

Food Ingredient Solutions, LLC.

Analysis

**Preserving vegetable oil with food
at frying temperature
with FRY AntiOx+ versus untreated oil**

Summary of results

- **Soybean oil with battered shrimp – 360°F : Page 5**

=> 33 % with FRY AntiOX+ 800 ppm and 66 % with 1000ppm of the frying time of the oil versus the non treated oil

- **Mid-oleic sunflower oil with fried chicken – 350°F : Page 9**

=> 80 % with FRY AntiOX+ 500 ppm of the frying time of the oil versus the non treated oil

- **Mid-oleic sunflower oil with potato chips – 350°F : Page 13**

=> 42 % with FRY AntiOX+ 800 ppm of the frying time of the oil versus the non treated oil

- **Soybean oil with breaded pickles – 360 F : Page 17**

=> 25 % with FRY AntiOX+ 800 ppm and 62 % with 1000 ppm of the frying time of the oil versus the non treated oil

Analysis methods

● **Measuring polar compounds (TPM) is one of the indicators of the fryer oil's degradation. Therefore, the polar compounds rate in the oil reflects its level of deterioration and of triglycerides dissociation, thus indicating the fried food level of safety. It is measured through a probe tester in the fryer oil.**

Per European Union regulation, a maximum of 25% of polar compounds in fryer oil is authorized. Beyond that level, the oil is not edible, as it has become toxic.

● **The free fatty acids (FFA) are more prone to oxidation and to turning rancid. Thus, FFA is a key feature linked with the quality and commercial value of oils and fats.**

Maximum amount authorized is generally 0.6%.

Analysis methods

- **Measuring the peroxide value (PV) is the usual method to evaluate the primary oxidation level of the unsaturated fatty acids in fat.**

It indicates the milliequivalent of active oxygen contained in 1kg of vegetable oil.

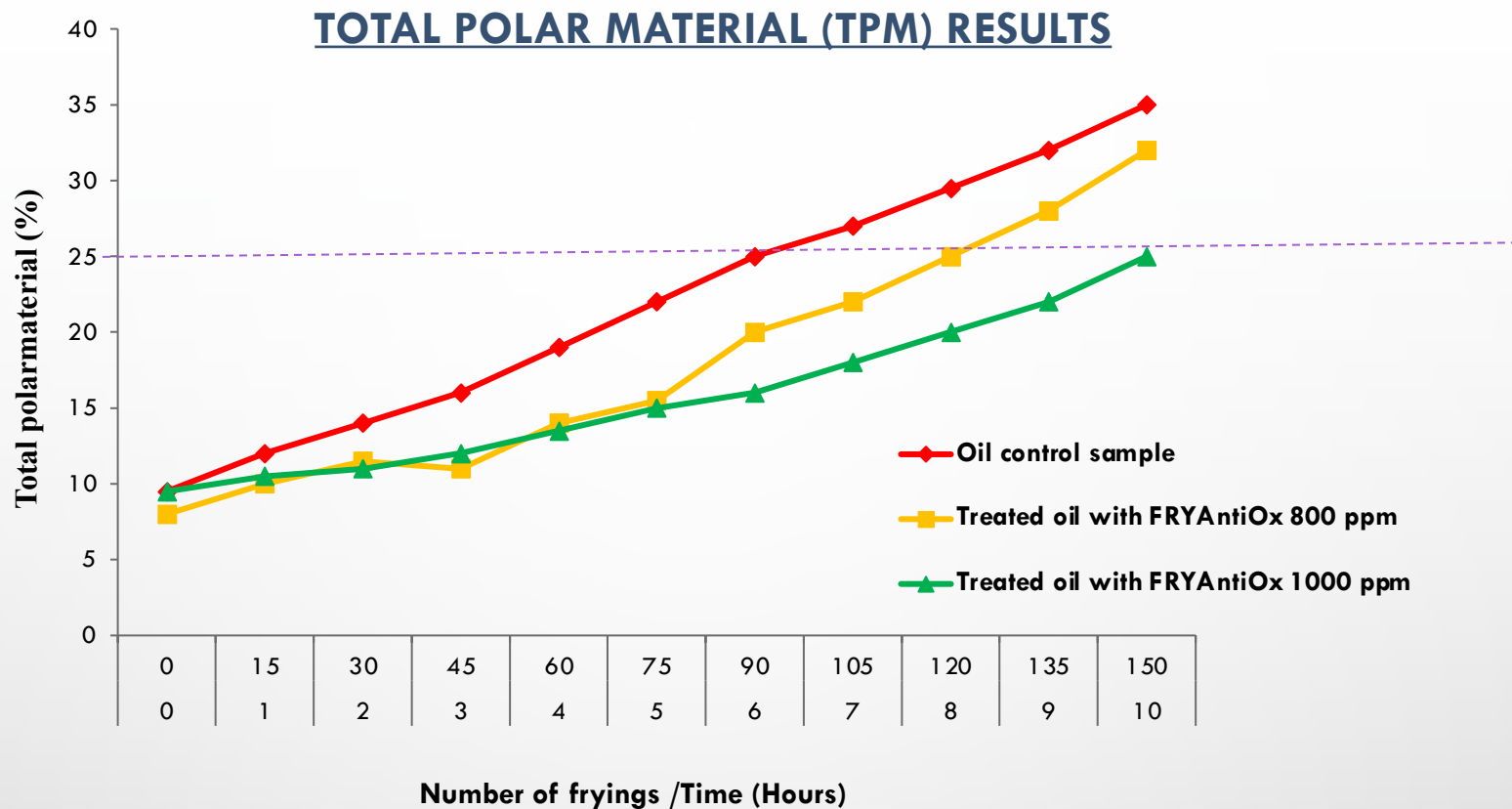
The higher the level, the more the fat is oxidized.

Test : Oxidation kinetics of soybean oil with battered shrimp – 360 F

Protocol

- 1
 - Treating the soybean oil with FRY AntiOx+ at 800 and at 1000 ppm.
 - Control sample : same with no preservative
- 2
 - Heating oil in a fryer at 360°F
- 3
 - Measuring the TPM rate at t_0 : oil reaches 360 F and 1st frying starts. Weight ratio: Shrimp 1/oil 100
- 4
 - Measuring TPM
- 5
 - Analyzing the Free Fatty Acid
- 6
 - Analyzing the Peroxide Value
- 7
 - Tests are stopped when TPM rates in all samples reach the maximum authorized level of 25%

