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The Dangers of HNE (4-Hydroxy-Nonenal) in hotel, public restaurants and home environments

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This article is provided for Clear the Air NGO as well as for all members of the public concerned with environmental and family health.

1. HNE (4-HNE) stands for 4-Hydroxy-Nonenal, a chemical often generated from oxidation of polyunsaturated fats in cooking oils.
2. HNE is highly carcinogenic.
3. All restaurants with the exception of a few, use deep fryers with overly-used oxidised oil which is often over heated to the extent that smoke appears. The more re-use, the more oxidization and the more HNE content.
4. There is currently no official preventative policy to handle the HNE contamination from such sources.
5. It is **Clear the Air's** objective to explain to the public that overuse of oxidised oil is not to be tolerated; it can and does cause cancers.
6. All citizens should be educated about the dangers of HNE and should be alerted to the over-use and over heating of cooking oil in general.

Further explanations:

1/ The generation of HNE

HNE stands for 4-Hydroxy-nonenal. It is an aldehyde moiety activated with a Hydroxyl group, making it dangerously active to react with other nucleophilic chemicals within our body. Think of the formaldehyde we often use for to preserving body part samples, it is carcinogen by nature! Just as dangerous are the formaldehyde emitted from some construction materials we had experienced in recent building materials. Such emission is tightly controlled in principle by governments, but never the less, from time to time we still have emission problems for modern homes. It is therefore not a good idea to have a tightly sealed unvented home especially when it is new. We can view HNE as one vital internal emission pollutant humans can only control poorly.

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Readers are referred to the following links for further understanding of this dangerous chemical. Just how dangerous HNE is to our health? The following citations will surely entice your imagination and curiosity:

https://en.wikipedia.org/wiki/4-Hydroxynonenal
Neurobiology of Aging
Volume 18, Issue 5, September–October 1997, Pages 457–461
Elevated 4-Hydroxynonenal in Ventricular Fluid in Alzheimer's Disease
M.A. Lovell[A, D], W.D. Ehmann[A, D], M.P. Mattson[C, D], W.R. Markesbery[B, D,]

http://www.sciencedirect.com/science/journal/22132317
Redox Biology
Volume 4, April 2015, Pages 193–199
Role of lipid peroxidation derived 4-hydroxynonenal (4-HNE) in cancer: Focusing on mitochondria chemical mechanism for generation of HNE is the following:

We hope these topics will demonstrate the idea that HNE is involved in more than just one disease: it is dangerously powerful in ending our comfortable life both in style and health.
One wonders why our governments are not actively controlling the presence of HNE in food and its sources.

Herewith a quote from the review article by Huiqin Zhong and Huiyong Yin, a recent one:

*"**Oxidative stress-induced lipid peroxidation has been associated with human physiology and diseases including cancer**. Overwhelming data suggest that reactive lipid mediators generated from this process, such as 4-hydroxynonenal (4-HNE), are biomarkers for oxidative stress and important players for mediating a number of signaling pathways. The biological effects of 4-HNE are primarily due to **covalent modification of important biomolecules** including proteins, DNA, and phospholipids containing amino group. In this review, we summarize recent progress on the role of 4-HNE in pathogenesis of cancer and focus on the involvement of mitochondria: generation of 4-HNE from oxidation of mitochondria-specific phospholipid cardiolipin; covalent modification of mitochondrial proteins, lipids, and DNA; potential therapeutic strategies for targeting mitochondrial ROS generation, lipid peroxidation, and 4-HNE".*
http://www.sciencedirect.com/science/article/pii/S2213231714001359

It should be noted that lipid oxidation is a general phenomenon that will occur within our cellular metabolism and in the frying pans and deep fryers. HNE is just one of the mutagens generated from lipid oxidation. These chemicals can lead to batteries of diseases. Scientists from around the world have concluded that oxidised oil is carcinogenic. Monitoring this HNE molecule is very easy for the government because it is an aldehyde - a molecule with an easily identifiable functional group.
The mechanism for the generation of HNE by peroxidation of lipids can be schematically represented as follows; (for non-chemists, it is not important to study this in detail, suffice to say, upon oxidation, HNE will be generated from polyunsaturated fats either through prolonged improper storage, or just air oxidation through frying and heating in our kitchens, and of course, oxidation will also happen within our own bodies.)

