Super-oxidized soups and the health risks to poor South Africans

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Prosperity in South Africa regularly ingests large quantities of highly oxidized abused fats also known as super-oxidized fats (SOF). These increase the levels of oxidized lipid in plasma and might result in additional stress on endogenous anti-oxidative systems, which, in turn, can reduce the immune system's ability to fight viral attack. Recent facts support that SOF smoke more easily than new, unused fats when heated, and the number of meals cooked by deep-frying and the frequency of meals of high smoking during cooking fats, in studies on Chinese women, been associated with the risk of contracting lung cancer. Extensive animal studies have shown that ingesting oxidized fats can cause oxidative stress and a variety of diseases. We recommend South African studies, therefore, to assess the risks to exposed local communities, especially in relation to HIV/AIDS and cancer.

Introduction

The poor health, especially related to HIV/AIDS, of many South Africans makes it imperative to minimize exposure to harmful substances. Oil consumption is the widespread practice by frying establishments of distributing such substances to poor South African communities in the form of large quantities of heavily oxidized edible fat waste (called super-oxidized soaps or SOF). More than 100 000 tons of unrefined oxidized fats and SOF (the highest levels ever recorded) are estimated to be consumed annually by these communities.

As the global demand for fast foods and meals prepared away from home increases (especially since the early 1990s), so do the amounts of oxidized unstable used fat and SOF distributed to impoverished South Africans. In a first survey of its kind that we conducted in 1994, we found that most frying establishments habitually disregarded their unstable, used, and often SOF waste to the poor for re-use in frying food. 1,2 (This fat waste contrasts with the high-quality frying fats used in developed countries.) Such establishments were ignorant of the health-related dangers,2,3 as there were no regulations or available information about fat abuse in the country before 1995.4

This widespread malpractice and the resulting dark, overused unstable fats 'fish oil' due to their fishy taste deriving from repeated frying of fish — became part of everyday life for the poor. The health risk is not limited to people ingesting food that has been fried in these unstable fats but may also compromise the health of those who inhale volatiles, potentially harmful compounds readily liberated from these fats when heated. By 1994, many countries had regulations in force to ensure that fats remain free of these potentially harmful products. They prohibited the use of fats containing around 25% total breakdown products (also known as polar compounds) or 5% polymers (that is, more than 10% of total breakdown products). No such regulations existed at that time, however, in any African country.4,5

This situation changed when South Africa introduced regulations on 16 August 1996,6 but extensive surveys conducted by our team show that many frying establishments still use SOF in frying processes, and unstable fats, frequently containing breakdown products far above the regulatory limits, are still being distributed by these businesses to the undernourished poor for re-use in food preparation.7 The literature reveals that some South African frying establishments abuse fats up to levels unheard of elsewhere in the world.6,7 and that their products may contain as much as 75% polymers. (This form contrasts dramatically with 1996 survey results from northeastern Australia,8 in which Somerset et al. highlighted two samples containing what were regarded as unacceptable levels of 15% and 26.7% total breakdown compounds.6,9)

Fat breakdown

New unused fats contain mainly triacylglycerols (approximately 99%). When heated, the fats start to break down, producing free fatty acids, diacyl-
glycerols, and monoacylglycerols. When the fats are re-heated, these compounds break down further, mainly through thermal oxidation,10 to produce large amounts of hydroperoxides and other products, characteristic of SOF. Polymers are produced through intra- and intermolecular reactions of aldehydes,11,12 allyl and perox radical, leading to the formation of dimers, trimers, and polymers of high molecular weight. Free radical reactions may be accelerated and propagated further via chain branching and homolytic fission of hydroperoxides to generate more free radicals. By combining radicals to form non-radical dimers or polymers, the free radical chain reaction is terminated. It can also be terminated by anti-oxidants such as vitamin E (tocopherol), which reacts competitively with perox radicals, for example, to remove free radicals from the reaction. Consequently, 50%, where large amounts of polymers are produced, are normally characterized by high free radical activity.

