

THE PHYSIOLOGY OF ALCOHOL COMPLICATIONS

ARNOLD S. LEONARD MD., PH.D. | GENERAL, THORACIC AND PERIATRIC SURGERY

INTRODUCTION

The physiology of alcohol complications is complex. A variety of problems exist. The type of alcoholic beverage, its' impurities, along with concentration and timing of ingestion are but a few of the variables. Also included in variables are the state of the immune system, the allergic susceptibility, the inflammatory process, the manufacture of free radicals, the complex hormone interaction, the state of hydration and the state of health of the liver and renal system. Most important also, is the body's ability to adapt its' insulin – glucose glycogen ratios to the rapid, glucose alteration generated in the liver by the alcoholic intake.

The Following facts have been suggested and remain controversial because of poorly constructed randomized trials and misunderstandings of both physiology as well as failure to collate the patterns on an individual making a great deal of variability in studies. Thus, many concoctions have been devised for "hangovers", however chemical evaluations vary due to the difference in adaptive mechanisms.

Upon ingestion of alcohol in sufficient amounts to cause headaches, fatigue, emesis, abdominal distress, and poor cerebration, the following physiologic and pathologic consequences occur.

1. Alcohol affects the stomach mucosa or lining – the mucous barrio altered so that the L-fucose, sialic acid, and hexosamine is penetrated. Thus, nerve endings are then exposed which alters the peristalses leading to emesis and painful contractions and loss of appetite. Also, the irritation of the neural endings sends signals to the brain – which is in part headache producing. Also, C-reactive protein can in part measure the inflammation of the stomach. (Gastroscopy reveals the gastritis with petechial hemorrhages at the end stage and possible bleeding.) Hydrochloric acid is secreted by the parietal cells when the mucous lining is altered and adds to the gastritis present.
2. Dehydration has been studied and occurs due to the stimulation of vasopressin in the brain (a hormone secreted by the pituitary gland stimulated by the alcohol intake) upon excessive alcoholic beverage intake. Vasopressin represses the renal tubules responsible for kidney absorption of fluid. Thus, frequent urination occurs, with subsequent dehydration. Other cellular systems are also affected due to the lack of hydration. Brain cells depleted of fluid may shrink the overall cortex and thus cause reactions from painful neurological sensitive system in the brain covering (meninges) and produce headaches. Dehydration also produces cellular acidosis, which effects normal cellular metabolism.
3. The liver is a complex organ generating many protective substances as well a storage system for glycogen (glucose storage). Alcohol or ethanol ingestion sets off chain reactions off in the liver to destroy its' protective properties. Free radicals, which are hydrogen ions with a one negative charge instead of two, are produced in excess. The free radicals raise havoc with cell membranes and their scavenger characteristics need to be neutralized. The liver's production of glutathione is decreased considerably and therefore the ability to reduce free radical production is repressed. Free radicals attack the cell membranes (a bilipid system). If the cell is penetrated over time, the main organelles of the cell (DNA, mitochondria and lysosomes) are affected. Mitochondria represent the body's energy production system resulting in fatigue from poor oxygenation. The cellular breakdown produces a complicated chemical reaction with production of aldehyde. The main aldehyde excreted in the urine is malonaldehyde. This substance can be measured with a color metric urine test and thus can demonstrate the free radical build up.
4. Important minerals such as sodium and potassium are lost in the urine as water is excreted in excess. Loss of these minerals thus creates poor muscle function, leading to cramps, weakness and accelerates central nervous systems. Urine sodium and potassium measurements can be made to verify this process.
5. The glycogen storage in the liver is affected and is broken down to glucose, which is also flushed out the urine adding also to body weakness. Urine measurement of glucose should pick up these phenomena.
6. Vitamin stores can also be depleted (B complex, Vitamin C). These vitamins are necessary for complete cell function and neutralization of free radicals. They are a part of the antioxidant system.
7. The immune system may also be depressed by the overproduction of free radicals. Thus chronic alcoholic

intake or excess acute ingestion may be devastating to the liver with decrease in glutathione and cysteine. The decrease in ability of the reticular endothelial system's ability to produce lymphokines responsible for T8 and NK production (immune boosters) makes the individual vulnerable to tumor production and chronic diseases as well as the aging process. (A chronic negative ability to neutralized free radicals. Also the resistance to systemic infections is considerably reduced.

8. Constant bombardment of the liver tissue by toxic alcoholic impurities can stimulate aldehyde productions and thus lead to psoriasis (fibrosis in the liver with replacement of hepatic cells). The chronic effect over time is well known – the production of hepatic cancers, especially with various forms of hepatitis.