For the sake of completeness, I have cropped a schematic mechanism for the generation of HNE for your enlightenment ; there are many routes HNE can be generated:
Full credit should be given to the authors. **It is sufficient to know, upon oxidation, HNE will be generated and it is a marker for danger.**

PMC full text: Redox Biol. 2013; 1(1): 145–152.
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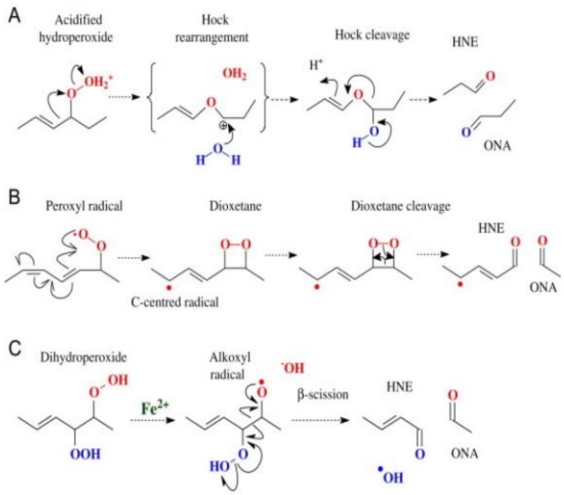
Fig. 1



2/ **Just how dangerous is HNE?**

It is unnecessary for us to demonstrate any further research on HNE, there are already volumes of well researched papers published.
e.g. The August 2003 issue of the journal Molecular Aspects of Medicine was entirely dedicated to 4-hydroxy-trans-2-nonenal which we abbreviated as HNE here in this article. During the last five to six years, we have seen thousands of articles related to HNE and per -oxidation lipids.

Oxidative Medicine and Cellular Longevity
Volume 2014 (2014), Article ID 360438, 31 pages
http://dx.doi.org/10.1155/2014/360438
Review Article
Lipid Peroxidation: Production, Metabolism, and Signaling Mechanisms of Malondialdehyde and 4-Hydroxy-2-Nonenal
Antonio Ayala, Mario F. Muñoz, and Sandro Argüelles

https://books.google.com.hk/books?id=95hSB3iN0koC&pg=PA33&dq=HNE+cancer&hl=en&sa=X&ved=0ahUKEwic4qbcjeXJAhUjiKYKHTS1BxcQ6AEILzAC#v=onepage&q=HNE%20cancer&f=false

BioFactors 24(2005)33-40 IOS Press

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Abstract. Gliomas are tumors originating from astrocytes, oligodendrocytes or ependimal cells. Those of astrocytic origin are the most widespread of primary brain tumors and account for more then 60% of all CNS neoplasms.

The current state of knowledge on the associations between tumor etiology and oxidative stress suggests that environmental factors that cause oxidative stress could also induce and promote cancer, especially in case of hereditary predisposition. Among mediators of oxidative stress, lipid peroxidation product 4-hydroxynonenal (HNE) is of particular relevance in oncology, as it is known to act as a growth-regulating factor and a signaling molecule.

The aim of present study was to investigate by immunohistochemistry the presence of HNE-modified proteins in different types of astrocytoma. Our study comprised 45 astrocytic tumors. These tumors were graded in accordance with the WHO classification as diffuse astrocytomas (DA), anaplastic astrocytomas (AA) and glioblastomas (GB), while each group comprised 15 tumors. Slides of paraffin-embedded tumor tissue were stained with hematoxylin-eosin or were prepared for immunohistochemistry with monoclonal antibodies to HNE-histidine conjugate. Positive immunohistochemical reaction to HNE was analyzed semi-quantitatively.