Test : Oxidation kinetics of soybean oil with battered shrimp – 360 F

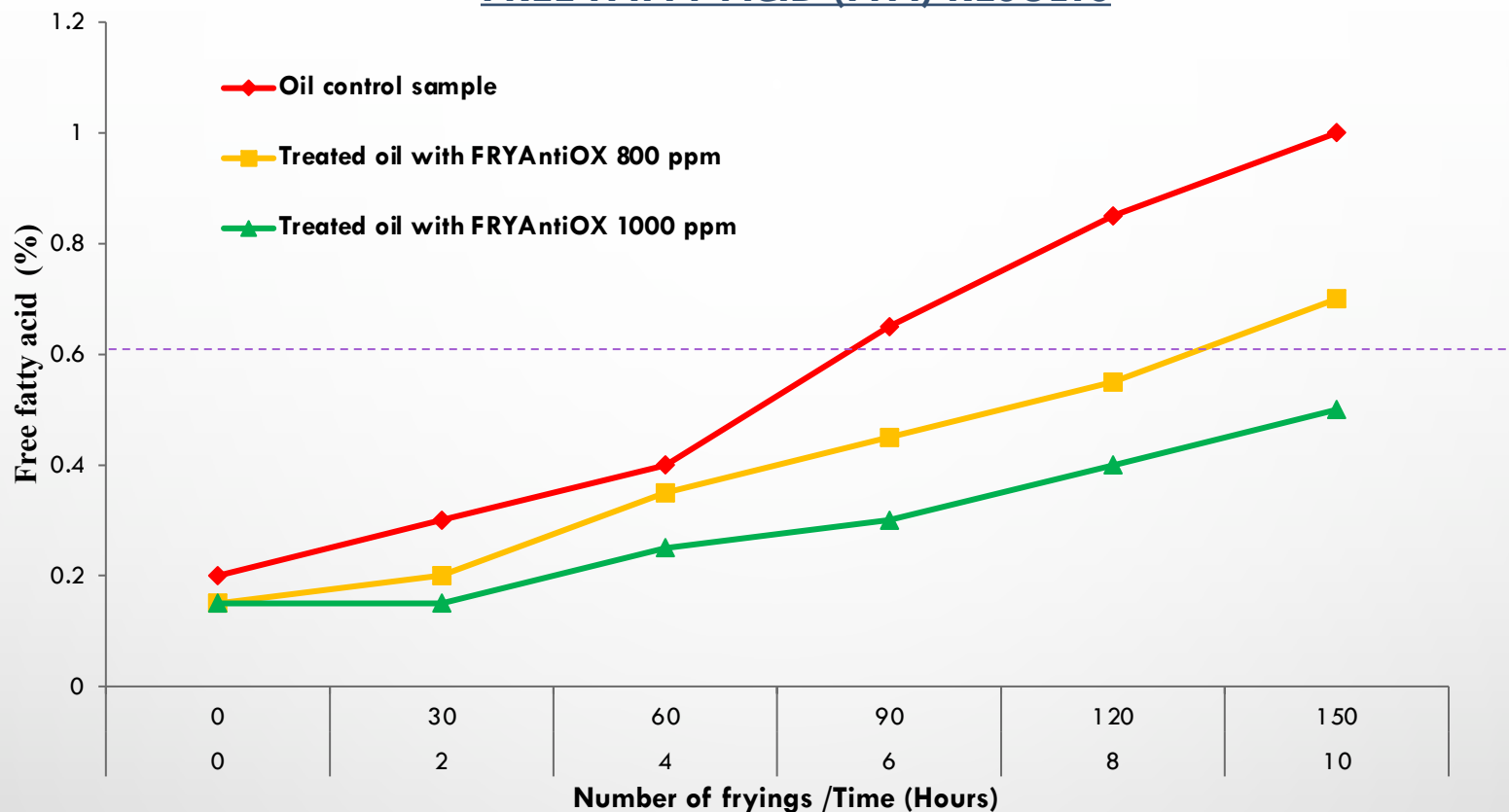


Graph 1: Oxidation kinetics in soybean oil with Shrimp -360F- TPM

**The control sample reaches the maximum amount of 25%TPM at 6 hours.
The oil treated with 800 ppm FRY AntiOx+ reaches the maximum TPM level after 8 hours.
The oil treated with 1000 ppm FRY AntiOx+ reaches 25% TPM after 10 hours, 2 hours later than with 800 ppm FRY AntiOX+ and 4 hours later than the control sample.**

Test : Oxidation kinetics of soybean oil with battered shrimp – 360 F

FREE FATTY ACID (FFA) RESULTS



Graph 2 : Oxidation kinetics in soybean oil with Shrimp - 360F - FFA

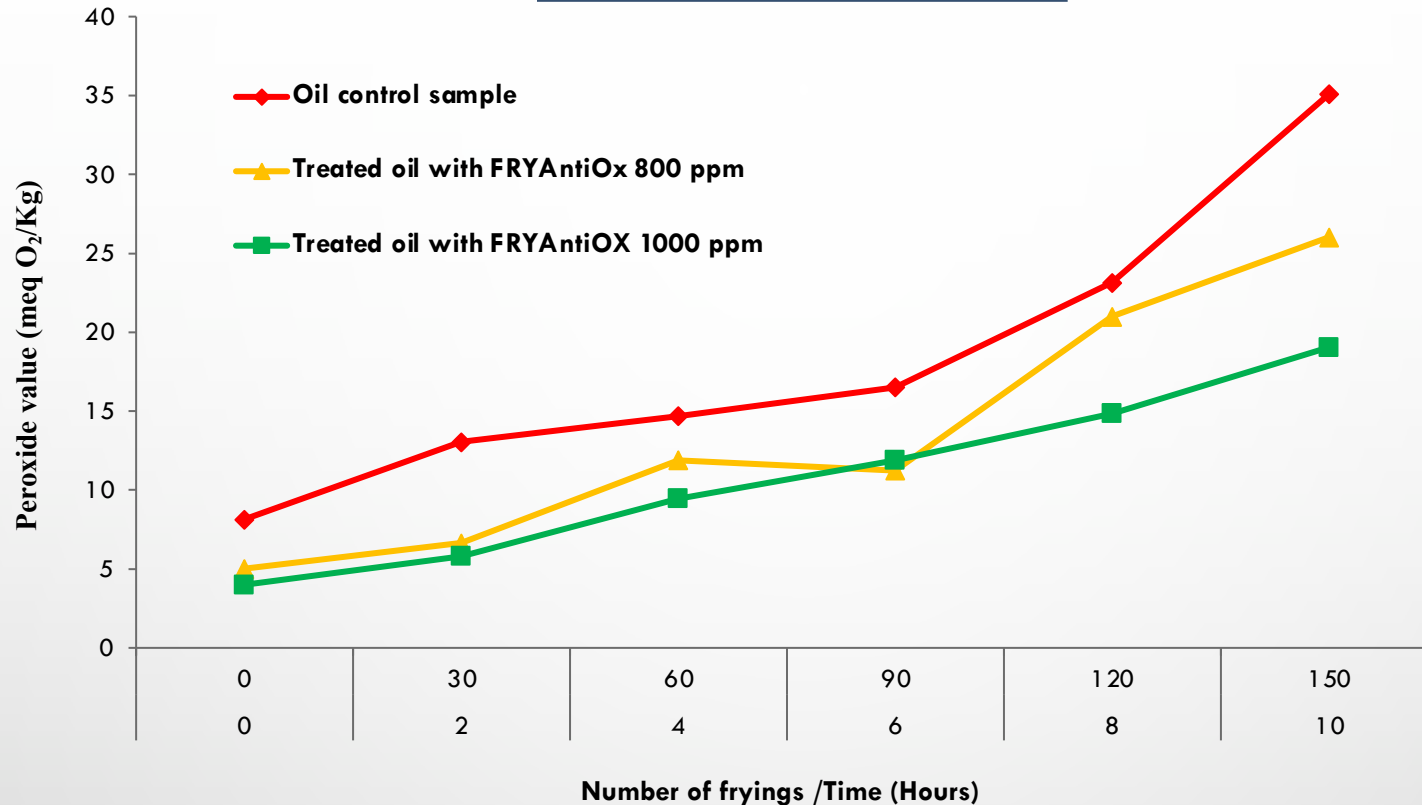
After 6 hours of frying, the control sample has already exceeded 0.6%, the maximum authorized.