HOW CAN ONE DECREASE THE SIDE EFFECTS OF EXCESS ALCOHOLIC INTAKE BESIDES THE OBVIOUS ANSWER – ABSTINENCE?

Several ingredients beside hydration and replacement with minerals and vitamins can be both practical and physiologic.

- A. Hydration
- B. Neutralization of the effects of excess hydrochloric acid in the gastric inflamed mucosa or lining with antacids and mucous stimulation. Reproduction of the mucosal barrier is the goal.
- C. The replacement of Vitamin C, and B complex helps the reparative process and helps to fight free radicals.
- D. The use of antioxidants such as guava leaf extract. Its high antioxidant value helps protect the cell wall from the effects of free radicals. This extract contains very high concentration of Quercetin. Quercetin is a very potent flavinoid. Guava leaf also has multiple antioxidants. It does therefore act to neutralized free radicals and cell damage. It does prevent the lipo protein layer of the cell wall from breaking down. Peroxynitrates are therefore reduced and also thus helps in the reductions of LDL (form cholesterol). Thus in chronic alcoholics and those with continuous acute episodic intake of alcohol, susceptibility to damaging effects of the coronaries may be present. (Page 120, James B., The Super Antiox.) Also present in the guava leaf extract are a number of other antioxidants measured by orac value, 791. Thus, this total antioxidant concentration give this extract the ability to neutralized free radicals and thus contribute to the prevention

and side effects of excess alcoholic intake and its end point – the “hangover”.

- E. The Drinkin' Mate tablets contain a group of substances that neutralized the effect of acid production in the stomach. This helps to protect the mucous layer and prevent the gastritis that is prevalent in acute alcoholic intake.

APPENDIX

1. Alcohol breakdown in the liver oxidation of ethanol Alcohol dehydrogenase removes electrons from ethanol to form acetaldehyde.

Acetaldehyde dehydrogenase converts the aldehyde with the help of oxygen to acetic acid($\text{H}_3\text{C}-\overset{\text{O}}{\text{C}}-\text{C}-\text{O}-\text{H}$) the two protein and two electrons exist and can form fatty acids or carbon dioxide and water when further degenerated and acidic acid and water and carbon dioxide can thus be excreted. Glutathione, which contains cystine, is attracted to acetaldehyde to form the nontoxic acetate, which is eliminated.

2. CNS effects

Nerve cells are affected primarily by alcohol and neurotransmitters send messages to cells – synapses or cell gags. Then, once the gap is crossed, the neurotransmitter binds to protein in the cell affected and stimulates the cell. Excitement or depression of the cell can occur depending on the status. The latter directly effects behavior and is illustrated by the bizarre behavior of alcoholics. Several areas in the brain are affected depending on the amount of alcohol consumed. In order, the cortex limbic system, cerebella, gypothalamus, pituitary and medulla can respond. If the lover system is affected (medulla) and depressed, breathing and cardiac arrest could occur.

3. Congeners

These are impurities in different alcoholic beverages and are byproducts of the fermentation process (mostly in red wines and dark liquors such as bourbon, brandy, tequila and whisky). These toxins must be neutralized by the body in the liver.

4. Glutamine rebound

Glutamine is a natural elemental stimulant in the body. Alcohol depresses its production. After ingestion of alcohol the body over reacts and produces more glutamine and thus

enhances effects resulting in tremors, anxiety, restlessness and increase in blood pressure.

5. **Alcohol is a stimulator of the parietal cells – which produce hydrochloric acid in the stomach. The inflammatory effects and protective mucous breakdown are the result. Also, the autonomic nervous system (parasympathetic) is affected and increased peristalsis occurs as well as neural factors transmitted to the brain.**

6. **Vasopressin inhibition**

Alcohol can affect the pituitary gland and depress the vasopressin normally produced. Vasopressin works to increase renal tubular absorption of water. Thus depression causes elimination of water by the kidney and subsequent dehydration.

7. **Glycogen or stored glucose in the liver is broken down by alcohol. Thus glucose in large amounts is formed and eliminated in the urine. The side effects are important because sodium, potassium and magnesium are all eliminated with the water (diuresis). These substances are necessary for good cell function. Weakness results from a negative effect on mitochondria of the cell and thus energy production**

8. **Sample ID | Guava ORAC**

	Brunswick Lab ID	ORACHydro* (µmoleTE/g)	ORAClipo^ (µmoleTE/g)	ORACtotal (µmoleTE/g)
Wild Guava Leaf Extract Lot # 14832	07-0886	783	8	791

