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## Lipid Hydroperoxide (LPO) Assay Kit

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Item No. 705002 (100 dtn)

Item No. 705003 (96 well)

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Customer Service 800.364.9897

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## GENERAL INFORMATION

### Materials Supplied

Item Number	Item	Quantity	Storage
705010	LPO Assay FTS Reagent 1	1 vial	4°C
705012	LPO Assay FTS Reagent 2	1 vial	4°C
705014	Lipid Hydroperoxide Standard	1 vial	-80°C
705016	LPO Assay Extract R	1 vial	4°C
705018	LPO Assay Triphenylphosphine	1 vial	4°C
400015	96-Well Solid Plate (glass)*	1 plate	RT
400023	Foil Plate Cover*	1 cover	RT

\*Supplied with Item No. 705003 only.

If any of the items listed above are damaged or missing, please contact our Customer Service department at (800) 364-9897 or (734) 971-3335. We cannot accept any returns without prior authorization.



**WARNING: THIS PRODUCT IS FOR RESEARCH ONLY - NOT FOR HUMAN OR VETERINARY DIAGNOSTIC OR THERAPEUTIC USE.**

## Safety Data

This material should be considered hazardous until further information becomes available. Do not ingest, inhale, get in eyes, on skin, or on clothing. Wash thoroughly after handling. Before use, the user must review the complete Safety Data Sheet, which has been sent *via* email to your institution.

## Precautions

**Please read these instructions carefully before beginning this assay.**

## If You Have Problems

### Technical Service Contact Information

Phone: 888-526-5351 (USA and Canada only) or 734-975-3888  
Fax: 734-971-3641  
Email: techserv@caymanchem.com  
Hours: M-F 8:00 AM to 5:30 PM EST

In order for our staff to assist you quickly and efficiently, please be ready to supply the lot number of the kit (found on the outside of the box).

## Storage and Stability

Store the Lipid Hydroperoxide Standard (Item No. 705014) at -80°C. The remaining components of the kit should be stored at 4°C and used before the expiration date indicated on the outside of the box

## Materials Needed But Not Supplied

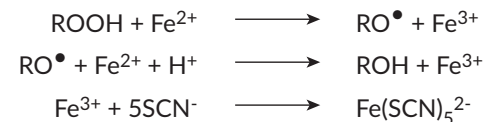
1. A spectrophotometer
2. Adjustable pipettes and a repeating pipettor
3. Polypropylene or Teflon based pipette tips (described on page 13)
4. A source of pure water; glass distilled water or HPLC-grade water is acceptable
5. Degassed chloroform and methanol (described on page 9)
6. A plate reader with a 500 nm filter (needed for use with the glass 96-well plate)

## Background

Quantification of lipid peroxidation is essential to assess the role of oxidative injury in pathophysiological disorders.<sup>1-3</sup> Lipid peroxidation results in the formation of highly reactive and unstable hydroperoxides of both saturated and unsaturated lipids. Traditionally, lipid peroxidation is quantified by measuring malondialdehyde (MDA) and 4-hydroxy nonenal (4-HNE), the degradation products of polyunsaturated fatty acids (PUFAs) hydroperoxides.<sup>4-6</sup> Sensitive colorimetric assays have been developed to measure these aldehydes.<sup>4</sup> However, these assays are non-specific and often lead to an over-estimation of lipid peroxidation. There are important additional problems in using these by-products as indicators of lipid peroxidation. The by-product formation is highly inefficient and varies according to the transition metal ion content of the sample. Only hydroperoxides derived from PUFAs give rise to these by-products. For example, 4-HNE is formed only from  $\omega$ -6 PUFA hydroperoxides and is catalyzed by transition metal ions like ferrous.<sup>5</sup> Decomposition of hydroperoxides derived from abundant cellular lipids such as cholesterol and oleic acid does not produce MDA or 4-HNE. These factors can lead to an under-estimation of lipid peroxidation. MDA is also produced in ng/ml concentrations by the platelet enzyme thromboxane synthase during whole blood clotting and platelet activation.<sup>7</sup> This leads to gross over-estimation of lipid peroxidation. Estimation of lipid hydroperoxide levels range from 0.3-30  $\mu$ M depending on the method used. However, direct methods of estimation suggest that the concentration in normal human plasma is approximately 0.5  $\mu$ M.<sup>8,9</sup> Given the limitations of the indirect methods, direct measurement of hydroperoxides is the obvious choice.