The oil treated with 800 ppm FRY AntiOx+ reaches the same level at around 9 hours.

The oil treated with 1000 ppm FRY AntiOx+ reaches 0.6% after 10 hours of frying.

Test : Oxidation kinetics of soybean oil with battered shrimp – 360 F

PEROXIDE VALUE RESULTS



Graph 3 : Oxidation kinetics in soybean oil with Shrimp - 360F - Peroxide value

Throughout the kinetics, the peroxide value of the oil treated with the FRYAntiOX+ is consistently lower than that of the control sample.

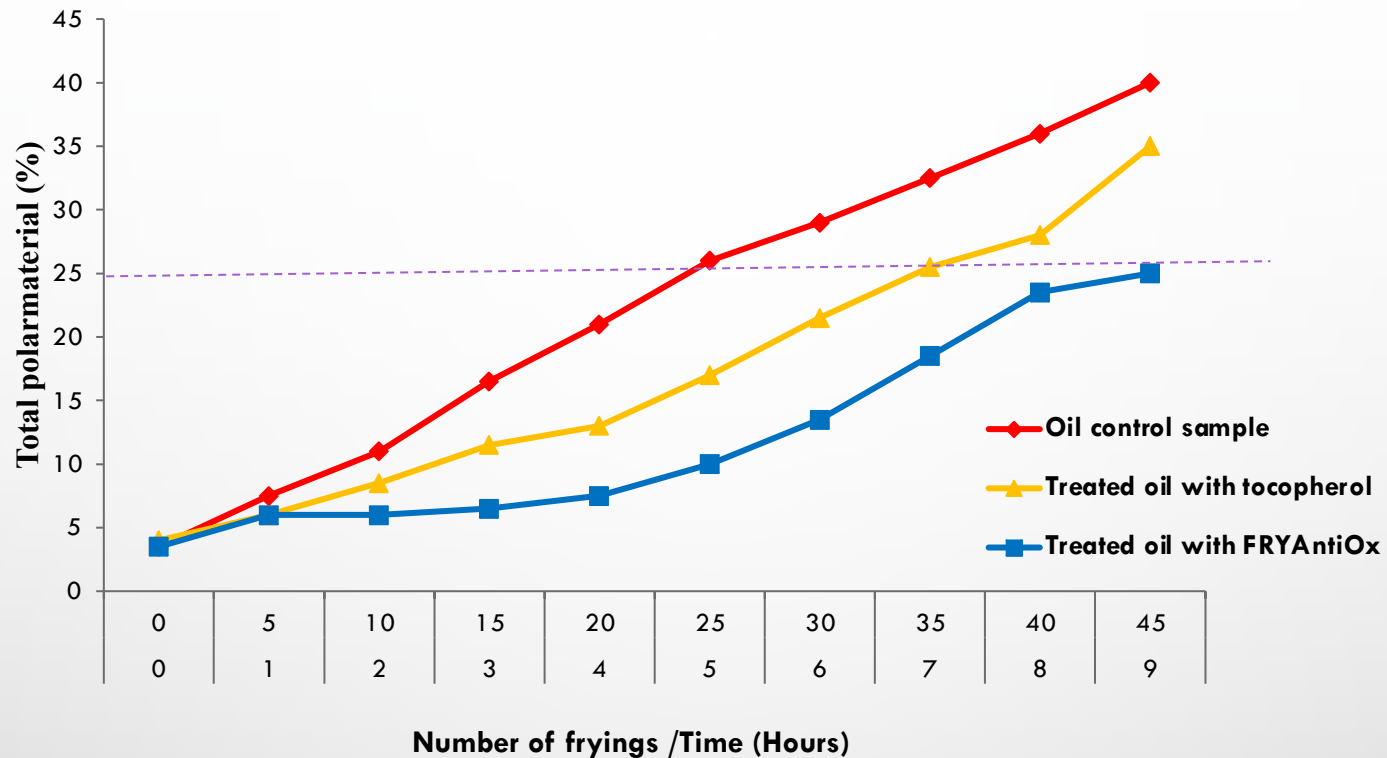
At 10 hours of frying, the peroxide value of the oil treated with 1000 ppm FRY AntiOx + grows slowly, reaching 19 meq O₂/kg, with 800 ppm FRYAntiOX+, it reaches 26 meq O₂/kg, , while that of the control sample increases to 35 meq O₂/kg.

Test : Oxidation kinetics of mid-oleic sunflower oil with fried chicken – 350°F

Protocol

- 1 • Treating the mid-oleic sunflower oil with tocopherol and with FRY AntiOx+ (500 ppm). Control sample : same with no preservative
- 2 • Heating oil in a fryer at 350°F
- 3 • Measuring the TPM rate at t_0 : oil reaches 350°F and 1st frying starts. Weight ratio: Chicken 1/oil 10
- 4 • Measuring TPM
- 5 • Analyzing the Free Fatty Acid
- 6 • Analyzing the Peroxide Value
- 7 • Tests are stopped when TPM rates in all samples reach the maximum authorized level of 25%