HNE positivity was proportional with malignancy of astrocytomas. The weakest presence of HNE-histidine adducts was found in DA, followed by AA and GB. Lowest intensity of HNE immunopositivity was present in tumor cells of almost all DA, predominantly around blood vessels. In malignant variants of astrocytoma, AA and GB, HNE positivity was moderate to strong, and diffusely distributed in all tumors.

Make no mistake, HNE can easily be generated from **Corn, Canola, Soybean and Sunflower oil and any oil with polyunsaturated fats**! These include our favourite Omega 6 and Omega -3 polyunsaturated fats. That is the reason behind **Clear the Air** efforts to advise users not to overheat fats at all. (see advisory smoke point table on the last page)

3/ There can be no doubt today HNE is the most dangerous chemical known to us on a day to day basis because more and more of us are willing to eat in restaurants and fast food places **where products are deep fried**. It is impossible for humans to have genetically altered our genes to such an extent that we are immune to a highly reactive chemical such as HNE.

http://cdn.intechopen.com/pdfs-wm/28094.pdf

"4- hydroxynonenal (HNE) is the most abundant aldehyde produced (Dianzani et al., 1999). Over the years, HNE has achieved a status as one of the best recognized and most studied of the cytotoxic products of lipid peroxidation (Poli et al., 2008). In addition to studies on its bioactivity, HNE is commonly used as a biomarker for the occurrence and/or the extent of oxidative stress. It appears to be produced specifically by peroxidation of ω-6 PUFAs, such as linoleic acid, arachidonic acid (AA) and -linolenic acid (Esterbauer et al., 1982). HNE has three main functional groups: the aldehyde group, the C=C double bond and the hydroxyl group, which can participate, alone or in sequence, in chemical reactions with other molecules (Esterbauer et al., 1991). HNE is a highly electrophilic molecule, which predisposes it to localize in the cell membranes. It can easily react with low molecular weight compounds, such as glutathione, with proteins, with lipids and, at higher concentration, with DNA (Esterbauer et al., 1991; Uchida, 2003). The double bond, the carbonyl group and the hydroxyl group, all contribute to making HNE highly reactive with nucleophiles with the primary reactivity of the molecule lying at the unsaturated bond of the C-3 atom. HNE has been shown to form Michael adducts via the C-3 atom with the sulfhydryl group of Cys residues, the imidazole group of His residues, and the ε-amino group of Lys residues on a large number of proteins (Esterbauer et al., 1991). Recently, it has been proposed that HNE can also modify Arg residues of proteins (Isom et al., 2004). In addition to Michael adduct formation, Lys residues also form Schiff bases and pentylpyrrole adducts with HNE via the C-1 aldehyde group (Sayre et al., 1993; Petersen & Doorn, 2004; Schaur, 2003)"

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4/ It is easy to list all the problems with fried food, especially from restaurants and fast food places. Even with all the known problems, including the possibility of cancer, for all practical purposes, french fries will continue to be served, from Hong Kong to Alaska.

With this pessimistic view on lifestyle, it is reasonable to attribute a heavy percentage of cancer caused by consumption of toxic oiled food (HNE). That means, in order to alert society to the dangers of HNE and the like, our government has a inalienable duty of care to the welfare of the general public. Consumption of HNE is no less dangerous than smoking cigarettes. Unfortunately there is no effective Governmental control in place in many places, including Hong Kong.

5/ We do not need an elaborate lobbying effort in order for the HK Government to take active steps for preventive measures on the HNE issue. Health Inspectors should be given test strips to directly monitor deep fryers' and used oil dangers. This is an issue with the world governments', WHO, who should issue proper guidelines. Hong Kong Government for once, should lead and facilitate new laws in this regard. There should be guidelines or warning labels placed on polyunsaturated cooking oil bottles, just like the cigarettes packages. The HNE problem is no longer at a research stage, it is a reality of cancer and many pathogenic diseases.