## About This Assay

Cayman's Lipid Hydroperoxide Assay Kit measures the hydroperoxides directly utilizing the redox reactions with ferrous ions (see Scheme 1).<sup>10</sup> Hydroperoxides are highly unstable and react readily with ferrous ions to produce ferric ions. The resulting ferric ions are detected using thiocyanate ion as the chromogen.



$$\begin{array}{l} \lambda_{\text{max}}: 500 \text{ nm} \\ \epsilon: 16,667 \text{ M}^{-1}\text{cm}^{-1} \end{array}$$

### Scheme 1. Reduction/Oxidation Reactions

Since this method relies on the measurement of ferric ions generated during the reaction, ferric ions present in the sample are a potential source of error. Also, many biological samples contain hydrogen peroxide which readily reacts with ferrous ions to give an over-estimation of lipid hydroperoxides. These problems are easily circumvented by performing the assay in chloroform.

An easy to use, quantitative extraction method was developed to extract lipid hydroperoxides into chloroform and the extract is directly used in the assay. This procedure eliminates any interference caused by hydrogen peroxide or endogenous ferric ions in the sample and provides a sensitive and reliable assay for lipid peroxidation.

### Reagent Preparation

#### 1. LPO Assay FTS Reagent 1 - (Item No. 705010)

This vial contains 4.5 mM ferrous sulfate in 0.2 M hydrochloric acid. The reagent is ready to use as supplied.

#### 2. LPO Assay FTS Reagent 2 - (Item No. 705012)

This vial contains a 3% methanolic solution of ammonium thiocyanate. The reagent is ready to use as supplied.

#### 3. Lipid Hydroperoxide Standard - (Item No. 705014)

This vial contains 50  $\mu$ M ethanolic solution of 13-HpODE (13-hydroperoxy octadecadienoic acid). Store the standard at -80°C and keep it on ice during the experiment. The standard is ready to use as supplied.

#### 4. LPO Assay Extract R - (Item No. 705016)

This vial contains a crystalline solid used for extraction of samples. Prepare a saturated solution of Extract R as follows: Weigh about 100 mg of the solid into a test tube, add 15 ml methanol and vortex thoroughly for about two minutes. The methanol will become cloudy and most of the solid remains undissolved. Use the Extract R saturated methanol within two hours. *CAUTION: Extract R is acidic and hence direct contact should be avoided. If exposed to skin, wash thoroughly with cold water. Excess reagent can be disposed of in sanitary sewer drains after dilution in 10 volumes of water.*

#### 5. LPO Assay Triphenylphosphine - (Item No. 705018)

This vial contains crystalline triphenylphosphine. Weigh 2.6 mg of triphenylphosphine and dissolve it in 1 ml chloroform-methanol solvent mixture (see below) to prepare a 10 mM solution. Keep the solution, tightly closed, on ice and use within 12 hours. *NOTE: Use of this reagent is optional and in most cases this is not necessary. See Interferences on page 19 for details.*

#### 6. Glass 96-Well Plate

The glass plate is supplied with Item No. 705003, and is reusable. The glass plate must be cleaned before use each time. Clean the plate with warm soapy water, and then rinse it with HPLC-grade water, followed by rinsing with acetone. *NOTE: Do not clean the plate with abrasive agents. The plate must be completely dry before use in the assay.*

### Solvents

Deoxygenate about 100 ml each of chloroform and methanol (these solvents are not provided as part of the kit) by bubbling nitrogen through the solvents for at least 30 minutes. The use of fresh chloroform is recommended for optimal results.

Cool part of the deoxygenated chloroform to 0°C and store it on ice for extraction of the samples. Two volumes of chloroform are required for the extraction of one volume of sample.

Mix two volumes of chloroform with one volume of methanol. The solvent mixture is ready for use in the assay. Approximately 1 ml of chloroform-methanol mixture is needed for each assay tube.

## Sample Preparation

Most tissues contain peroxidases (e.g., glutathione peroxidase) that effectively reduce endogenous lipid hydroperoxides to their corresponding alcohols. Peroxidase activity decreases hydroperoxide concentrations to extremely low or undetectable levels in normal tissues. Even under oxidative stress conditions, hydroperoxide production by free radicals must overwhelm the peroxidase defenses before a detectable increase in lipid hydroperoxide concentration will occur. Measurement of lipid hydroperoxides provides a snapshot of the lipid peroxidation level at the time of the assay. Integrated values of lipid peroxidation (lipid peroxidation over time) can be determined more reliably by measuring the 8-isoprostane levels (8-Isoprostane EIA Kit, Item No. 516351).<sup>11,12</sup>

Any sample containing lipid hydroperoxides is suitable for this assay. Tissues, cultured cells, plant materials, foods, and biological fluids such as plasma can be used in the assay. Tissues, plant materials, and foods should be homogenized in HPLC-grade water or in buffer containing no transition metal ions before use. Cultured cells should be sonicated in HPLC-grade water or in media containing no transition metal ions before use. Samples should be assayed immediately upon collection. If samples cannot be assayed fresh, then the lipid hydroperoxides should be extracted and the extracts should be stored at -80°C. The extracted lipid hydroperoxides are stable for at least one month at -80°C.

