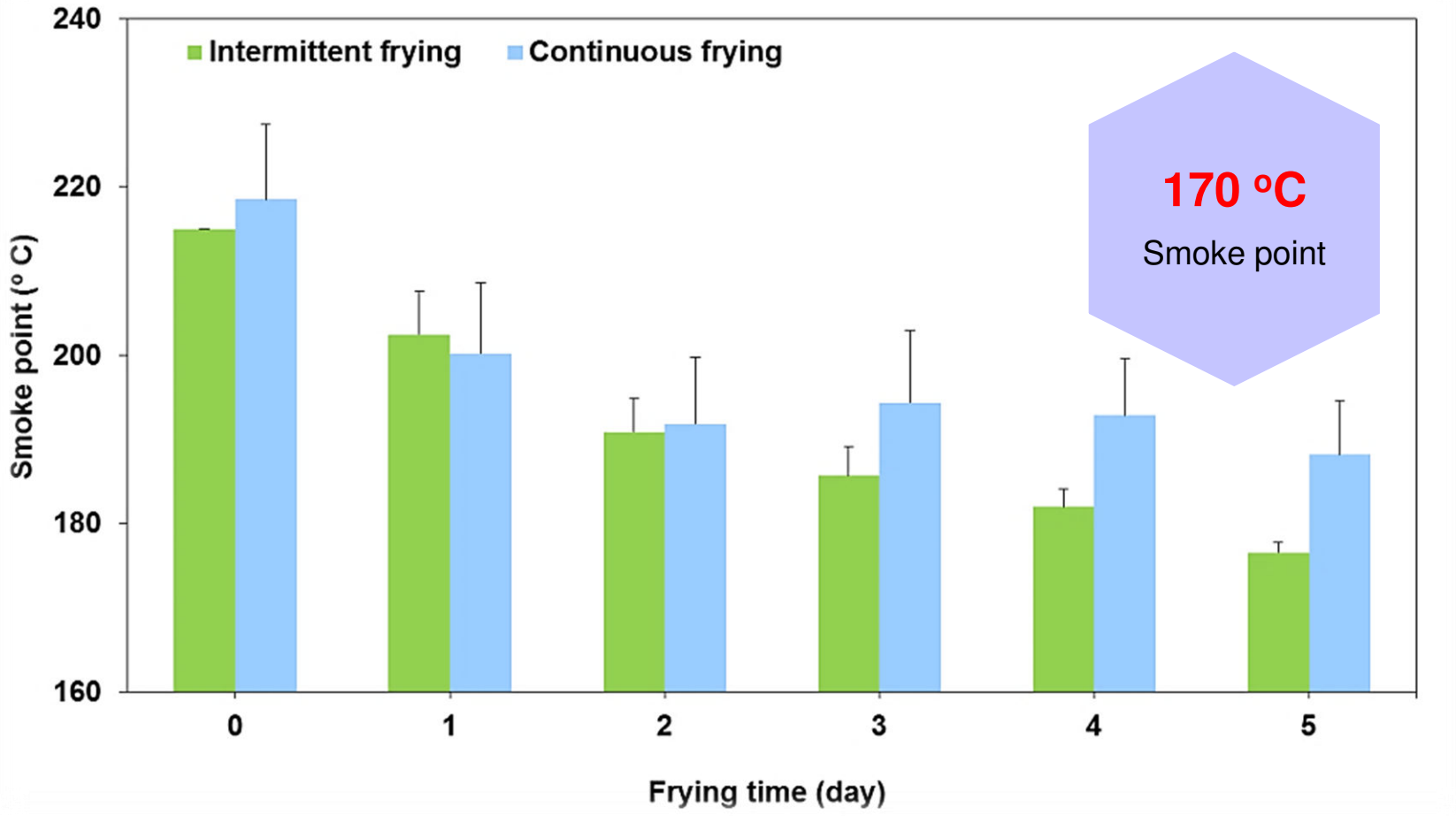


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