

The Truth about Detoxification

Toxins are poisonous substances capable of causing ill-health, disease and death. The injurious nature of toxins varies depending on the agent in question and includes damage to cellular structures and inhibition of cellular division. Detoxification, on the other hand is known as the removal of toxic substances from the body. Detoxification occurs mainly in the liver, the organ responsible for the filtration of the blood and the elimination of toxins.¹ Other organs such as the kidneys, gastrointestinal tract and skin are also important when it comes to clearing toxins from the body. Detoxification can also refer to the time period needed for the body to regain its natural state of balance after the long term use of an addictive substance. Unfortunately, detoxification has also become synonymous with cleansing - a term loosely used to describe all sorts of treatments aimed at purifying or purging the body. Many such treatments are unproven and make little sense physiologically. Although detoxification is essential for health, certain cleanses do little to enhance health and may even be harmful. It is important to understand detoxification before you embark on a cleanse.

Smoke, Mirrors and Dirty Water

Detoxification has become a broad and non-specific term used to cover a wide range of therapeutic approaches, some of which are grounded in science and many of which are purely speculative in nature. Pollutant-draining foot baths, coffee enemas, cleansing diets and the use of laxatives are largely unproven approaches that have been ascribed detoxification properties. In many cases, such therapies offer little in terms of health benefits. In the worst cases, serious harm has come to those who have subscribed to those treatments, with reports of colitis and serious burns to the gastrointestinal tract and even liver damage in some cases.²⁻⁵

Detoxification as it is understood by many is unsupported by research. The notion that periodic cleansing promotes health is a paradox. There are obviously fundamental changes required to your diet and lifestyle if you think that you must cleanse your body to stay healthy. Overindulging is certainly problematic, but the answer is not cleansing.

A Note on Ionic Foot Baths

Ionic foot baths are the perfect example of a detoxification treatment that is not useful. Although the treatment provides visual awe, the science shows that the visual effects are the only thing this approach provides. The electrical current and electrodes used during the treatment cause the metals in the sea water to precipitate out of solution, leading to dirty water. The water would turn green and grey by itself. This treatment does not detoxify the body.

The Effects of Fasting on Detoxification



The idea that fasting promotes detoxification is widespread and many detoxification programs involve complete or partial fasting for this reason. The concept is simple; if you are not eating, your body can process the toxins it has accumulated because it is not busy digesting and processing food. However, there is another important factor to consider – your body needs nutrients and energy to support detoxification.⁶⁻⁸

Animal studies have shown that fish have diminished detoxification rates when their food supply is running low.⁹ This can have dire consequences in polluted environments where animals are exposed to high toxic loads and limited food.

When embarking on a cleanse, some of us are looking to shed more than toxins. Often, weight loss is the only thing a cleanse will achieve. Weight loss is obviously a good thing for a substantial portion of the population

given that obesity is now the second leading cause of preventable death in the U.S. (see figure 1).¹⁰ Many cleanses involve very low calorie diets, some even recommend complete fasting and this caloric deficiency will lead to weight loss. Since losing weight is a matter of expending more calories than you are consuming, fasting translates into rapid weight loss. Rapid weight loss is often not recommended and maintaining a healthy weight is much better for your health than yoyo dieting, which has been shown to be ineffective anyway. Again, cleansing is not the answer, portion control, eating a balanced diet and exercise will all get you much further.¹¹