Lipid hydroperoxides must be extracted from the sample into chloroform before performing the assay. The standard Bleigh and Dyer<sup>13</sup> extraction protocol is not reproducible and hence not suitable for quantitative analysis. In this kit, a deproteination procedure is combined with the extraction of lipid hydroperoxides to achieve quantitative extraction of lipid hydroperoxides. This extraction step ensures the elimination of nearly all interfering substances from the sample. The following is a typical extraction procedure using plasma as the sample:

1. Aliquot a known volume of sample (e.g., 500 µl of plasma) into a glass test tube (12 x 75 mm).
2. Add an equal volume of Extract R saturated methanol (500 µl for this example) to each tube and vortex.
3. Add 1 ml of cold chloroform to each tube and mix thoroughly by vortexing.
4. Centrifuge the mixture at 1,500 x g for five minutes at 0°C.
5. Collect the bottom chloroform layer by carefully inserting a pasteur pipette or syringe needle along the side of the test tube. Transfer the chloroform layer to another test tube and store on ice. *CAUTION: Avoid collecting the middle protein layer or the upper water layer along with the chloroform layer. Any water carried over to the assay tube will interfere with color development. It is not necessary to collect all of the chloroform layer; 700 µl will be sufficient.*

## ASSAY PROTOCOL

### Plate Set Up

There is no specific pattern for using the wells on the plate. A typical layout of LPO standards and samples to be measured in duplicate is given below in Figure 1. We suggest you record the contents of each well on the template sheet provided (see page 22).

	1	2	3	4	5	6	7	8	9	10	11	12
A	A	A	S1	S1	S9	S9	S17	S17	S25	S25	S33	S33
B	B	B	S2	S2	S10	S10	S18	S18	S26	S26	S34	S34
C	C	C	S3	S3	S11	S11	S19	S19	S27	S27	S35	S35
D	D	D	S4	S4	S12	S12	S20	S20	S28	S28	S36	S36
E	E	E	S5	S5	S13	S13	S21	S21	S29	S29	S37	S37
F	F	F	S6	S6	S14	S14	S22	S22	S30	S30	S38	S38
G	G	G	S7	S7	S15	S15	S23	S23	S31	S31	S39	S39
H	H	H	S8	S8	S16	S16	S24	S24	S32	S32	S40	S40

A-H = Standards

S1-S40 = Sample wells

Figure 1. Sample plate format

### Pipetting Hints

- When pipetting chloroform or chloroform-methanol only polypropylene or teflon based pipette tips should be used. *NOTE: Pipette tip manufacturers may add slip and/or antistatic agents to their finished products. Organic solvents, such as chloroform, are known to extract these agents from the plastic. Tips must be tested to ensure they do not interfere in the assay. A background absorbance (Std. A) greater than 0.3 may suggest the tip is interfering in the assay.*
- Before pipetting each reagent, equilibrate the pipette tip in that reagent (i.e., slowly fill the tip and gently expel the contents, repeat several times).
- Do not expose the pipette tip to the reagent(s) already in the test tube.

### General Information

- The final volume of the assay is 1 ml in all tubes.
- It is not necessary to use all the reagents at one time. However, a standard curve must be run simultaneously with each set of samples.
- If the concentration of lipid hydroperoxides in the sample is not known or if it is expected to be beyond the range of the standard curve, it is prudent to assay the sample at several dilutions.
- It is recommended that the samples and standards be assayed in triplicate but it is the user's discretion to do so.
- Prepare the Chromogen (see page 15) just before its addition to the tubes.
- The background absorbance (abs. of Std. A) should be  $\leq 0.3$ .

### Standard Preparation

Take 24 clean test tubes (glass or polypropylene) and mark them A-H in triplicate. Aliquot the Lipid Hydroperoxide Standard (HP) (Item No. 705014) and chloroform-methanol mixture to each tube as described in Table 1.