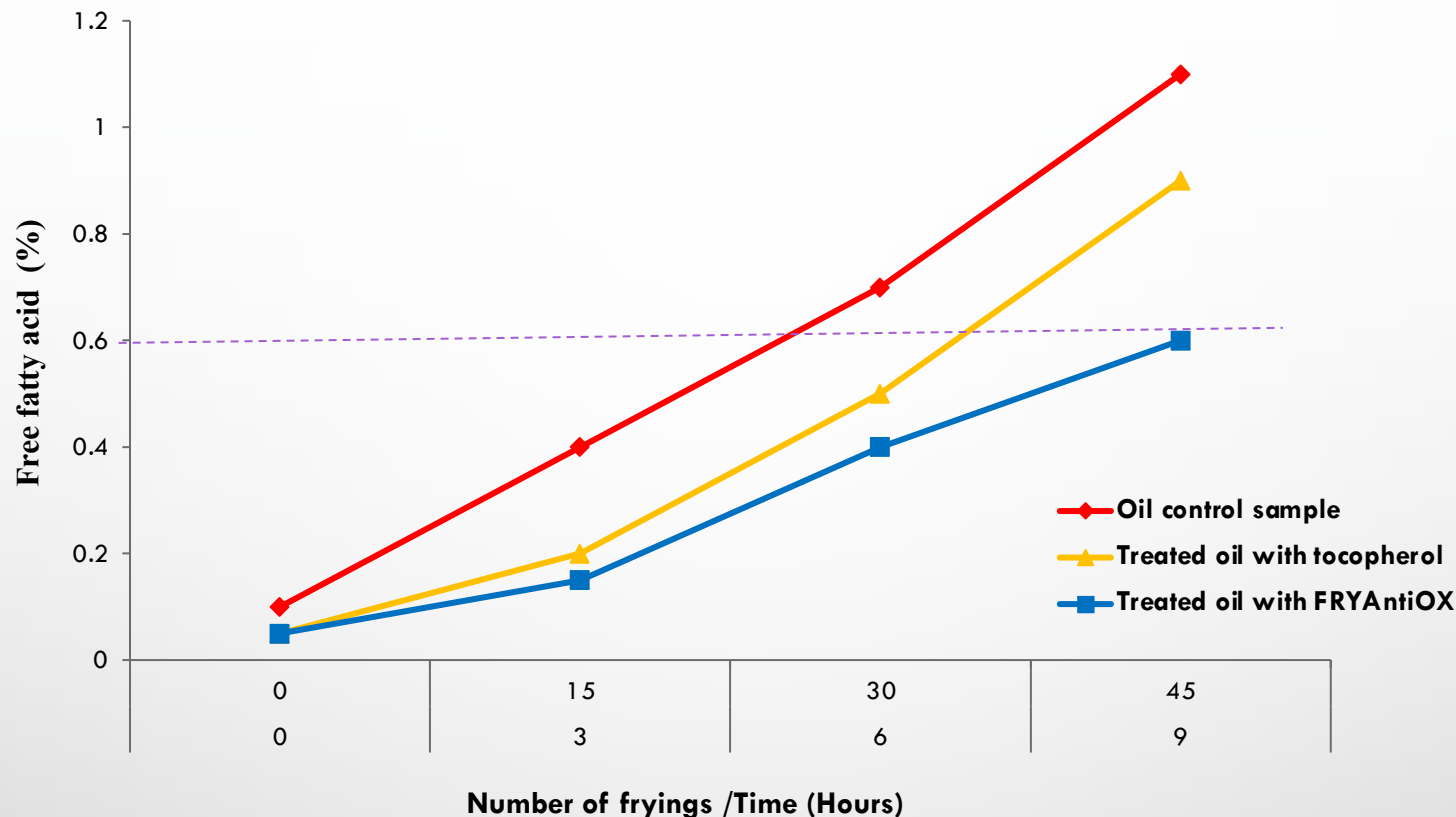
TOTAL POLAR MATERIAL (TPM) RESULTS



Graph 1: Oxidation kinetics in mid-oleic sunflower oil with fry chicken -350°F- TPM

The control sample reaches the maximum amount of 25%TPM at 5 hours.
The oil treated with tocopherol reaches the maximum TPM level after 7 hours.
The oil treated with FRY AntiOx+ reaches 25% TPM after 9 hours, 2 hours later than with tocopherol and 4 hours later than the control sample.

FREE FATTY ACID (FFA) RESULTS

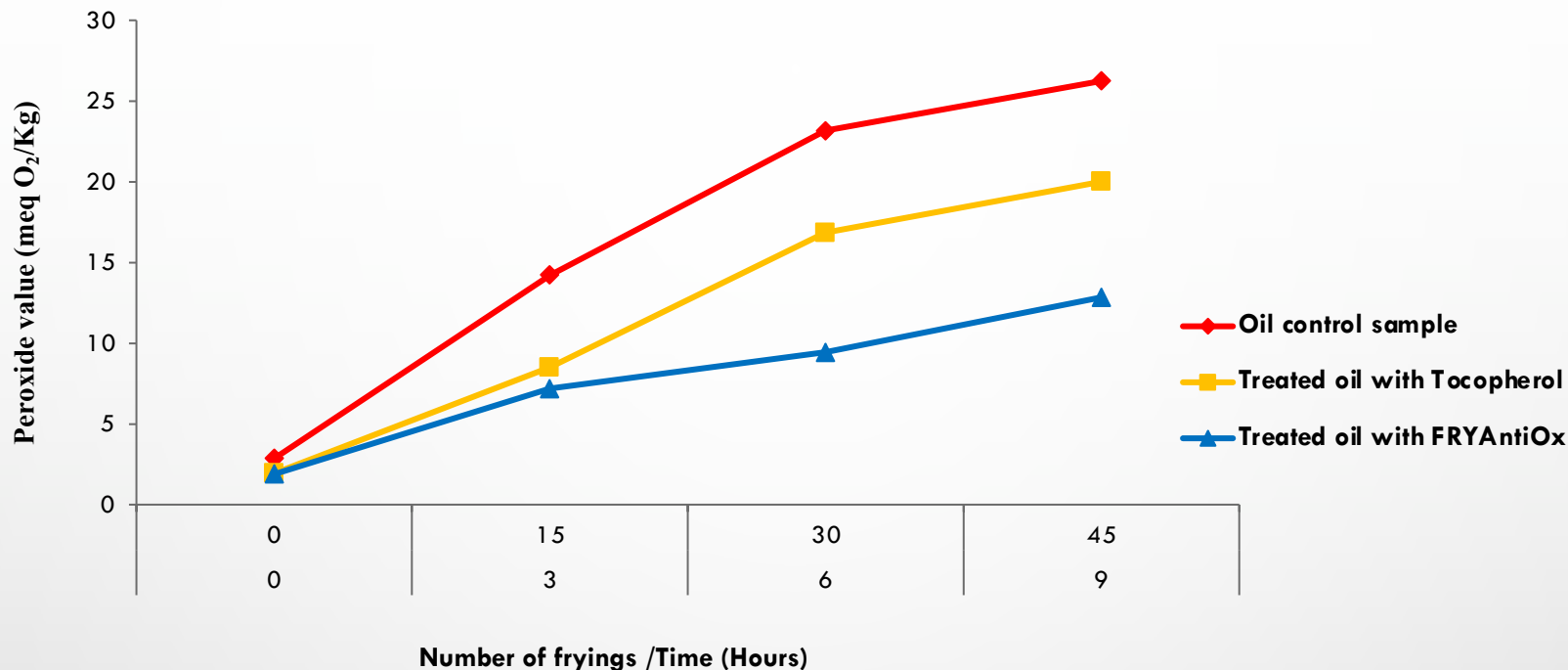


Graph 2 : Oxidation kinetics in mid-oleic sunflower oil with fry chicken -350°F- FFA

**At around 5 hours, the control sample reaches 0.6%, the maximum authorized.
The oil treated with the tocopherol reaches the same level at around 7 hours.
The oil treated with FRY AntiOx+ reaches 0.6% at 9 hours of frying.**

Test : Oxidation kinetics of mid-oleic sunflower oil with fried chicken – 350°F

PEROXIDE VALUE RESULTS



Graph 3 : Oxidation kinetics in mid-oleic sunflower oil with fry chicken - 350°F - Peroxide value

