

P A P E R S

Industrial frying trials with high oleic sunflower oil

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SUMMARY

Industrial frying trials with high oleic sunflower oil

High oleic sunflower oil has been developed for some special purposes where a good oxidation stability is needed and a healthy fatty acid profile is preferred. The oil is especially suitable for deep fat frying. These industrial frying trials with high oleic sunflower oil were part of the AIR-project CT 920687 "Utilisation of Sunflower Oils in Industrial Frying Operations". High oleic sunflower oil (HOSO) was tested against the traditional oils and fats in two industrial deep fat frying applications, namely crisps and prefried frozen french fries. The frying trials took place in Raisio Groups factories in Pyhäntä and Vihanti, Finland in 1993 and 1994.

According to the trials, high oleic sunflower oil is very suitable for deep fat frying. Problems occurred when a hard fat was substituted for a liquid oil in the preparation of prefrozen French Fries. These problems could be partly overcome by adjustments in the processing line.

KEY-WORDS: *Crisps – Deep fat frying – French fries – Frying fat – Frying oil – High oleic sunflower oil – Industrial frying.*

1. INTRODUCTION

Liquid vegetable oils are still not widely used in industrial deep fat frying even if there is a certain consumer demand towards them due to some possible adverse health effects of saturated and trans fatty acids.

The aim of this study was to determine whether it is safe or practical to use liquid oils in frying French fries and crisps and to offer new products with better nutritional value in the future.

Prefried frozen French fries and crisps were chosen as the tested products because French fries are widely consumed in increasing amounts and crisps contain high amounts of fat, normally c.a. 30% w/w. Normal and high oleic sunflower oils were tested against palm oil and a hydrogenated mixture of rapeseed and palm oil.

The study was divided into five parts, namely, industrial trials, laboratory scale trials, chemical analyses of the final products, nutritional and toxicological studies and sensory evaluations. This article is covering up the industrial trials of French fries and crisps.

2. INDUSTRIAL FRYING OF CRISPS

Industrial fryings of crisps were done during May 1993 and parts of them were repeated in October 1994 (new samples for sensory analyses) in Raisio Groups crisp factory in Pyhäntä, Finland.

2.1. Frying equipment

The production scheme of frying crisps is shown in Figure 1. A continuous fryer was used where new oil is automatically added to the fryer to keep the oil level within certain limits. The dimensions of the fryer are shown in Table I.

Table I
Dimensions of the fryer for crisps

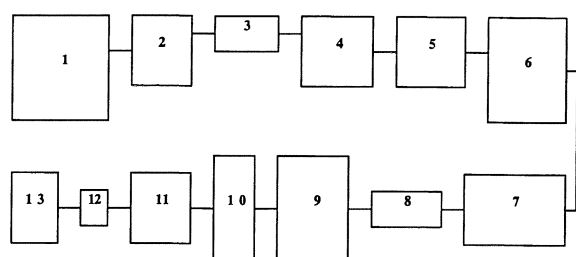
Volume	700 L
Length	550 cm
Width	50 cm
Surface area	2.75 m ²
Depth (oil layer)	22 to 26 cm *

* varies due to refilling

2.2. Oils

Palm olein (PO), which is quite commonly used for industrial deep fat frying and normally used in this very factory, was used as a reference oil. Two different oils, normal sunflower oil (SO) and high oleic sunflower oil (HOSO), with and without a protective agent, dimethyl polysiloxane (DMPS), were tested for crisps.

The fatty acid compositions of the used oils are shown in Table II. The test oils were delivered by Medeol, France and the reference oil by Raisio Group, Finland.



- | | |
|---|--|
| 1. Loading | 8. Washing and rinsing off the sugars etc |
| 2. Stone separator | 9. Frying (180°C appr. 90 sec.) |
| 3. Mechanical peeling | 10. Salting |
| 4. Washing | 11. Rotating mixer |
| 5. Slicing by rotating blades (1,5 mm.) | 12. Visual check point |
| 6. Washing | 13. Packing (175 g and 300 g aluminum coated foil) |
| 7. Cooking | |

Figure 1
Industrial process for frying crisps

Table II
Fatty acid compositions of oils used
for frying crisps (%)

Fatty acid	PO	SO	HOSO
C14:0	0.8	-	-
C16:0	34.4	6.8	4.5
C18:0	3.8	4.9	4.3
C18:1	46.4	21.4	72.4
C18:2	12.8	65.1	16.9
C18:3	0.7	0.1	0.1
Others	≈ 1	≈ 2	≈ 2

2.3. Frying set up

The fryings were carried out in the following three groups:

Group 1	PO	SO	HOSO
Group 2	PO	SO	SO + DMPS
Group 3	PO	HOSO	HOSO + DMPS

Crisps were produced in two shifts per day (10 hours of effective frying) and each oil was used for two days (= 20 hours). The oil was pumped out from the fryer and let to cool down overnight.

2.4. Frying conditions

Frying conditions are shown in Table III.

Table III
Frying conditions of crisps

Frying temperature	180°C
Production rate of the crisps	140 Kg / h
Oil consumption	48 Kg / h
Total turnover rate	13 h

2.5. Sampling

Samples of each oil were taken out from the fryer after 0, 5 10, 15 and 20 hours of frying for chemical analyses and nutritional studies. Crisp samples for storage tests were taken out after 10 hours and 20 hours of frying. Samples were coded by a system shown in Table IV.