When fats are re-used for frying, more breakdown products are formed, some of which may be hazardous when consumed or inhaled. They not only influence the organoleptic character of fried foods, but may cause fats containing these compounds to smoke more easily at lower temperatures, thereby exposing people to volatile breakdown compounds such as aldehydes, ketones, hydrocarbons, lactones, and substituted furans. The principal volatile constituents identified in frying fats derive from the decomposition of lipid oxidation products and include 1-pentanal, heptanal, furfural alcohols, benzaldehyde, 2-methylbutyraldehyde, 1-penten-3-ol, octanal, 2-pentylfuran, trans-2-hexen-4-ol acetate, and benzylacetaldehyde.13 Prolonged heating accelerates the production of free radicals and breakdown products, resulting not only in the formation of potentially unhealthy volatile chemicals, but also in a greater amount of the deteriorated fried fat by re-fried food.14

Public health implications

Animal studies. The biological and toxicological properties of oxidized fats have been studied extensively, and there is general agreement that undesirable or harmful metabolites are formed during the abuse of fats.14,15 Most research has been performed on animals, however, and shows experimental subjects to be resistant to the adverse effects of fats that have been heated under conditions that approximate human culinary practices.
that is containing less than 16% poly-
mers. Extrems thermally oxidized fats or isolated free radicals containing oxidation and degradation products have caused adverse biological effects in laboratory animals, however, including growth retardation, diarrhea, teratogenicity, urine damage and increased mass of liver and kidneys, cellular damage to the liver and epididymides, increased peroxi-
dation of membrane and tissue lipids, inhibition of cytochrome P-450 activities in the liver and colon, enhanced urine mutagenicity, raised cell prolifera-
tion in the cormophages, and even death. Hageman et al. concluded that short-
term consumption of heated deep-frying fats containing as little as 15% of break-
down products can cause increased cell proliferation in the gastrointestinal tract and induce oxidative stress (in particular the depletion of anti-oxidant agents such as vitamin E). In these studies, the deter-
ated fats used were far less degraded than those commonly found at South African frying establishments, where fats can be heated till they contain some 25% of free-radical-induced polymers.

Human studies. Although there is little in the literature that describes the effects of thermally oxidized fats on humans, studies have been conducted on the influ-
ence of mildly thermally oxidized fats when ingested and inhaled by people. When thermally oxidized soybean oil (peroxide value 4.8 mEq/kg oil) was fed orally to men aged 25 to 35 years, the level of lipid peroxides in human plasma increased within four hours, thereby adding to their oxidative stress levels. No such increases were observed after the intake of fresh oil (peroxide value 1.6 mEq/kg oil). Results from various experiments suggest that chronic oxidative stress can affect the immune system’s fight against HIV.

A study, conducted by the Shanghai Cancer Institute in collaboration with the US National Cancer Institute, was based on interviews with 672 female lung cancer patients and 730 controls, and investigated the high rates of lung cancer among Shanghai women. Associations were found between lung cancer and measures of exposure to cooking oil vapour. Risks increased with the amount of meals cooked by stir-frying or deep-
frying; the presence of smokeless during cooking; and the frequency of eye irri-
tation during cooking. A similar study, which included interviews with 965 female patients and 493 controls in the industrial cities of Shenyang and Harbin, also found that the number of deep-fried meals consumed and the incidence of smoking during cooking were associ-
ated with a higher than normal risk of lung cancer.

The future. Since 1995, in collaboration with our group, the Department of Health as well as industry are actively addressing the problem countrywide, but more invest-
ment from government and the private sector is required, to effect a change in culture in poor communities accustomed to frying with ‘fry oil’. The consumption of used oils should be stopped immedi-
ately through increased pricing of frying establishments and improved public awareness campaigns.

Ungated epidemiological studies are needed throughout sub-Saharan Africa to investigate possible links between AIDS exposure over extended periods of time and disease, oxidative stress, and the progression of HIV/AIDS and infections such as tuberculosis. The database (obtain-
able from the authors) and expertise developed in these areas should be incorporated into the database.


Adaptive Herbicide Ecology
From Resources to Populations in Variable Environments
Normal Open-Access

Centre for Ecological Ecology, University of the Witwatersrand

This book links the principles of adaptive behaviour to their consequences for the metabolism and ecological models and the main focus is on large mammal herbivores occupying seasonally variable environments such as those characterized by African savannas, but applications to temperate zone ungulates are also included. The book is aimed particularly at academic researchers and graduate students in the field of ecology.