Tube	HP Standard (μl)	CHCl <sub>3</sub> -CH <sub>3</sub> OH (μl)	Final HP* (nmol)
A	0	950	0
B	10	940	0.5
C	20	930	1.0
D	30	920	1.5
E	40	910	2.0
F	60	890	3.0
G	80	870	4.0
H	100	850	5.0

**Table 1.**  
\*This is the final amount of hydroperoxide in the assay tube.

### Performing the Assay

1. Add 500 μl† of the chloroform extract of each sample to appropriately labeled glass test tubes. *NOTE: Avoid any transfer of water from the extract.*
2. Aliquot 450 μl of chloroform-methanol solvent mixture to the sample test tubes.

3. Prepare the Chromogen by mixing equal volumes of FTS Reagent 1 and FTS Reagent 2 in a test tube and vortex. The volume of Chromogen to be prepared is dependent on the number of tubes assayed. Calculate 50 μl for each tube (e.g., 24 x 50 μl for the tubes of the standard curve).
4. Add 50 μl of the freshly prepared Chromogen to each assay tube and mix well by vortexing. Close the test tubes tightly with polypropylene caps.
5. Keep the assay tubes at room temperature for five minutes.

*NOTE: There are two methods of completing this assay, either using a spectrophotometer to test each sample separately (see step 6) or when using the glass 96-well plate, the values can be read with a plate reader (see steps 7-9).*

6. Measure the absorbance of each tube at 500 nm using either glass or quartz 1 ml cuvettes. Use chloroform-methanol solvent mixture for blank if the spectrophotometer requires it.

OR

7. Transfer 300 μl from each tube into the 96-well plate following the configuration shown in Figure 1. (There is no specific pattern for using the wells on the plate. A typical layout of standards and samples to be measured in duplicate is given on page 12.) To avoid evaporation from the wells, you may cover the plate with aluminum foil as you aliquot the samples. *NOTE: Do not use plastic plate covers, the solvent will dissolve the cover. Do not shake the plate on the table top, it will scratch the bottom of the plate.*
8. Read the absorbance at 500 nm using a 96-well plate reader.
9. The 96-well plate can be reused, see **Pre-Assay Preparation** (see page 8) for instructions on how to clean the plate.

*NOTE: The color is stable for two hours. If the test tubes are not closed tightly, evaporation of solvent will result in change of absorbance.*

†Volume of the extract used for the assay can be changed depending on the concentration of hydroperoxide. However, adjust the volume of the chloroform-methanol solvent mixture accordingly to a final volume of 950 μl before the addition of the chromogen.



## Calculations

1. Calculate the average absorbances of each standard and sample.
2. Subtract the average absorbance of standard A from itself and all other standards and samples.
3. Plot the corrected absorbance of standards (from step 2 above) as function of final hydroperoxide value from Table 1 (see page 14). See Figure 2 below, for a typical standard curve using a spectrophotometric assay. See Figure 3, (page 18), for a typical standard curve using a 96-well plate format.