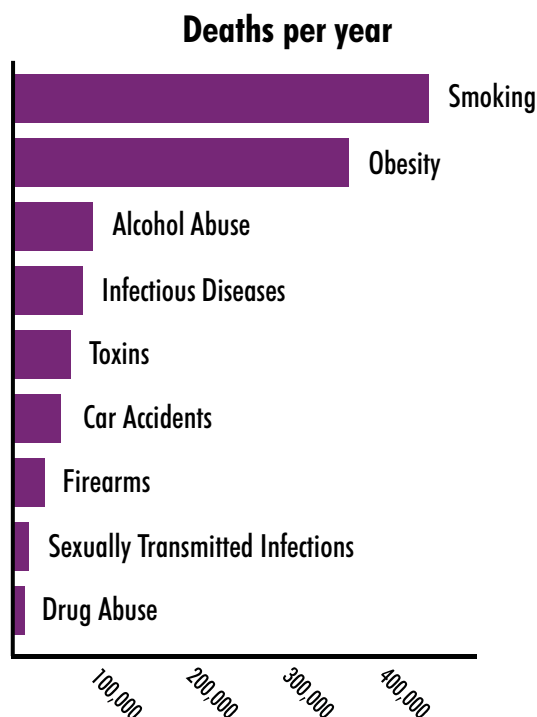


Figure 1. Preventable causes of death

During a cleanse, the weight that is lost is mainly comprised of water and to some extent fat, but there is little evidence showing that fasting will help to purge the body of toxins.¹² Fasting can also be dangerous, as it depletes the body of nutrients, some of which are needed to maintain a competent immune system.¹³ Fasting also decreases blood glucose levels and leads to the breakdown of muscles and lean tissue for the production of energy. Due to the effects it has on immunity and muscle mass, fasting is especially dangerous for those who are malnourished or suffering from chronic illness. Studies also show that fasting can increase the risk of organ injury from new toxins because it depletes nutrients required to sustain detoxification pathways.¹⁴



It's the Dose that Makes the Poison

Any chemical can be toxic if you are exposed to a large enough quantity. Similarly, a small dose of a chemical that is known to be toxic in larger amounts may be harmless. This is an important concept to understand because irrational fears are created when we assume that just because something is toxic in a high concentration it will be toxic at every dose. This argument is based on pseudoscience and is a flawed premise. Many toxins have a threshold below which no adverse health effects are seen. This is known as the dose-response relationship (see figure 2).

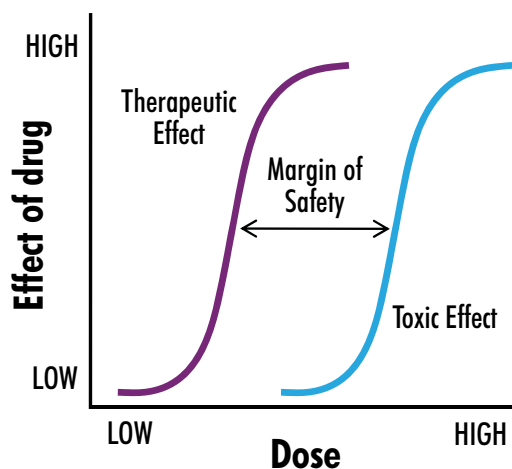


Figure 2. An example of a dose response curve showing the effect of a drug. The curve demonstrates how different doses can have different effects, with lower doses having a desirable effect and higher doses having an undesirable or toxic effect.

Each contaminant is different and the threat posed by a chemical depends on how it is handled by our body. There is more to toxicity than short-term high dose exposure. Certain chemicals, such as lead, can accumulate in our body and cause toxicity due to chronic exposure to relatively low doses of contaminants. Cancer causing agents, also known as carcinogens, are much more dangerous and, in some cases, no safe exposure level can be determined. In such cases, exposure should be limited as much as

possible and regulators will require the lowest feasible exposure levels based on the technology available. In the case of contaminants that mimic hormones, such as xenoestrogens, low doses can lead to disruption of crucial functions since hormones regulate growth, reproduction and digestion. In the case of biological contaminants such as bacteria and viruses, infection by a single organism can lead to disease, especially if the immune system is not functioning properly.

In many cases, a chemical is beneficial or even essential in small amounts but becomes toxic if a large dose burdens the body. Most essential minerals behave in this manner. For instance, iron is needed by the immune system and for the formation of red blood cells, but high dosages can damage the liver and blood vessels. The recommended daily intake for iron in women is 18mg per day, but iron becomes toxic in concentrations of 10 to 20mg/Kg which is why iron supplements should be kept away from young children.

The toxicity of any chemical depends on a variety of factors, the most important being how quickly the toxin enters and leaves our body. The organs involved in the elimination process, our body composition, the physical characteristics of the toxin, our life stage, and many other factors determine how quickly a toxin is metabolized by our body. Children, infants and fetuses tend to be the most sensitive to toxins and contaminants.