At 6 hours of frying, the peroxide value of the oil treated with FRY AntiOx + does not exceed 10 meq O₂/kg, while that of the control sample increases to 23 meq O₂/kg (2 times more), and with tocopherol treatment, the peroxide value reach 16 meq O₂/kg;

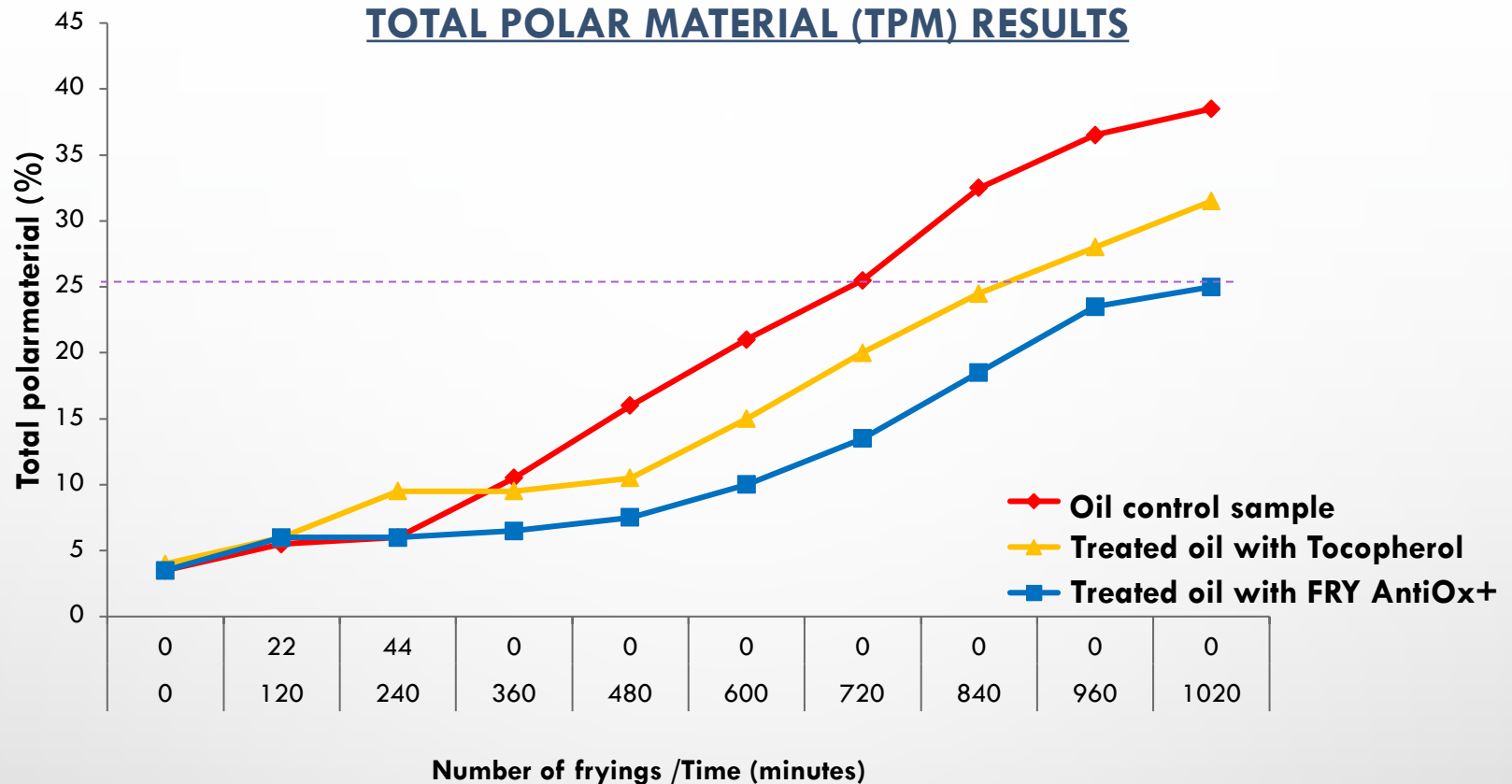
After 9 hours, this difference between the 3 peroxide values can still be observed : 12 meqO₂/kg for the treated oil with FRY AntiOx+, 20 meqO₂/kg for the treated oil with Tocopherol and 26 meqO₂/kg for the control sample.

Test 3 : Oxidation kinetics of mid-oleic sunflower oil with potato chips – 350°F

Protocol

- 1 • Treating the mid-oleic sunflower oil with tocopherol and with FRY AntiOx+ (800 ppm). Control sample : same with no preservative
- 2 • Heating oil in a fryer at 350°F
- 3 • Measuring the TPM rate at t_0 : oil reaches 350°F and 1st frying starts. Weight ratio: Chips 1/oil 10
- 4 • After 44 fryings, heating without food at 350°C until 25% ppm is reached
- 5 • Measuring TPM
- 6 • Analyzing the Free Fatty Acid
- 7 • Analyzing the peroxide value
- 8 • Tests are stopped when TPM rates in all samples reach the maximum authorized level of 25%