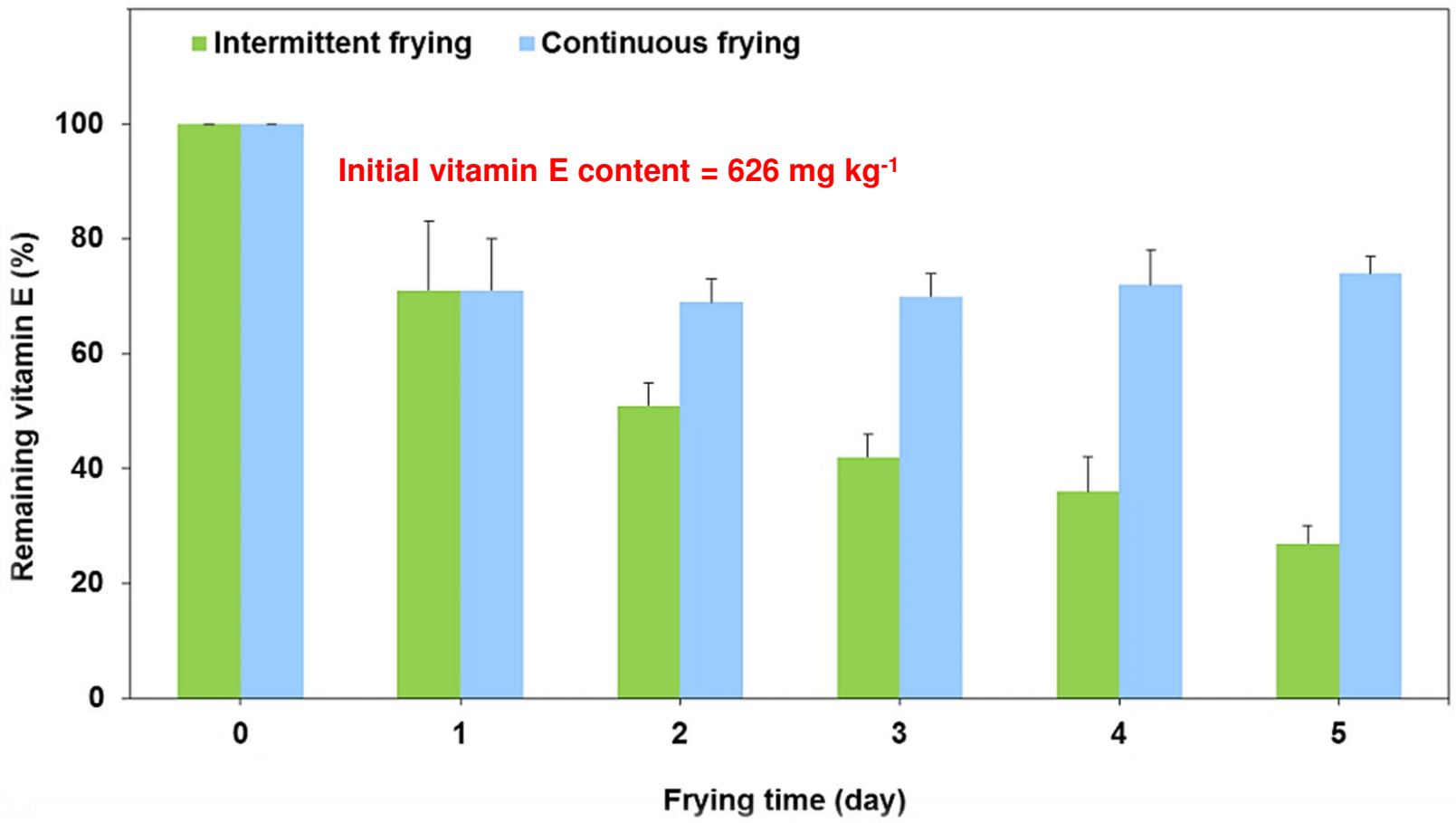
Free fatty acid