In general, water soluble exogenous compounds are excreted by the kidneys. However, the majority of toxins are fat soluble and need to be metabolized and transformed into water soluble substances before they can be eliminated – hence the importance of the liver. The liver filters blood, enzymatically breaks down and removes toxins through phase I and phase II detoxification and is also responsible for the production of bile, which is how fat-soluble toxins and cholesterol are excreted. Different reactions are involved in phase I and phase II liver detoxification and include oxidation, reduction and hydrolysis (see pages 6 and 7).

During Phase I, toxins are prepared for elimination via the phase II detoxification pathway. Phase I detoxification leads to the production of activated intermediates which are more reactive and can cause more harm than the initial contaminant. It is therefore essential that phase I and phase II work synergistically. The cytochrome P450 enzyme system is central to phase I detoxification. This enzyme system can metabolize thousands of substances including drugs, toxins and natural metabolites such as bilirubin and hormones. Free radicals are produced during phase I, which means that if antioxidants are not present in sufficient quantities, liver and tissue damage can result. Glutathione is essential for the prevention of free radical damage during phase I.

Phase II is a conjugation pathway during which another substance is added to a toxin to make it less harmful. The toxin is also modified to make it water soluble which allows for excretion in bile or urine. Although several conjugation pathways are required for phase II detoxification, glutathione S-transferases are the most prominent. Indeed, glutathione S-transferase binds to toxins and acts as a transport protein. Glutathione S-transferases allow for the conjugation of toxins to reduced glutathione, which facilitates transport in aqueous environments, thereby permitting the elimination of toxins from the organism.²³

A Note on Grapefruit Juice

Our diet can also influence our ability to handle various chemicals. For example, grapefruit juice contains furanocoumarins which interact with the cytochrome P450 detoxification pathways in the liver and intestines.²¹ This interaction can be dangerous if the patient is taking prescription medications as it affects the ability to handle and clear certain drugs from our system. This effect lasts for up to 24 hours and leads to higher blood concentration of the medication thereby increasing the risk of adverse effects.²²

Detoxification in the Liver

Detoxification is an extremely complex process; the immense array of possible toxicants is such that the processes required to get rid of them must be intricate.

A Note on Mercury in Vaccines

Many people are very concerned about the presence of mercury in vaccines like the flu vaccine. It is important to note that the type of mercury makes a significant difference to the toxicity of the compound due to variations in bioaccumulation and absorption. Organic mercury or methylmercury is the most dangerous because it accumulates in the body more than other forms of mercury. Inorganic mercury is a lot less dangerous because it is not as easily absorbed. Methylmercury is organic mercury and safe exposure guidelines are usually based on exposure to methylmercury. Mercury toxicity is almost always related to exposure to methylmercury. The absorption of metallic mercury is 7% of the ingested dose whereas the absorption of methylmercury is more than 95%. Methylmercury is also more toxic once in the body because it can cross the blood-brain barrier and also the placental barrier.¹⁵

The Thimerosal found in vaccines, contains ethylmercury which is not the same as methylmercury, as it does not seem to bioaccumulate as much as methylmercury. Ethylmercury can be toxic but all reported instances of toxicity with ethylmercury were related to long term exposure to high concentrations as is usually the case with mercury.

It takes a relatively high SINGLE dose of mercury to kill an animal. The LD50 of oral methylmercury in guinea pigs is 16.5 mg of mercury per kg of body weight. For a 70 kg adult that translates to 1.155 grams.

In 1972, the WHO established guidelines for a tolerable weekly intake of mercury and methylmercury. This was set at 0.005 mg/kg body weight for mercury and 0.0033 mg/kg body weight for methylmercury. For a 70 kg adult, this translates to 231 mcg per week for methylmercury and 350 mcg for mercury.¹⁶

The Health Canada guidelines for women of childbearing age, pregnant women, and young children are 0.2 mcg per kg body weight per day. For the rest of the population, the recommendation is a maximum of 0.47 mcg per kg body weight per day. So again for 70 kg pregnant women, the tolerable intake is 14 mcg per day, for a non pregnant adult, 32.9 mcg per day.¹⁷

For the sake of argument, let's assume that ethylmercury is as toxic as methylmercury. There is 5mcg of thimerosal in a typical dose of the flu vaccine. Thimerosal contains about 49% mercury by weight which works out to 2.5 mcg of mercury per dose of the vaccine, which is well below the established guidelines. Studies also show that blood mercury levels are not raised beyond safe levels after vaccination.¹⁸

In comparison, the concentration of methylmercury in large fish species can be much higher.