Test 3 : Oxidation kinetics of mid-oleic sunflower oil with potato chips – 350°F



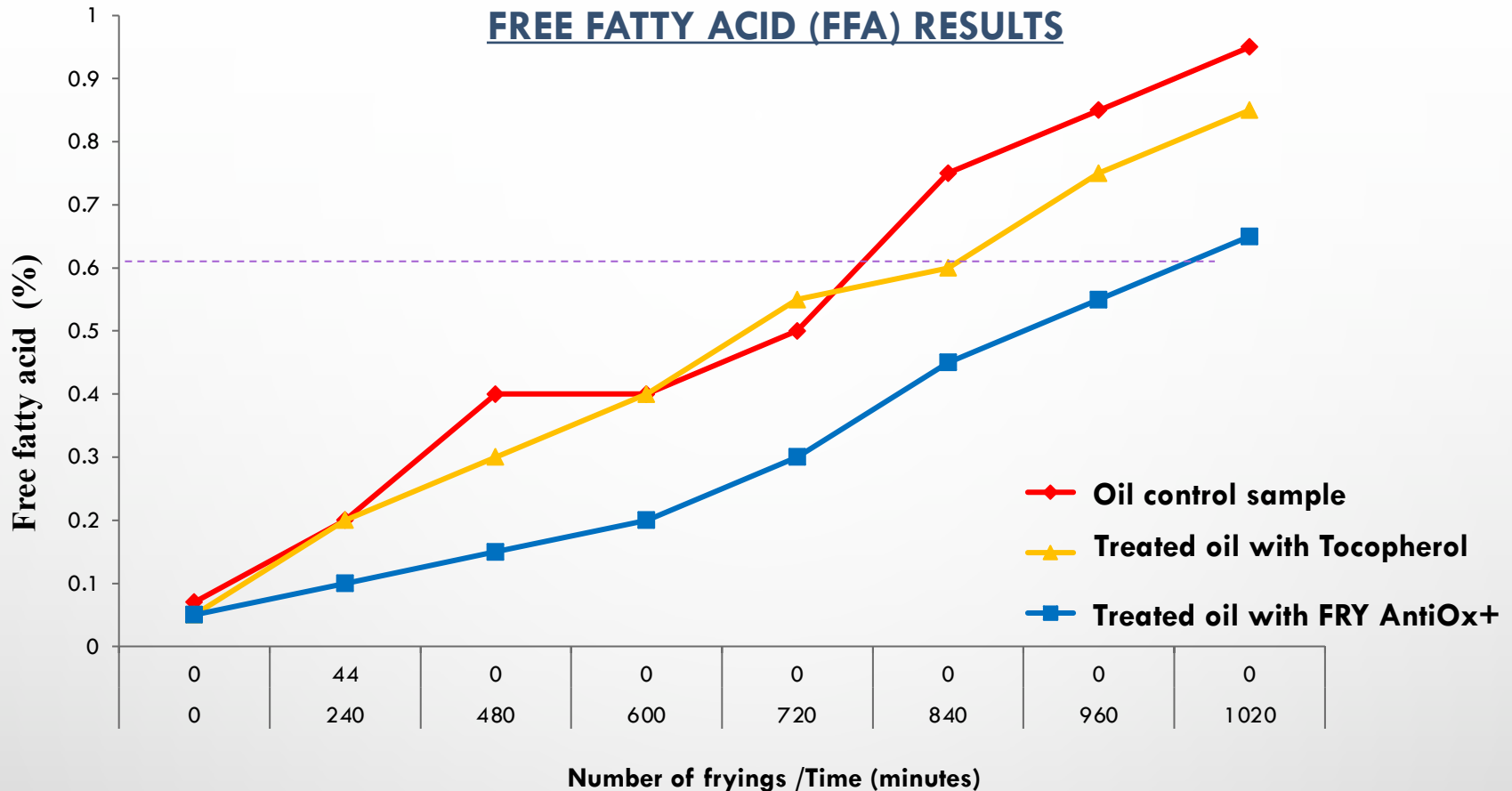
Graph 3: Oxidation kinetics in mid-oleic sunflower oil with chips -350°F- TPM

The control sample reaches the maximum amount of 25%TPM at 720 min.

The oil treated with tocopherol reaches the maximum TPM level after 840 min.

The oil treated with FRY AntiOx+ reaches 25% TPM after 1020 minutes, 180 minutes later than with tocopherol and 300 minutes later than the control sample.

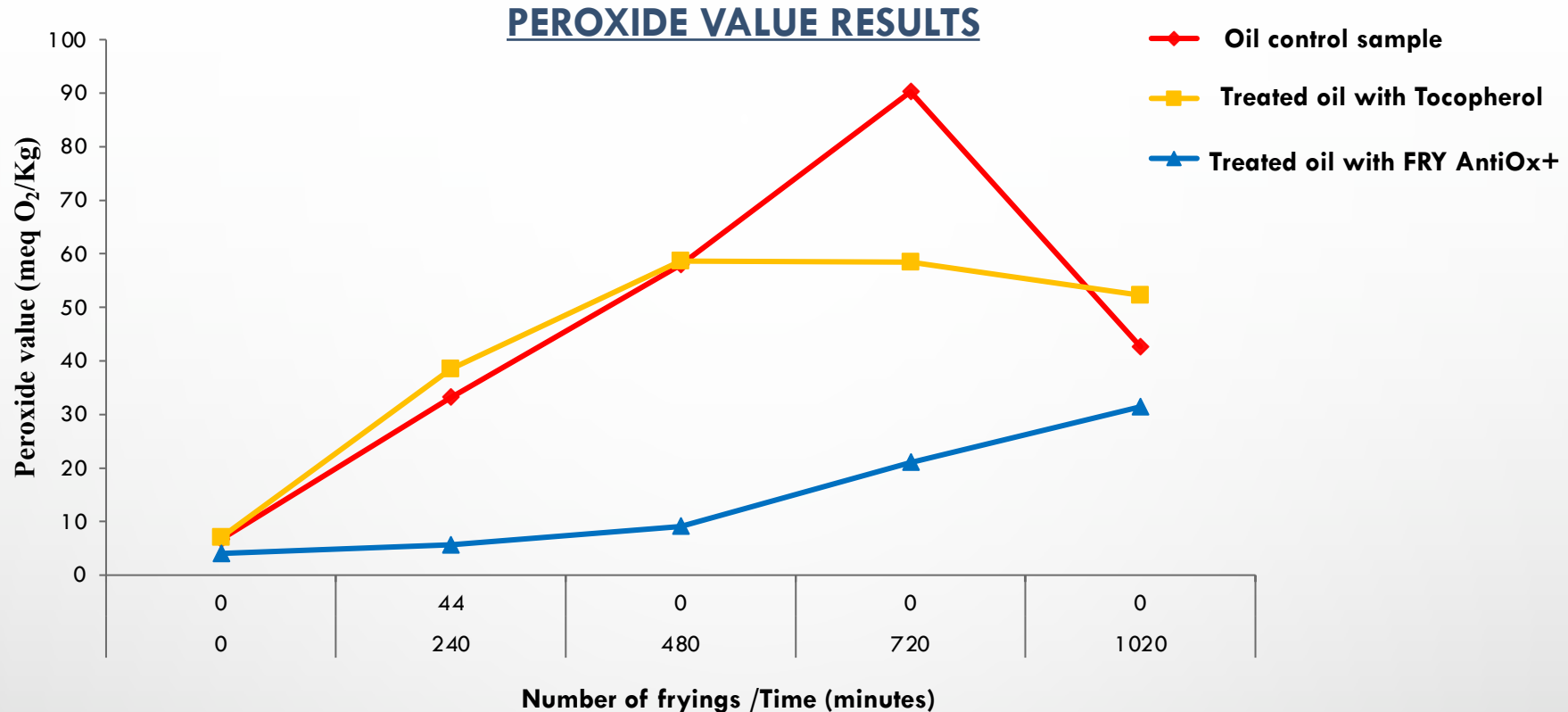
Test 3 : Oxidation kinetics of mid-oleic sunflower oil with potato chips – 350°F



Graph 4 : Oxidation kinetics in mid-oleic sunflower oil with chips -350°F- FFA

**At around 780 min, the control sample reaches 0.6%, the maximum authorized.
The oil treated with the tocopherol reaches the same level at around 840 min.
The oil treated with FRY AntiOx+ reaches 0.6% at 990 min.**

Test 3 : Oxidation kinetics of mid-oleic sunflower oil with potato chips – 350°F



Graph 5 : Oxidation kinetics in mid-oleic sunflower oil with chips - 350°F - Peroxide value

At 480 min of frying and heating, the peroxide value of the oil treated with FRY AntiOx + remains steady and does not exceed 10 meq O₂/kg, while that of the control sample and tocopherol treatment grows fast up until 59 meq O₂/kg (6 times more);