*The ORAC analysis provides a measure of the scavenging capacity of antioxidants against the peroxy radical, which is one of the most common reactive oxygen species (ROS) found in the body. ORACHydro reflects water-soluble antioxidant capacity and the ^ ORAClipo is the lipid soluble antioxidant capacity. ORACtotal is the sum of ORACHydro and ORAClipo. Trolox, a water-soluble Vitamin E analog, is used as the calibration standard and the ORAC result is expressed as micromole Trolox equivalent (TE) per gram. The acceptable precision of the ORAC assay is 15% relative standard deviation. i-ii-

TESTING PERFORMED BY J. FRIETAS AND J. THEOBALD

9. **GUAVA**

Family: Myrtaceae

Genus: Psidium

Species: guajava

Properties/Action: Antimicrobial, Astringent, Bactericide, Cicatrizing, Emmenagogue, Hyperglycemic, Laxative, Nutritive, Spasmolytic

Phytochemicals: Alanine, Alpha-humulene, Alpha-linolenic-acid, Alpha-selinene, Araban, Arabinose, Arginine, Ascorbic-acid, Ascorbigen, Aspartic-acid, Benzaldehyde, Benzene, Beta-bisabolene, Beta-carotene, Beta-caryophyllene, Beta-copaene, Beta-farnesene, Beta-humulene, Beta-ionine, Beta-pinene, Beta-selinene, butanal, calcium, Cinnamylacetate, Bitral, Citric-acid, Copper, d-galactose, D-galacturonic-acid, Delta-cadinene, Ellagic-acid, Fructose, Gallic-acid, Glutamic-acid, Glycine, Histidine, iron, Isoleucine, L-malic-acid, Lactic-acid, Leucine, Leucocyanidins, Limonene, Linoleic-acid, Lysine, Magnesium, manganese, Methylcyanin, Methylcinnamate, Methylisopropylketone, Mufa, Myristic-acid, Niacin, Oleic-acid, Oxalic-acid, Palmitic-acid, Palmitoleic-acid, Pantothenic-acid, Pectin, Phenylalanine, Phosphorus, Phytinphosphorus, Potassium, Proline, Pura, Rhamnose, Riboflavin, Serine, SFA, Stearic-acid, Sulfur, Thiamin, Threonine, Tryptophan, Tyrosine, Valine, Vit-B-6, Xylose, Zinc.

(WWW.RAINTREE-HEALTH.CO.UK/CGI-BIN/GETPAGE.PL?/PLANTS/GUAVA.HTML)

REFERENCES:

The Healing Power of Rainforest Herbs by Leslie Taylor © 2005 Tropical Plant Database (www.rain-tree/guava.htm)

Ojewole, JA. **Antiinflammatory and analgesic effects of Psidium guajava Linn. (Myrtaceae) leaf aqueous extract in rats and mice. Methods find Esp Lin Pharmacol**, 2006 Sep;28(7):441-6

Liang Q, Oian H, Yao W. **Identification of flavinoids and their glycosides by high-performance liquid chromatography with electrospray ionization mass spectrometry and with diode array ultraviolet detecton.** Eur J Mass Spectrom (Chichester, Eng.). 2005;11(1):93-101.

[Http://home.howstuffwork.com](http://home.howstuffwork.com)

[Http://medicalnewstoday.com/medicalnews.](http://medicalnewstoday.com/medicalnews.php?newsid=5089)

[php?newsid=5089](http://medicalnewstoday.com/medicalnews.php?newsid=5089)

Article date: December 31, 2003.

<http://beginnersguide.com/common-ailments/hangovers-and-hangover-cures/hangover-causes.php>

Quian, he, Nihorimbere, Venant, 2004. **Antioxidant power of phytochemicals from Psidium guajava leaf.** Journal of Zhejiang Universty Science, 5(6):676-683

Blois, M.S., 1958. **Antioxidant determinations by the use of a stable free radiacal.** Nature, 181:1199-1201

Brand-Williams, W., Cuvelier, M.E., Berset, C, 1995. **Use of free radical method to evaluate antioxidant activity.** Lebensmittel-Wissenschaft and Technologie, 28(1):25-30

Coppen, P.P., 1983. **The Use of antioxidants. In: Rancidity in Foods,** J.C. Allen, R.J. Hamilton (Eds.). Applied Science Publisher, London and New York.

Hagerman, A.E., Riedl, K.M., Jones, G.A., Sovik, K.N., Ritchard, N.T., Hartzfeld, P.W., Riechel, T.L., 1998. **High molecular weight plant polyphenolics (Tannins) as biological antioxidants.** Journal of Agriculture and Food chemistry, 46:1887-1892.

Halliwell, B., 1990. **How to characterized a biological antioxidant.** Free Radical Reseach communications, 9:1-