Table 1: Methylmercury content of different fish species available in Canada.¹⁹

Fish Species	Mean [MeHg] (µg/g)
Cod	0.06
Cusk	0.35
Grouper	0.45
Halibut	0.31
Marlin	0.69
Sauger	0.46
Sea Bass	0.62
Shark	1.36
Shrimp / Prawn	0.05
Swordfish	1.82
Tuna, albacore, canned	0.36
Tuna, fresh or frozen	0.93
Walleye / Yellow Pickerel	0.37

According to research conducted by Health Canada, there is 0.36 mcg/g of mercury in canned albacore tuna and 0.14 mcg/g in regular canned tuna. A small can of tuna weighs 6 oz or 170 g. So a can of albacore tuna contains 61.2 mcg of mercury or 24 times more mercury than the flu vaccine. Regular canned tuna contains 23.8 mcg or 9 times more mercury, and in this case we are talking about methylmercury, which is the most toxic form of mercury.

The side effects and complications associated with vaccinations are likely related to the activation of the immune system, not their Thimerosal content.²⁰

The Effects of Toxicity

When exposure occurs at levels that lead to toxicity, the body systems start to break down. Depending on the offender organ function can be affected, usually starting with the liver and kidneys. In some cases, the problem can lead to cancer and hormonal imbalances.²⁴ The effects are not limited to the physical health of the individual; there are also effects on both mental and cognitive function, which are specific to the contaminant. In the case of heavy metals, for example, the effects are widespread, affecting the gastrointestinal tract, kidneys, liver, airways, immunity, joints, bones, hearing, coordination, memory and reproductive system.²⁵

Nutritional Supplementation for Detoxification

Several studies have now shown that many nutrients are capable of enhancing detoxification in the liver. When detoxification systems are functioning poorly, supplementation with nutrients that enhance detoxification will help to improve health, lifespan and relieve symptoms associated with toxicity.²⁶ Such nutrients include taurine, glutathione, selenium, milk thistle, artichoke extract, sulforaphane, schizandra and vitamin E.²⁷⁻³⁰ For example, animal studies show that

selenium prolongs survival in animals exposed to mercury.³¹ Selenium supplementation also increases the mercury concentration in the liver and kidneys of animals preparing it for excretion.³² Selenium and vitamin E both have a similar mechanism of action; their antioxidant potential diminishes the damage caused by the free radicals associated with exposure to toxins.³³ Schizandra and sulforaphane are potent inducers of phase II liver detoxification, while milk thistle protects the liver from the injurious effects of toxins. Artichoke has a very important role and increases bile production and therefore stimulates the excretion of toxins from the body.

When it comes time to detoxify your body please do not let yourself be deceived. The old saying that "things that are too good to be true usually are" definitely holds true in this case. If you are relying on periodic cleanses or fasts to remedy the injurious effects of an unhealthy lifestyle you are treading in unknown waters. Remember that strength requires support; while eating a healthy diet, exercising and maintaining a healthy lifestyle will promote health and detoxification, proper nutritional support will further assist you in achieving your potential.

The Best ways to Stimulate Liver Detoxification

Reduce the intake of processed foods and eat more fresh, raw and whole foods.

Eat cruciferous vegetables.³⁴

Exercise regularly.

Avoid the use of alcohol, tobacco, carbonated drinks and coffee.

Get the nutrients you need to support your detoxification systems.³⁵



Protect Your Heart by Lowering Homocysteine



Phase I & II Liver Detoxification

TOXINS

Fat Soluble

Metabolic end-products, carcinogens, environmental pollutants, pesticides, exhaust fumes, toxic pharmaceuticals, heavy metals, cigarette smoke etc.