Table IV
Sample coding system for crisps and French fries

	Crisps:	French fries:
Level 1	IC = Industrial sample from frying crisps	IF = Industrial sample from frying French fries
Level 2	O = Oil F = Food	O = Oil F = Food
Level 3	1 = Group 1 2 = Group 2 3 = Group 3	RP = Hydrogenated rapeseed/palm oil mixture SO = Sunflower oil HOSO = High oleic sunflower oil
Level 4	PO = Palm olein SO = Sunflower oil HOSO = High oleic sunflower oil	0 = Sample before frying 1 = Sample after 1 day of frying 2 = Sample after 2 days of frying
Level 5	DMPS or A = DMPS added to the oil - = no DMPS added	* Ref. 1 = RP before test oils * Ref. 2 = RP after test oils
Level 6	0 = Sample before frying 1 = Sample after 1 day of frying 2 = Sample after 2 days of frying	* Only for sensory and headspace analyses
Examples	ICO1HOSODMPSO= High oleic sunflower oil with added antioxidant belonging to group 1 before frying crisps	IFOSO2 = Sunflower oil used 2 days for frying French fries

2.6. Observations

No major problems occurred during the trials. All oils tested were suitable for frying crisps and the process parameters could be kept the same as those with reference oil.

The quality (oxidation/hydrolysis) of all the oils after 20 hours of frying was very good due to the high turnover rate (every 13 hours). This clearly shows that a continuous process can be run with these oils without a need for oil change.

The only practical problem was the varying sugar content of the potato raw material. It was caused by starch, which starts to break down into simple sugars

during long storage (trials were done in May 1993, with potatoes from 1992 crop). Sugars give the final product a brownish colour and also a slightly different texture. To minimise this effect the potatoes used in the trials were chosen by their sugar contents and the washing step in the process was improved. Even with these measures all the variations could not be fixed.

The protective agent DMPS did not have any noticeable effect in frying.

2.7. Conclusions

From a technical and practical point of view, high oleic sunflower oil as well as normal sunflower oil can be used equally to the reference palm olein in crisp frying.

Adding a protective agent (DMPS) did not have any positive or negative effect on frying performance in the continuous frying process used.

3. INDUSTRIAL FRYING OF PREFRIED FROZEN FRENCH FRIES

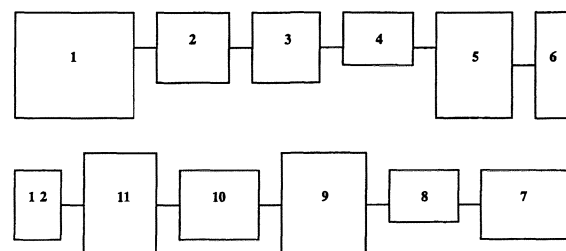
Industrial fryings of prefried frozen French fries were first started at Raisio Groups factory in Vihanti, Finland in the beginning of February 1994, but they were soon stopped after running into problems in the processing. The problems were mainly due to excessive oiling of the product even after freezing. To overcome and minimise these problems the following changes were done:

- * only deep frozen products were produced packed in plastic packing instead of cartons that would have got wet.
- * the production rate was decreased to improve crystallisation of the fat (from 2000 to 1500 kg per hour).
- * the test period was limited to two days with each oil/fat instead of the planned five days.

The tests were restarted on April 19th 1994 and they were successfully finished by May 5th.

3.1. Frying equipment

The production scheme of frying French fries is shown in Figure 2. A continuous fryer was used with automatic refilling as with crisps. The dimensions of the fryer are shown in Table V.



- | | |
|--------------------------|----------------------------------|
| 1. Loading | 7. Cooking |
| 2. Steam peeling | 8. Washing |
| 3. Washing | 9. Drying |
| 4. Sorting by size | 10. Frying (180°C, appr. 30 sec) |
| 5. Slicing | 11. Freezing (-20° C) |
| 6. Automatic check point | 12. Packing (500 g plastic bags) |

Figure 2
Industrial process for frying French Fries

Table V
Dimensions of the fryer for French fries

Volume	400 L
Length	250 cm
Width	80 cm
Surface area	2 m ²
Depth (oil layer)	17 to 20 cm *

* varies due to refilling

3.2. Oils/fats

Partially hydrogenated rapeseed/palm oil mixture (RP) was used as a reference. Test oils were the same as with crisps: sunflower oil and high oleic sunflower oil. The protective agent DMPS was not tested with French fries. Tested oils were delivered by Medeol, France and the reference fat by Raisio Group, Finland.

3.3. Frying set up

The fryings were done continuously in three shifts. Each oil was used for two days (48 hours) for frying. The potato variety used was Swedish Sabina except for the reference samples before studied oils a Dutch variety Record was used.

3.4. Frying conditions

Frying conditions are shown in Table VI.

Table VI
Frying conditions of French fries

Frying temperature	180°C
Production rate of the French fries	1500 Kg / h
Oil consumption	100 Kg / h
Total turnover rate	3.4 h

Because of the quick turnover of the oil, the test could be limited from five to two days per oil.

3.5. Sampling

The oil and fat samples were taken out from the fryer after 0, 4, 8, 12, 24 and 48 hours of frying for chemical analyses and nutritional studies. Samples of prefried French fries for shelf life tests were taken out after 24 and 48 hours of frying. Samples were coded by a system shown in table IV.

3.6. Observations

After the modifications to the process the trials went well. The turnover rate was high so the oils remained very good throughout the trials. The products fried in liquid oil had an oily structure but, in normal use (heating in an oven before serving), this

did not make any marked difference. The products were normally sold in Finnish markets.

3.7. Conclusions

High oleic and normal sunflower oil (liquid oils) can be used with some limitations and possible modifications on the processing of prefried frozen French fries. However, hard fats are easier to handle in processing and might be even necessary if the product is stored in temperatures higher than freezer temperature.

4. DISCUSSION

These industrial trials were part of a large AIR study in which the storage stability and nutritional aspects of the products fried in different oils were also studied. The results have been and will be published as separate articles in various publications.

ACKNOWLEDGMENTS

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