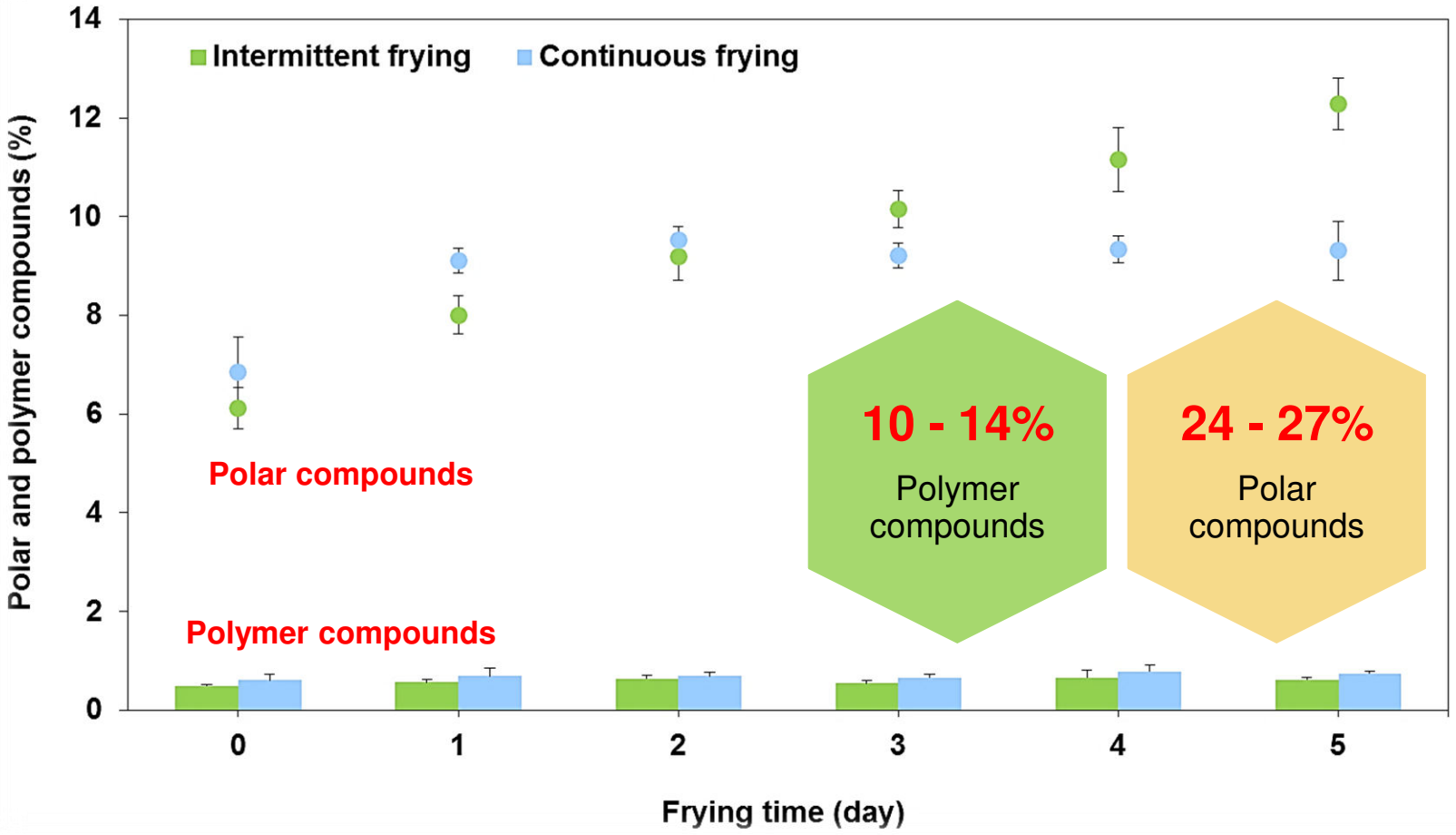
Smoke point


240
220
200
180
160
Smoke point (° C)
Intermittent frying
Continuous frying
0
1
2
3
4
5
Frying time (day)
170 °C
Smoke point