Intermediate Metabolites

Water Soluble
Potentially Harmful

Phase I

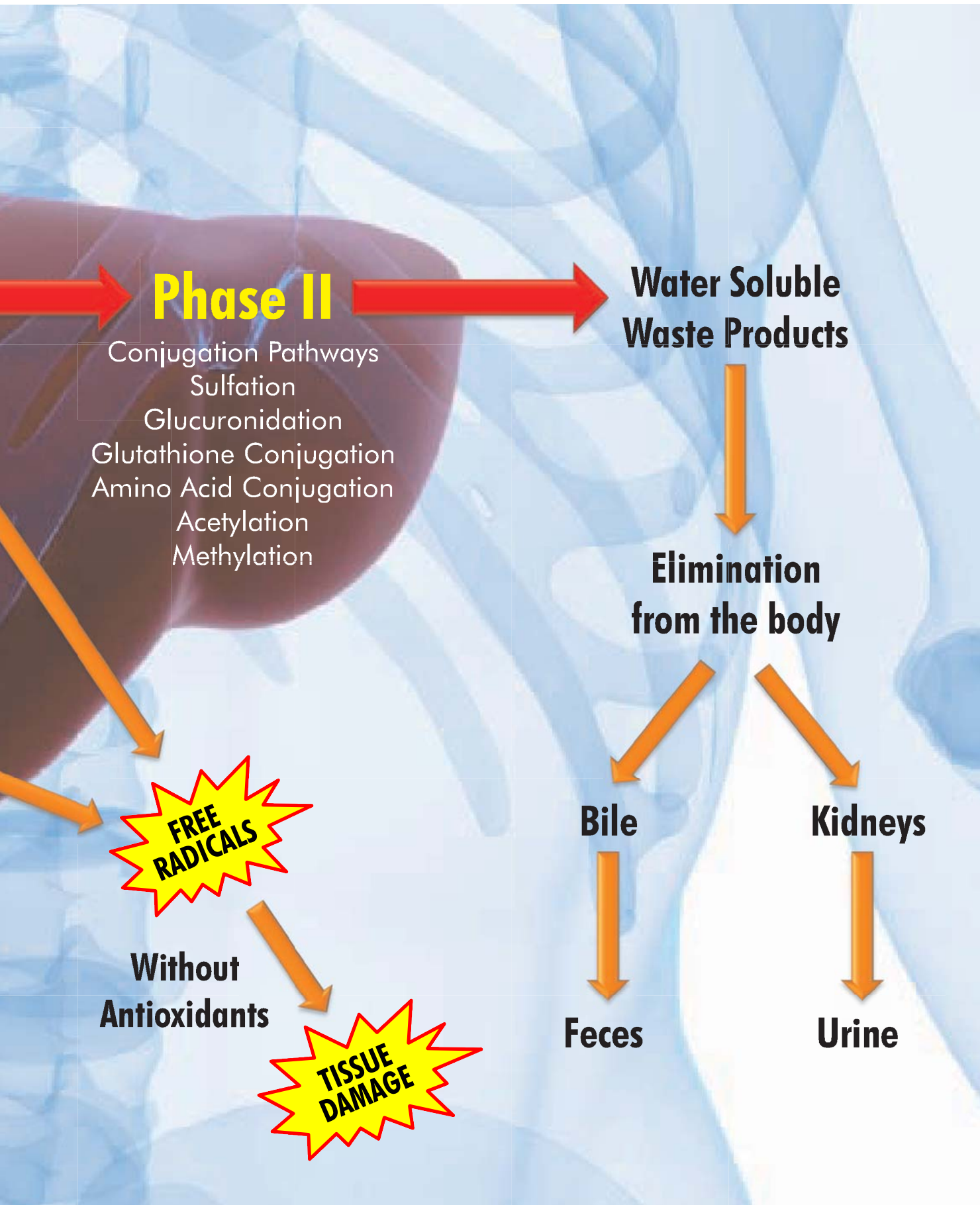
Cytochrome P450 Enzymes
Oxidation
Reduction
Hydrolysis
Hydration
Dehalogenation