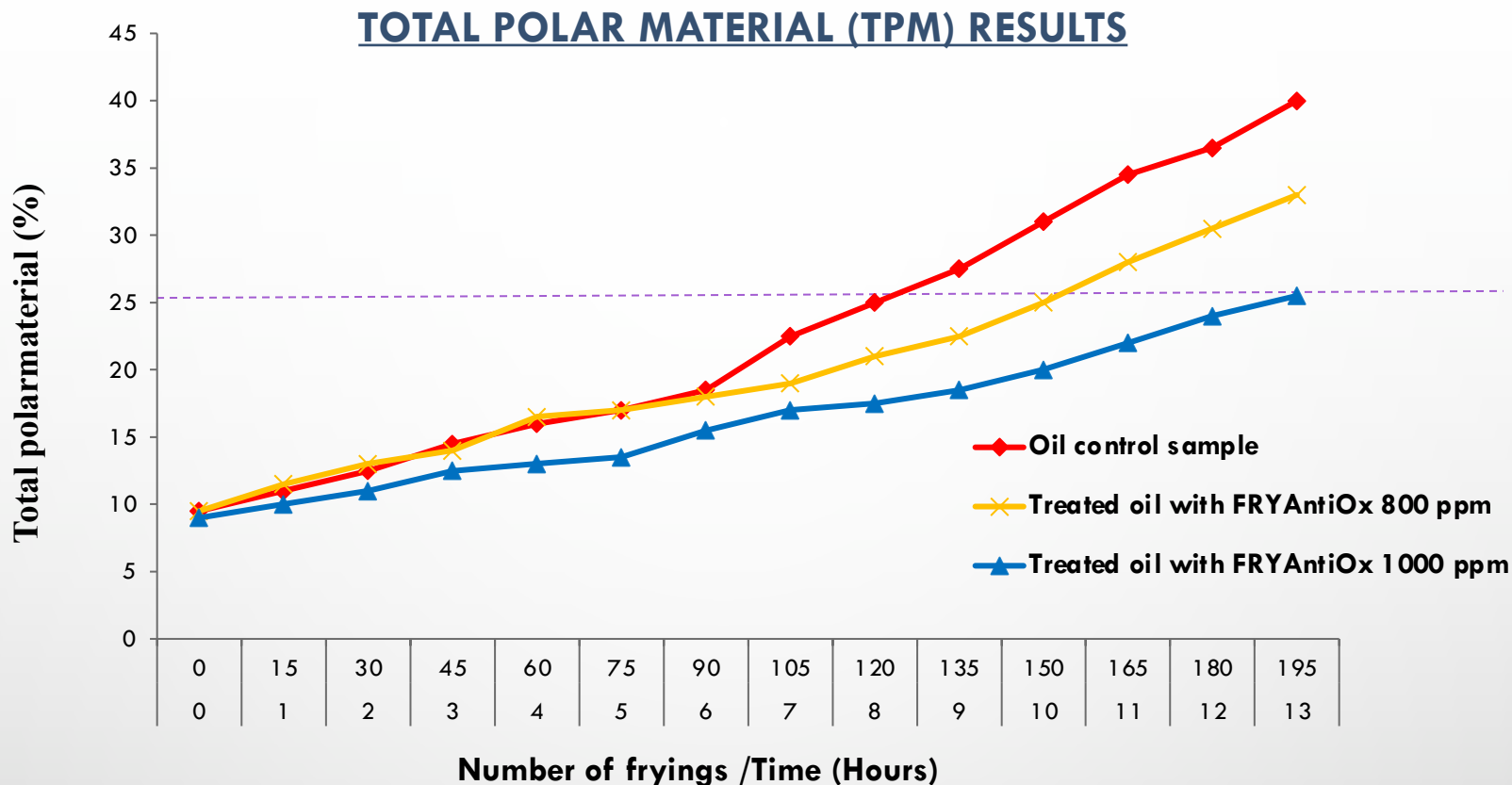
After 720 min, a substantial gap between the 3 peroxide values can still be observed: 21 meqO₂/kg for the treated oil with FRY AntiOx+, 58 meqO₂/kg for the treated oil with Tocopherol and 90 meqO₂/kg for the control sample. at this stage, the control sample peroxide value goes down because peroxides become aldehydes (secondary oxidation)

Test : Oxidation kinetics of soybean oil with breaded pickles – 360°F

Protocol

- 1
 - Treating the soybean oil with FRY AntiOx+ at 800 and at 1000 ppm.
 - Control sample : same with no preservative
- 2
 - Heating oil in a fryer at 360 F
- 3
 - Measuring the TPM rate at t_0 : oil reaches 360 F and 1st frying starts. Weight ratio: Pickles 1/oil 100
- 4
 - Measuring TPM
- 5
 - Analyzing the Free Fatty Acid
- 6
 - Analyzing the Peroxide Value
- 7
 - Tests are stopped when TPM rates in all samples reach the maximum authorized level of 25%

