The Australian Wine Research Institute

Wine safety

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Introduction

AWRI

Wine safety is a pun on food safety.

Grapes are not simply transformed into wine but undergo a complex interaction with additives and processing aids in addition to the winemaking process.

Some of these raw materials such as diatomaceous earth and sulfur dioxide, as well as cleaning solvents, have health and safety issues.

The final product also has some potential health and safety issues such as allergenicity and food intolerance, in addition to its amount and pattern of consumption.

Outline

Health and safety associated with:

1. **raw materials**
   - diatomaceous earth
   - sulfur dioxide
   - caustic soda
2. **final product**
   - histamine
   - sulfur dioxide
   - proteinaecous fining agents
3. **consumption of final product**
   - amount and pattern

1. Raw materials

Diatomaceous earth

Source

Diatomaceous earth (DE), also referred to as diatomite or diatomaceous silica, is a non-metallic mineral composed of the skeletal remains of microscopic single-celled aquatic plants called diatoms. These plants and the ability to absorb water-soluble forms of silica from their environment to form a skeleton of amorphous silica. It is usually a relatively non-compressible particle of 10–2000 μm in diameter, often off-white in colour.

DE is, therefore, predominantly amorphous silica (non-crystalline silicon dioxide) and may also contain small amounts of crystalline silica (quartz), adhering water insoluble oxides of calcium, magnesium, iron, aluminium and other trace elements.

The diatomite ore is mined and three different grade products are available—natural; non-flux (straight) calcined; and flux-calcined. The latter two processed products contain crystalline silica, primarily cristobalite, which has implications for carcinogenicity/toxicity.

Usage

Transported in paper bags, the various grades of DE are used in the wine industry as a filteraid, i.e. it is added to juice or wine for the purpose of removing suspended solids to produce a clarified juice or wine. The DE forms a filter bed or surface, and is of two primary types: filter elements in a pressure vessel or rotary vacuum pre-coat filters. DE was considered as an acceptable alternative to asbestos filter pads in the early 1980s.

DE

Potential effects on human health

Cristobalite, the crystalline silica produced during processing of the natural grade DE, is capable of producing fibrosis in the lungs of animals, and if inhaled in sufficient quantity and for a sustained period of time by humans, is capable of producing a fibrotic lung disease called pneumoconiosis; this disease has not been observed with short or occasional sporadic exposure to DE (WHO 1997).

Carcinogenicity

Exposure to DE has not been observed to have any systemic toxic effects in humans.

The International Agency for Research on Cancer (IARC), however, has stated that there is sufficient evidence that inhaled cristobalite is a carcinogen in animals. There is also sufficient (although limited) evidence of carcinogenicity in humans, such that all products containing cristobalite are legally required to have accompanying warnings to this effect. There is inadequate evidence in humans that amorphous silica is carcinogenic (WHO 1997).

In 1997, the IARC published the DE component cristobalite as category 2A 'probably carcinogenic to humans' and the primary component, amorphous silica, as category 3 'not classifiable as to human carcinogenicity' (WHO 1997).

DE

Other effects

DE can be a mild irritant to skin and mucous membranes, such that gloves should be worn when handling DE in the winery.

DE

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Recommended storage and handling conditions

In order to ensure that a low airborne concentration of DE is maintained, the following storage and handling procedures are recommended for wine industry employees in direct contact with DE:

1. Inspection of bagged products on receipt of goods. Powder spills should be removed before and during unloading by vacuum cleaning or wet sweeping, where broken bags should be repaired; dry sweeping will create airborne dust. It has been suggested that respiratory masks/protection should be worn during cleaning procedures, in addition to safety glasses;

2. Bags of product should be carefully handled and stored to prevent breakage of bags and spillage. Again, powder spills should be removed as they occur. Waste products should be carefully disposed of so as not to create airborne dust; and

3. The work environment should be adequately ventilated to prevent excessive exposure to airborne dust.

Sulfur dioxide

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Source

Potassium metabisulfite, $K_2S_2O_5$, is a white crystalline free-flowing powder or granules with a pungent sulfur odour.

It is a sulfite and is chemically similar to sodium metabisulfite, with which it is sometimes used interchangeably. Potassium metabisulfite is generally preferred out of the two as it does not contribute sodium to the diet.

Potassium metabisulfite has a monoclinic crystal structure which decomposes at 190℃, yielding potassium oxide and sulfur dioxide:

$$K_2S_2O_5(s) \longrightarrow K_2O(s) + 2SO_2(g)$$

SO_2

Usage

Potassium metabisulfite is added to wine or must, where it forms sulfur dioxide gas (SO_2). This both prevents most undesirable wild microorganisms from growing, and it acts as potent antioxidant, protecting both the color and flavors of wine.

Typical dosage is 1/4 tsp potassium metabisulfite per 6 gallon bucket of must (yielding roughly 75 mg/L of SO_2) prior to fermentation, and 1/2 tsp per 6 gallon bucket (150 mg/L of SO_2) at bottling.