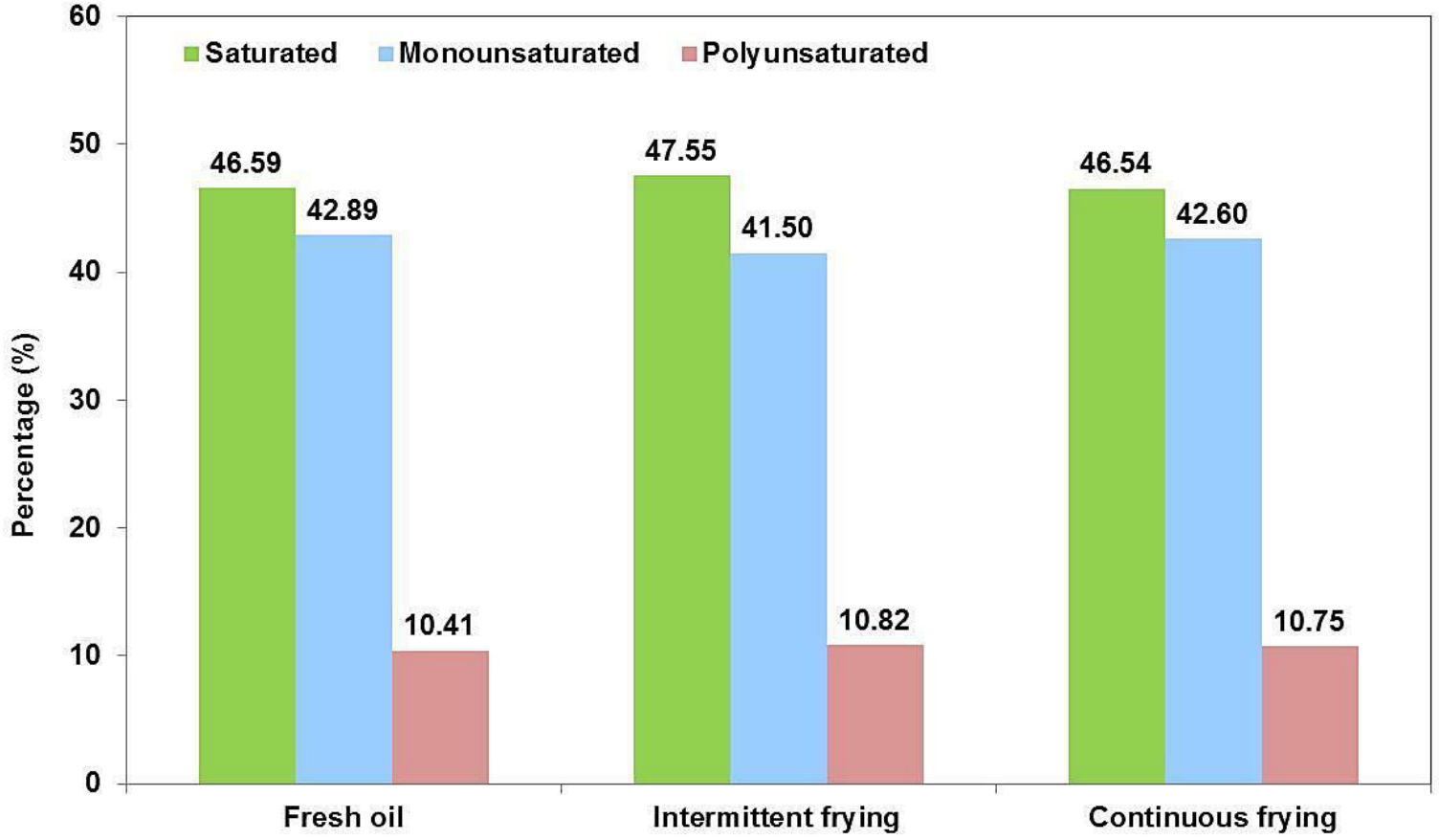
Vitamin E


Intermittent frying
Continuous frying
Initial vitamin E content = 626 mg kg-1
Remaining vitamin E (%)
100
80
60
40
20
0
0
1
2
3
4
5
Frying time (day)

Polar and polymer compounds



Fatty acids composition



Parameter	Fresh oil	Intermittent frying after 5 days	Continuous frying after 5 days
C18:2 / C16:0	0.25	0.26	0.26
Polyene index	0.22	0.23	0.23
Iodine value	56.9	56.5	57.4