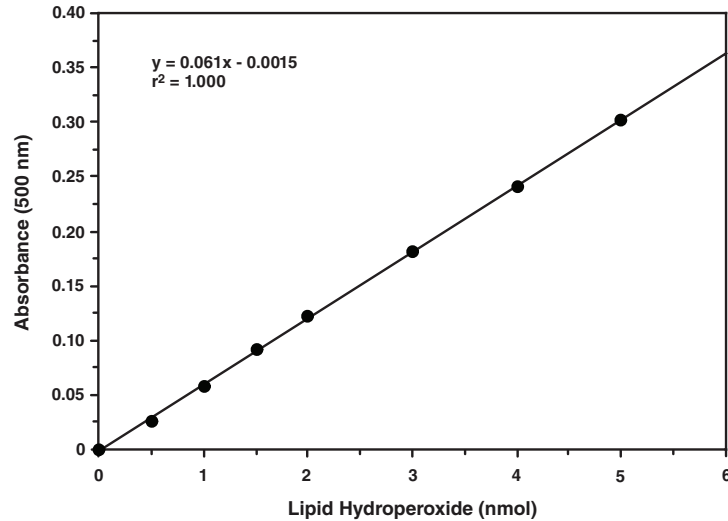


Figure 2. Typical standard curve for the spectrophotometric assay

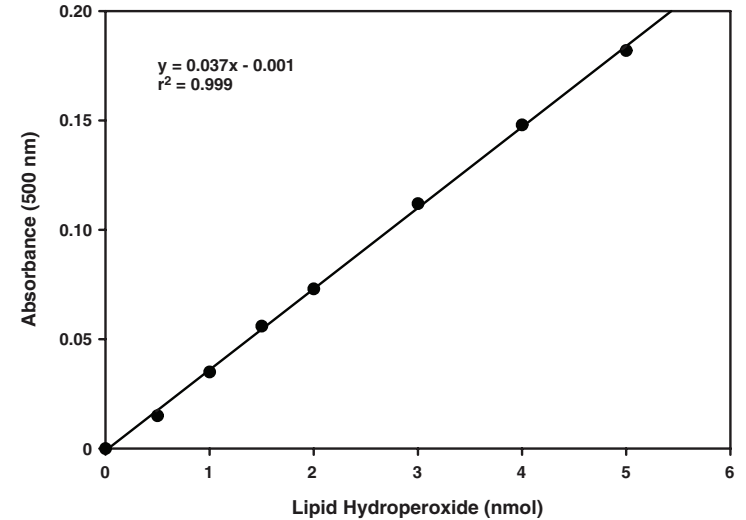


Figure 3. Typical standard curve for the 96-well plate format

4. Calculate the hydroperoxide values of the sample tubes (HPST) using the equation obtained from the linear regression of the standard curve substituting corrected absorbance values for each sample.

$$\text{HPST (nmol)} = (\text{sample absorbance} - \text{y-intercept})/\text{slope}$$

5. Calculate the concentration of hydroperoxide in the original sample as shown below:

$$\text{Volume of extract used for the assay} = \text{VE (ml)}$$

$$\text{Volume of the original sample used for extraction} = \text{SV (ml)}$$

$$\text{Hydroperoxide concentration in sample (}\mu\text{M)} = \frac{\text{HPST}}{\text{VE}} \times \frac{1 \text{ ml}}{\text{SV}}$$

## Performance Characteristics

### **Sensitivity:**

Under the standardized conditions of the assay described in this booklet, the dynamic range of the kit is 0.25-5 nmol hydroperoxide per assay tube.

## RESOURCES

### Interferences

The extraction protocol used in the sample preparation eliminates nearly all possible interfering substances. However, if the extracts exhibit strong absorbance at 500 nm (before the addition of chromogen), they may not be suitable for this assay. The color of commonly used samples such as plasma do not interfere with the assay. Any non-hydroperoxide generated color in the assay can be measured by first reducing the hydroperoxides with triphenylphosphine. Triphenylphosphine reduces hydroperoxides very efficiently and eliminates the color development due to hydroperoxides in the assay. The resultant absorbance after treating the sample with triphenylphosphine represents the background absorbance which can be subtracted from the sample data to correct for any 500 nm absorbance not due to hydroperoxides. The procedure is as follows:

1. Perform extraction of samples as described in **Sample Preparation** (see page 10), in duplicate.
2. Add 10  $\mu\text{l}$  of chloroform-methanol solvent mixture to one extract and keep it on ice.
3. Add 10  $\mu\text{l}$  of triphenylphosphine solution to the second extract, mix well and let it stand at room temperature for one hour. If the sample is not used immediately, store it on ice until use.
4. Aliquot the required amount of extract from each tube as described in step 2 under **Performing the Assay** (see page 14) and proceed with the rest of the assay.
5. Multiply the absorbance values of the triphenylphosphine containing samples by 1.28 (to correct for the effect of triphenylphosphine on the chromogen) and use these values as blanks for the corresponding samples. The remaining calculations should be identical to those described above.

## Troubleshooting

Problem	Possible Causes	Recommended Solutions
Erratic values; dispersion of duplicates/triplicates	A. Poor pipetting/technique B. Bubble in the well(s)	A. Be careful not to splash the contents of the wells B. Carefully tap the side of the plate with your finger to remove bubbles
No color development	Both reagents are not added to prepare the chromogen or hydroperoxide standard decomposed	Make sure to add both reagents to prepare the chromogen; obtain a fresh hydroperoxide standard
No color in the sample above the background	Concentration of lipid hydroperoxides in the sample is too low (<0.25 $\mu$ M)	Use more volume of the extract for the assay while keeping the final assay volume at 1 ml; use more sample for extraction.
Absorbance value of the sample higher than the highest point of the standard curve.	Sample is too concentrated	Use less volume of the extract while keeping the final assay volume to 1 ml; alternatively, dilute the extract with chloroform-methanol solvent mixture
Background absorbance value is higher than 0.3	A. The solvents were not sufficiently degassed B. Interference from the pipette tip	A. Make sure to degas the chloroform and methanol with nitrogen for at least 30 minutes B. Tips must be tested to ensure they do not interfere in the assay

## References

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NOTES

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