It is also a sterilant. Winemaking equipment is sanitized by spraying with a 1% SO_2 (2 tsp potassium metabisulfite per L) solution.

When mixed with water, however, it releases a pungent, unpleasant suffocating sulfur-smelling gaseous SO_2 that can also cause breathing difficulties in individuals. Correspondingly, it is less popular than chemicals such as hydrogen peroxide for effective and odorless sterilization of equipment.

SO_2

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Potential effects on human health

When ingested, sulfur dioxide is not expected to be a health hazard but large amounts may cause gastrointensinal disturbances due to release of sulfur dioxide. Nausea, vomiting, diarrhea may result. The acceptable daily intake is 0.7 mg/kg bdoy weight (JECFA 1998).

In addition, individuals who are asthmatics or who are allergic to sulfur dioxide, may experience an allergic reaction, such as central nervous system depression, bronchoconstriction and anaphylaxis, to either ingested sulfur dioxide or airborne sulfur dioxide (acute exposure).

It may cause irritation and possibly dermatitis on contact with skin, and redness and pain on contact with eyes.

No adverse health effects are expected with chronic exposure.

SO_2

Recommended storage and handling conditions

In order to ensure that a low airborne concentration of SO_2 is maintained, the following storage and handling procedures are recommended for wine industry employees in direct contact with SO_2:

Keep in a tightly closed container, stored in a cool, dry, well ventilated area. Protect against physical damage.

If there is an accidental leak or spillage, ventilate the area of leak or spill. Wear appropriate personal protective equipment. Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal.

For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator may be worn. For emergencies or where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Wear protective gloves and clean body-covering clothing. Use chemical safety goggles. Maintain an eye wash fountain and quick-drench facilities in work area.

Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

Sodium hydroxide (caustic soda)

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Source

Sodium hydroxide (NaOH) or caustic soda is a caustic metallic base. Pure sodium hydroxide is a white solid which is available in pellets, flakes, granules and as a 50% saturated solution. In bulk it is most often handled as an aqueous solution.

Usage

NaOH is very soluble in water. It also dissolves in ethanol and methanol, though it exhibits lower solubility in these solvents than potassium hydroxide. As it forms a strong alkaline or basic solution when dissolved in these solvents, it is therefore used in many industries, including the wine industry, as a cleaning agent.

NaOH

Potential effects on human health

Solid NaOH or solutions containing a high concentration of NaOH are caustic and may react with fats and oils on skin surface which may cause chemical burns and permanent injury or scarring to skin and eyes, as well as blindness. A solution of 0.5M or more of NaOH should be labelled corrosive, while a solution between 0.5-0.05M should be labelled irritant.

Indeed, dissolution of NaOH is highly exothermic, and the resulting heat may cause heat burns or ignite flammables.

Correspondingly, ingestion of NaOH may result in perforation of digestive tract, hemorrhage and severe burns of mouth and throat, while inhalation may result in severe burns to the respiratory tract.

NaOH

Handling and storage

The following storage and handling procedures are recommended for wine industry employees in direct contact with NaOH:

Always wear safety glasses and gloves when handling NaOH or its solutions. Do not allow either the solid or solution to come into contact with skin. When preparing solutions swirl the liquid constantly to prevent "hot spots" developing.

Small amounts of dilute NaOH can be flushed down a sink with a large quantity of water, unless local rules prohibit this. Larger amounts should be neutralised before disposal.

NaOH is a strong base, reacting violently with acid and is corrosive in moist air to metals like zinc, aluminium, tin and lead forming a combustible/explosive hydrogen gas. It also reacts with ammonium salts to produce ammonia, causing a fire hazard. It attacks some forms of plastics, rubber or coatings. In addition, it rapidly absorbs carbon dioxide and water from air, while on contact with moisture or water heat is generally generated.

Therefore, NaOH should be stored separated from strong acids, metals, food and feedstuffs, dry and in a well closed container, and in an area having corrosion resistant concrete floor.

2. The final product

From a comprehensive literature review

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Only a few cases of severe adverse reactions to the consumption of wine have been identified, which have been anecdotally attributed to biogenic amines, salicylates or sulfites, in addition to grapes.