Test : Oxidation kinetics of soybean oil with breaded pickles – 360 F

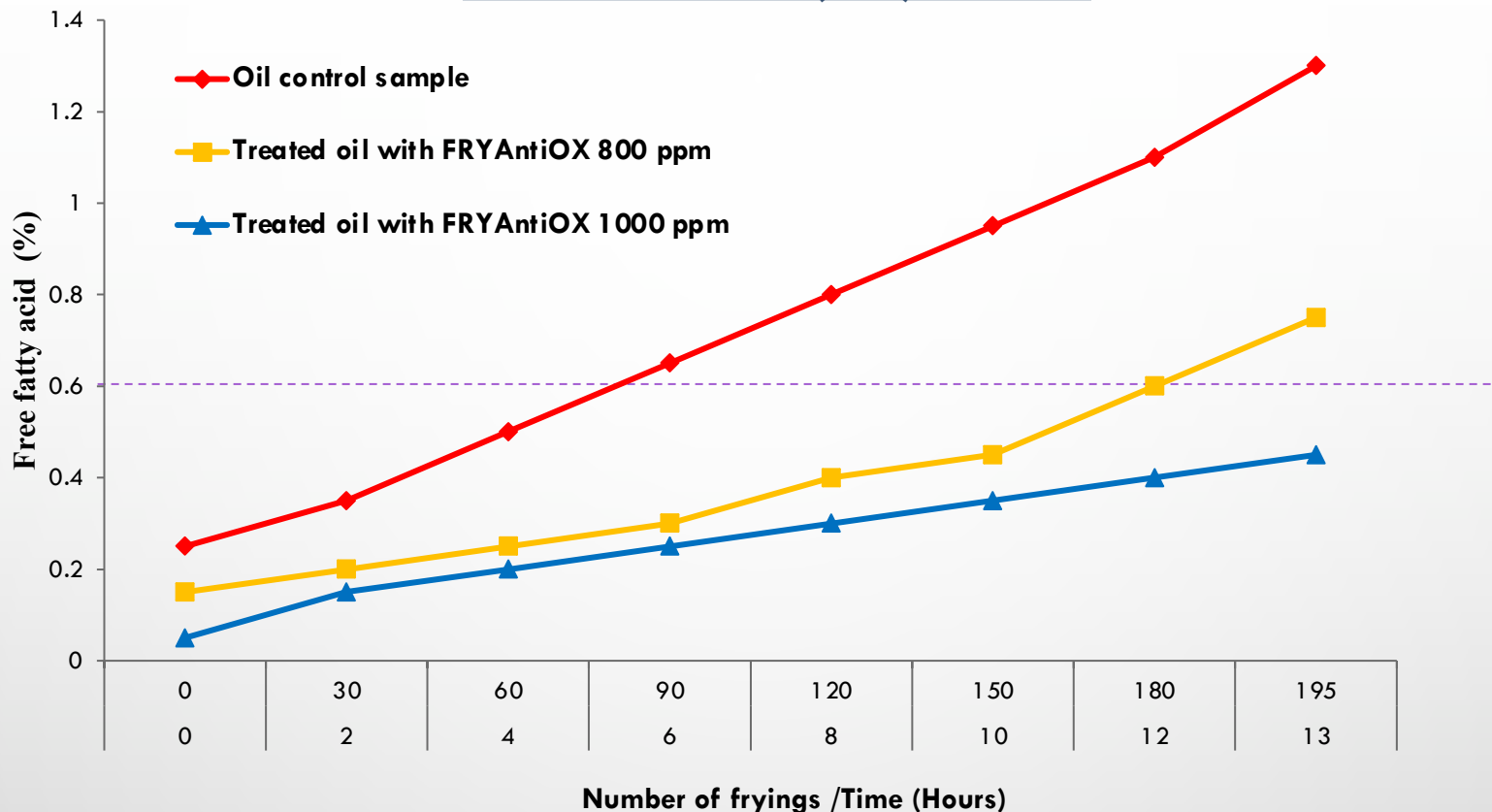


Graph 1: Oxidation kinetics in soybean oil with Pickles -360F- TPM

**The control sample reaches the maximum amount of 25%TPM at 8 hours.
The oil treated with 800 ppm FRY AntiOx+ reaches the maximum TPM level after 10 hours.
The oil treated with 1000 ppm FRY AntiOx+ reaches 25% TPM after 13 hours, 3 hours later than with 800 ppm FRY AntiOX+ and 5 hours later than the control sample.**

Test : Oxidation kinetics of soybean oil with breaded pickles – 360 F

FREE FATTY ACID (FFA) RESULTS



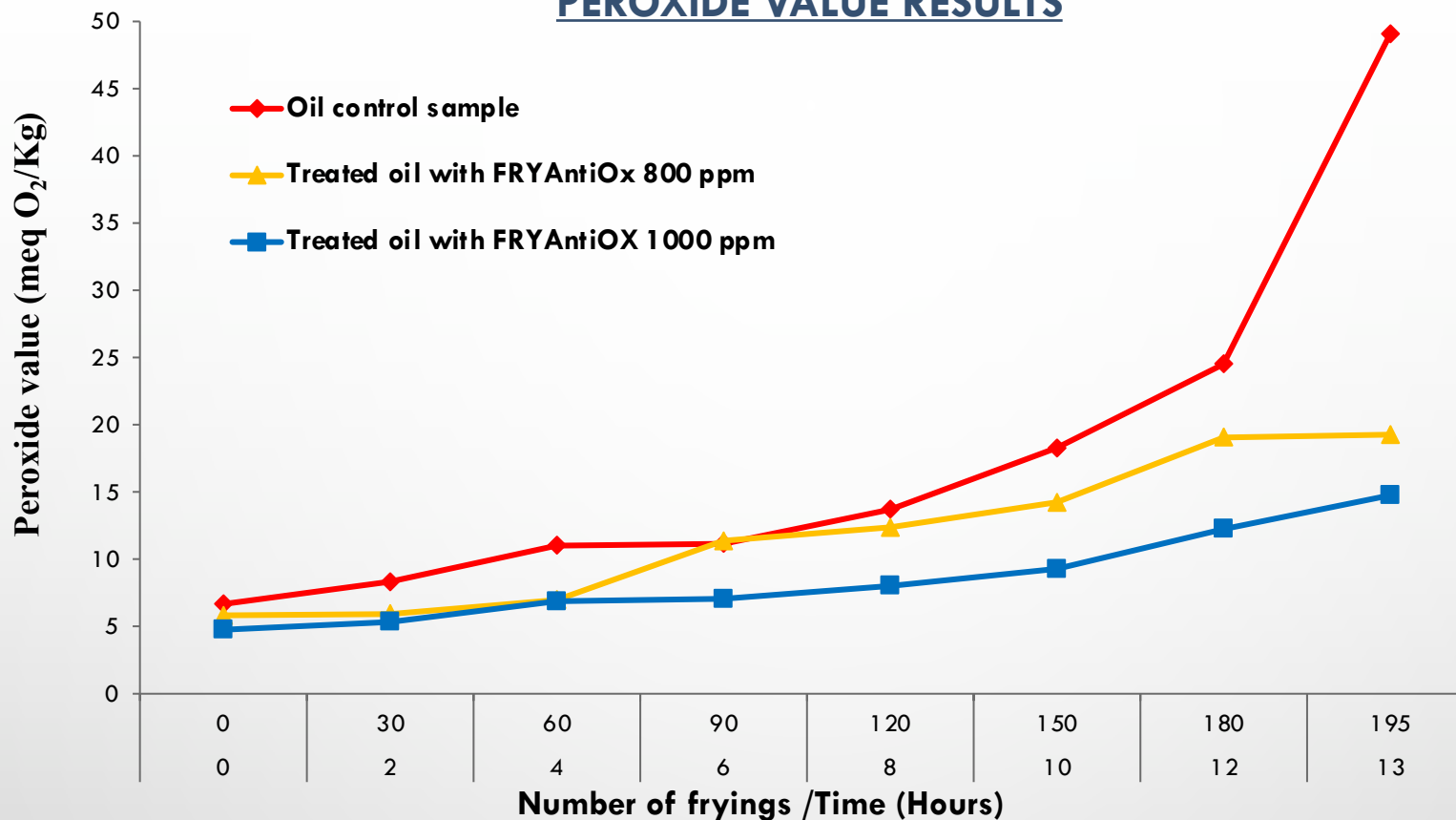
Graph 2 : Oxidation kinetics in soybean oil with pickles - 360F - FFA

After 6 hours of frying, the control sample has already exceeded 0.6%, the maximum authorized.

**The oil treated with 800 ppm FRY AntiOx+ reaches the same level at around 12 hours.
The oil treated with 1000 ppm FRY AntiOx+ doesn't exceed 0.5% even after 13 hours of frying.**

Test : Oxidation kinetics of soybean oil with breaded pickles – 360 F

PEROXIDE VALUE RESULTS



Graph 3 : Oxidation kinetics in soybean oil with pickles - 360F - Peroxide value

Throughout the kinetics, the peroxide value of the oil treated with the FRY AntiOx+ is consistently lower than that of the control sample.

At 13 hours of frying, the peroxide value of the oil treated with 1000 ppm FRY AntiOx + grows slowly, reaching 15 meq O₂/kg. With 800 ppm FRY AntiOX+, it reaches 19 meq O₂/kg, , while that of the control sample increases to 49 meq O₂/kg.