Government action needed:

- Public Education re: HNE in oxidised cooking oil – the more oxidization, the more HNE present
- Recommendations of maximum temperature and maximum allowed re-use of cooking oil in deep fryers
- Monitoring of hotel /restaurant / food factory / canteen commercial premises by FEHD for compliance and HNE testing
- Mandatory color coded bottles / containers based on cooking oil smoke points

Further evidence of the Environmental and Behavioural causative factors for most common cancers can be found at : http://tinyurl.com/h5vva7x and http://news.cleartheair.org.hk/?p=8927

http://sb.cc.stonybrook.edu/news/general/2015-12-16-study-reveals-environment-behavior-contribute-to-some-80-percent-of-cancer.php

Read and learn: http://tinyurl.com/z23wlur Deep frying
http://thehealthsciencesacademy.org/health-tips/oils-for-cooking/

http://www.medicinebynature.com/which-oils-are-best-to-use-when-frying-sauteing-or-eating-raw-atop-a-salad/

WHICH OILS ARE BEST TO USE WHEN FRYING, SAUTÉING, OR EATING RAW ATOP A SALAD?

It's important to consider the oils' "smoke point." The smoke point is determined by the type of oil. Grape seed oil can be heated to 420 degrees Fahrenheit before it starts to smoke. Extra virgin olive oil starts to smoke at 320 degrees. While refined or, "light" olive oil can be heated to 420 degrees. **Once the oil is heated beyond its smoke point, it starts to chemically change; this is when the molecules break, forming free radicals and other harmful compounds**. Minimizing free radicals in our diet is important so that we reduce the amount of anti-oxidants needed from our bodies to combat the bad effects of oxidation caused by free radicals. What I mean by bad effects is aging process, endothelial vascular damage which includes our arteries and veins, etc. **Beyond smoke point, the other important piece to consider is a harmful compound called HNE**. This happens when a polyunsaturated fat such as soy or corn is heated beyond its smoke point. HNE ends up in the food that the oil is cooked in, consumed and taken up by the body and once again the body needs anti-oxidants to combat the oxidant effects as described earlier. Having said all that, here are a list of oils and their normal heating or smoke point. Again, it is beyond the heating or smoke point that molecular bonds break causing oxidation in the body. Also note that most frying happens at around 350 degrees F /177 degrees C.

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Cooking Oils / Fats	Smoke Point °C	Smoke Point °F
Unrefined flaxseed oil	107°C	225°F
Unrefined safflower oil	107°C	225°F
Unrefined sunflower oil	107°C	225°F
Unrefined corn oil	160°C	320°F
Unrefined high-oleic sunflower oil	160°C	320°F
Extra virgin olive oil	160°C	320°F
Unrefined peanut oil	160°C	320°F
Semi refined safflower oil	160°C	320°F
Unrefined soy oil	160°C	320°F
Unrefined walnut oil	160°C	320°F
Hemp seed oil	165°C	330°F
Butter	177°C	350°F
Semi refined canola oil	177°C	350°F
Coconut oil	177°C	350°F
Unrefined sesame oil	177°C	350°F
Semi refined soy oil	177°C	350°F
Vegetable shortening	182°C	360°F
Lard	182°C	370°F
Macadamia nut oil	199°C	390°F
Canola oil (Expeller Pressed)	200°C	400°F
Refined canola oil	204°C	400°F
Semi refined walnut oil	204°C	400°F
High quality (low acidity) extra virgin olive oil	207°C	405°F
Sesame oil	210°C	410°F
Cottonseed oil	216°C	420°F
Grapeseed oil	216°C	420°F
Virgin olive oil	216°C	420°F
Almond oil	216°C	420°F
Hazelnut oil	221°C	430°F
Peanut oil	227°C	440°F
Sunflower oil	227°C	440°F
Refined corn oil	232°C	450°F
Palm oil	232°C	450°F
Palm kernel oil	232°C	450°F
Refined high-oleic sunflower oil	232°C	450°F
Refined peanut oil	232°C	450°F
Semi refined sesame oil	232°C	450°F
Refined soy oil	232°C	450°F
Semi refined sunflower oil	232°C	450°F
Olive pomace oil	238°C	460°F
Extra light olive oil	242°C	468°F
Rice Bran Oil	254°C	
Refined Safflower oil	266°C	510°F
Avocado oil	271°C	520°F