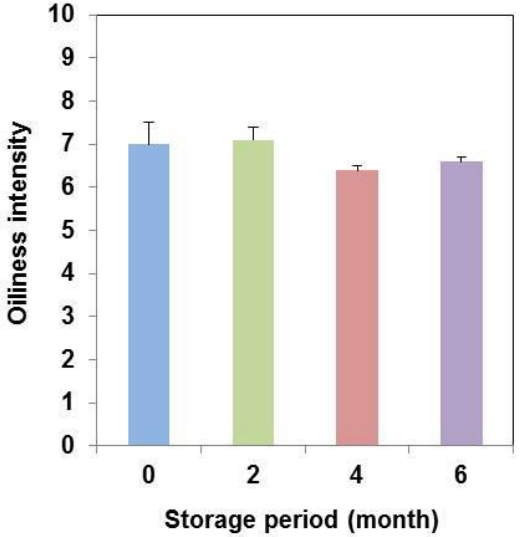
Other quality indices

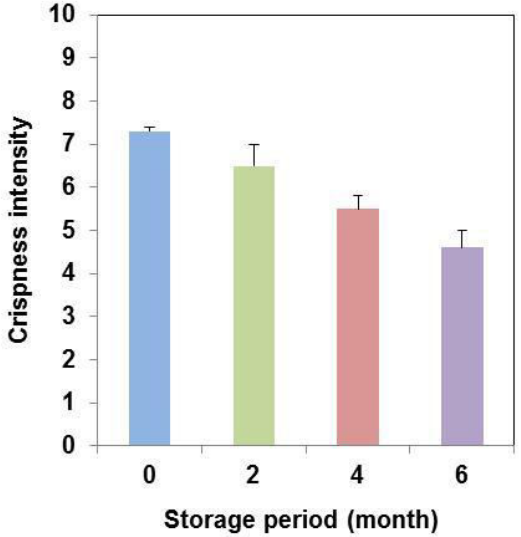
Parameters	Frying protocol	Fresh	Day 1	Day 3	Day 5
Peroxide value (meq O_2 kg^{-1})	Intermittent	1.2 ± 0.0	8.3 ± 1.9	7.8 ± 0.4	7.9 ± 0.3
	Continuous	1.0 ± 0.1	7.4 ± 2.0	4.4 ± 0.1	6.9 ± 2.8
***p*-anisidine value (unit)**	Intermittent	1.5 ± 0.2	15.9 ± 2.1	30.9 ± 2.0	42.0 ± 8.5
	Continuous	1.3 ± 0.1	12.5 ± 1.2	14.5 ± 3.5	18.8 ± 2.6
Totox value (unit)	Intermittent	5.9 ± 0.3	32.5 ± 5.3	46.5 ± 2.4	57.8 ± 9.0
	Continuous	3.3 ± 0.2	27.2 ± 5.0	23.2 ± 3.6	32.5 ± 3.1
Induction period (h)	Intermittent	26.5 ± 0.3	18.6 ± 1.7	14.3 ± 1.8	12.2 ± 1.4
	Continuous	27.4 ± 1.7	25.4 ± 1.5	23.5 ± 1.7	26.6 ± 0.8
Colour (R)	Intermittent	3.0 ± 0.0	4.8 ± 0.2	6.6 ± 0.3	8.9 ± 0.1
	Continuous	3.0 ± 0.1	10.9 ± 0.1	14.2 ± 0.1	17.1 ± 2.1

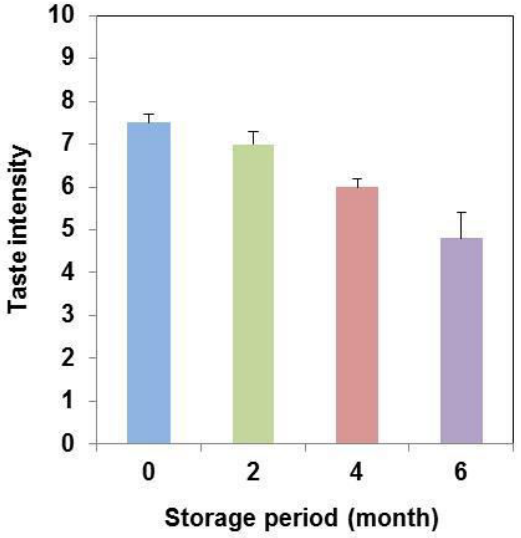
Storage stability test

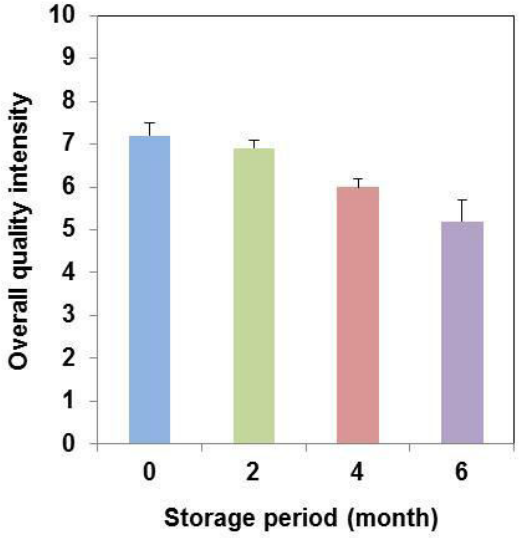
Parameters	Per 100 g
Energy (kcal)	412.5
Carbohydrate (g)	62.1
Protein (g)	23.0
Fat (g)	4.1
Dietary fibre (g)	17.9

Fatty acids	Chickpea oil
C16:0	11.69
C18:0	1.24
C18:1	20.89
C18:2	60.09
C18:3	4.19
Others	1.90
SFA	12.93
MUFA	20.89
PUFA	64.28
IV	133.4









Conclusions



"…Performance of palm olein was more pronounced when extruded product was processed using continuous frying system..."

"…Stability of the oil also reflected by the acceptable sensory properties of extruded product after 4 months of storage..."

"…Snack food manufacturers – particularly cottage industry – can opt to shift from conventional batch fryer to continuous frying system..."


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