NUTRITIONAL SUPPORT

Phase I: B Complex Vitamins, Folic Acid, Milk Thistle, Vitamin E, Selenium

Phase 2: Sulforaphane, Schizandra, Taurine, N-acetylcysteine, Glutamine, Glycine

Elimination of Toxins: Artichoke Leaf



References

1. Teschke R, Nishimura M, Gellert J. Toxic and metabolic liver injury. *Leber Magen Darm*. 1981 Sep;11(5):227-34.
2. Lee CJ, Song SK, Jeon JH, Sung MK, Cheung DY, Kim JI, Kim JK, Lee YS. [Coffee enema induced acute colitis]. *Korean J Gastroenterol*. 2008 Oct;52(4):251-4.
3. Sashiyama H, Hamahata Y, Matsuo K, Akagi K, Tsutsumi O, Nakajima Y, Takaishi Y, Takase Y, Arai T, Hoshino T, Tazawa A, Fu KI, Tsujinaka Y. Rectal burn caused by hot-water coffee enema. *Gastrointest Endosc*. 2008 Nov;68(5):1008; discussion 1009.
4. Vanderperren B, Rizzo M, Angenot L, Hautroid V, Jadoul M, Hantson P. Acute liver failure with renal impairment related to the abuse of senna anthraquinone glycosides. *Ann Pharmacother*. 2005 Jul-Aug;39(7-8):1353-7.
5. Zhang L, Yang X, Sun Z, Qu Y. Retrospective study of adverse events of *Polygonum multiflorum* and risk control. *Zhongguo Zhong Yao Za Zhi*. 2009 Jul;34(13):1724-9.
6. Miranda CL, Reed RL, Kuiper HC, Alber S, Stevens JF. Ascorbic acid promotes detoxification and elimination of 4-hydroxy-2(E)-nonenal in human monocytic THP-1 cells. *Chem Res Toxicol*. 2009 May;22(5):863-74.
7. Nakamura K, Hisaeda Y, Pan L, Yamauchi H. *Chem Commun (Camb)*. Detoxification system for inorganic arsenic: transformation of As₂O₃ into TMAO by vitamin B12 derivatives and conversion of TMAO into arsenobetaine. 2008 Nov 7;(41):5122-4.
8. Antelava NA, Gogoluari MI, Gogoluari LI, Pirtskhala shvili NN, Okudzava MV. Efficacy and safety of heptral, vitamin B6 and folic acid during toxic hepatitis induced by CCL4. *Georgian Med News*. 2007 Sep;(150):53-6
9. Kennedy CJ, Tierney KB. Energy intake affects the biotransformation rate, scope for induction, and metabolite profile of benzo[a]pyrene in rainbow trout. *Aquat Toxicol*. 2008 Nov 21;90(3):172-81.
10. Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States, 2000. *JAMA*. 2004 Mar 10;291(10):1238-45.
11. Pedersen SD, Kang J, Kline GA. Portion control plate for weight loss in obese patients with type 2 diabetes mellitus: a controlled clinical trial. *Arch Intern Med*. 2007 Jun 25;167(12):1277-83.
12. Siervo M, Faber P, Gibney ER, Lobley GE, Elia M, Stubbs RJ, Johnstone AM. Use of the cellular model of body composition to describe changes in body water compartments after total fasting, very low calorie diet and low calorie diet in obese men. *Int J Obes (Lond)*. 2010 Feb 9.
13. Pires J, Curi R, Otton R. Induction of apoptosis in rat lymphocytes by starvation. *Clin Sci (Lond)*. 2007 Jan;112(1):59-67.
14. Adams SD, Delano BA, Helmer KS, Mercer DW. Fasting exacerbates and feeding diminishes LPS-induced liver injury in the rat. *Dig Dis Sci*. 2009 Apr;54(4):767-73.
15. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption. Health Canada.
16. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption. Health Canada.
17. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption. Health Canada.
18. Pichichero ME, Cernichiari E, Lopreiato J, Treanor J. Mercury concentrations and metabolism in infants receiving vaccines containing thiomersal: a descriptive study. *Lancet*. 2002 Nov 30;360(9347):1737-41.
19. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption. Health Canada.
20. Stowe J, Andrews N, Wise L, Miller E. Investigation of the temporal association of Guillain-Barre syndrome with influenza vaccine and influenzalike illness using the United Kingdom General Practice Research Database. *Am J Epidemiol*. 2009 Feb 1;169(3):382-8. Epub 2008 Nov 24.
21. Edwards DJ, Bellvue FH, Woster PM. Identification of 6',7'-Dihydroxybergamottin, a cytochrome p450 inhibitor in grapefruit juice. *Drug Metabol Disp* 1996; 24: 1287-90.
22. Lundahl J, Regardh CG, Edgar B, Johnsson G. Relationship between time of intake of grapefruit juice and its effect on pharmacokinetics and pharmacodynamics of felodipine in healthy subjects. *Eur J Clin Pharmacol* 1995;49:61-7.
23. MM Manson, HW Ball, MC Barrett, HL Clark, DJ Judah, G Williamson and GE Neal. Mechanism of action of dietary chemoprotective agents in rat liver: induction of phase I and II drug metabolizing enzymes and aflatoxin B1 metabolism. *Carcinogenesis*, Vol 18, 1729-1738
24. Khan MM, Sakauchi F, Sonoda T, Washio M, Mori M. Magnitude of arsenic toxicity in tube-well drinking water in Bangladesh and its adverse effects on human health including cancer: evidence from a review of the literature. *Asian Pac J Cancer Prev*. 2003 Jan-Mar;4(1):7-14.
25. Lockitch G. Perspectives on lead toxicity. in *Biochem*. 1993 Oct;26(5):371-81.
26. Scanlan N. *Altern Med Rev*. Compromised hepatic detoxification in companion animals and its correction via nutritional supplementation and modified fasting. 2001 Sep;6 Suppl:S24-37.
27. Barve A, Khor TO, Nair S, Reuhl K, Suh N, Reddy B, Newmark H, Kong AN. Gamma-tocopherol-enriched mixed tocopherol diet inhibits prostate carcinogenesis in TRAMP mice. *Int J Cancer*. 2009 Apr 1;124(7):1693-9.
28. Stapleton PP, Charles RP, Redmond HP, Bouchier-Hayes DJ. Taurine and human nutrition. *Clin Nutr*. 1997 Jun;16(3):103-8.
29. Choi EH, Lee N, Kim HJ, Kim MK, Chi SG, Kwon DY, Chun HS. Schisandra fructus extract ameliorates doxorubicin-induced cytotoxicity in cardiomyocytes: altered gene expression for detoxification enzymes. *Genes Nutr*. 2008 Feb;2(4):337-45.
30. Yadav UC, Ramana KV, Awasthi YC, Srivastava SK. Glutathione level regulates HNE-induced genotoxicity in human erythroleukemia cells. *Toxicol Appl Pharmacol*. 2008 Mar 1;227(2):257-64.
31. El-Begearmi MM, Ganther HE, Sunde ML. Dietary interaction between methylmercury, selenium, arsenic, and sulfur amino acids in Japanese quail. *Poult Sci*. 1982 Feb;61(2):272-9.
32. Kling LJ, Soares JH Jr. Mercury metabolism in Japanese quail. I. The effect of dietary mercury and selenium on their tissue distribution. *Poult Sci*. 1978 Sep;57(5):1279-85.
33. Park S, Kim AJ, Lee M. Synergic effects of alpha-tocopherol and beta-carotene on tert-butylhydroperoxide-induced HepG2 cell injury. *Toxicol Ind Health*. 2009 May-Jun;25(4-5):311-20.
34. Angeloni C, Leoncini E, Malaguti M, Angelini S, Hrelia P, Hrelia S. Modulation of phase II enzymes by sulforaphane: implications for its cardioprotective potential. *J Agric Food Chem*. 2009 Jun 24;57(12):5615-22.
35. Pagonis TA, Koukoulis GN, Hadjichristodoulou CS, Toli PN, Angelopoulos NV. Multivitamins and phospholipids complex protects the hepatic cells from androgenic-anabolic-steroids-induced toxicity. *Clin Toxicol (Phila)*. 2008 Jan;46(1):57-66.