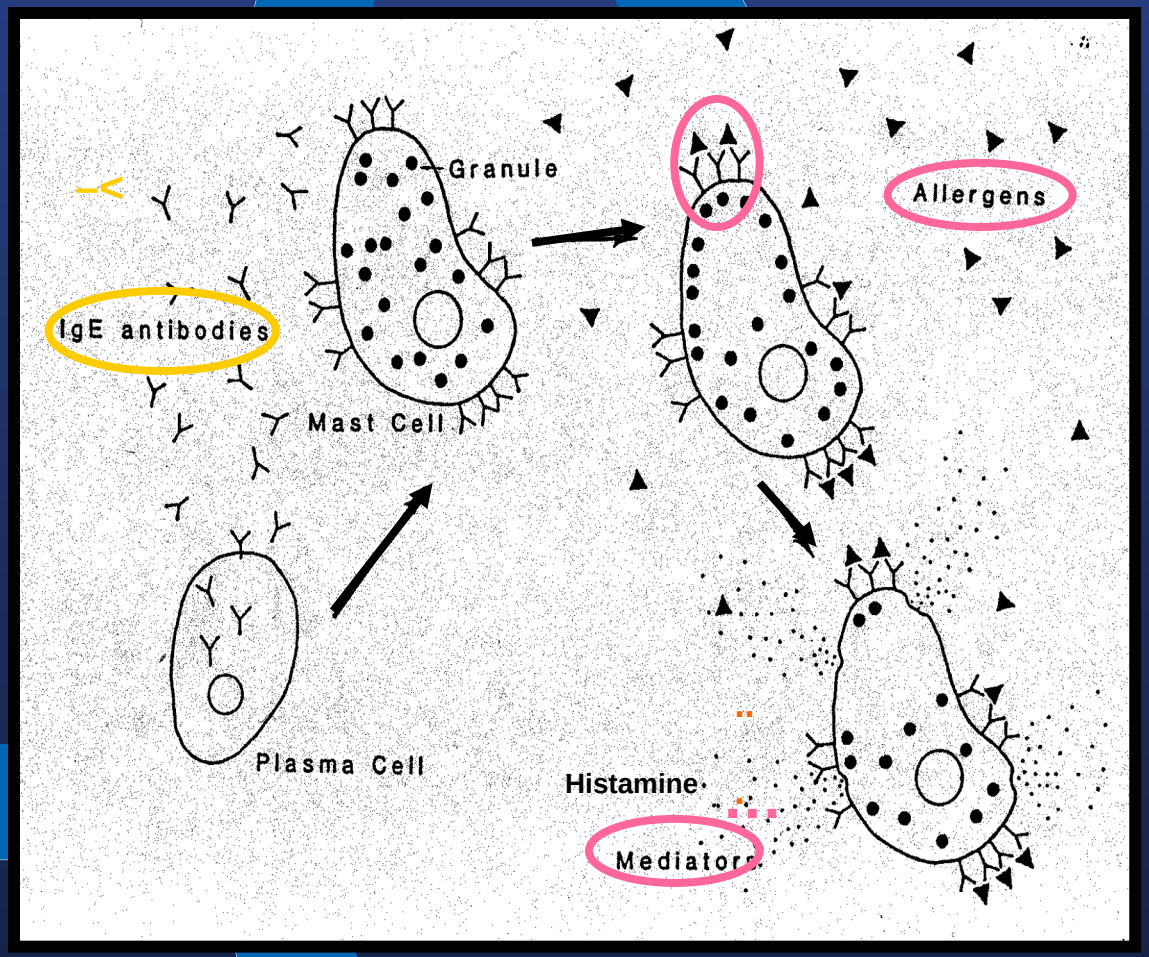
What is an adverse food reaction?

immunologically mediated = food allergy

or

non-immunologically mediated = food intolerance

Mechanism of an IgE-mediated allergic reaction



(Taylor 1992)

What are the symptoms of a food allergy?

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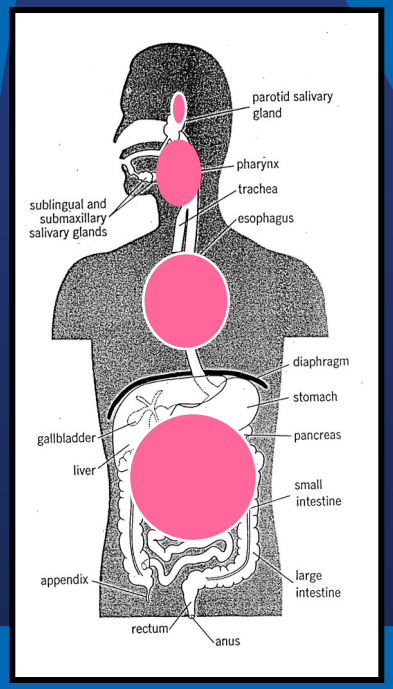
Immediate onset (0-2 h)



Symptoms reflect where the mast cells are situated in the body.

What are the symptoms of a food allergy?

Symptoms	
Respiratory –	Rhinitis (runny nose)
	Asthma (difficulty breathing)
	Laryngeal oedema (constriction of throat)
Cutaneous –	Angioedema (swelling)
	Urticaria (hives)
	Eczema/atopic dermatitis (skin rash)
Gastroinestinal -	Abdominal cramps
	Diarrhoea
	Nausea
	Vomiting
Systemic - Analphylatic shock (cardiac/respiratory)	

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Histamine

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What is histamine?

The biogenic amine, histamine, is an endogenous compound. It is produced in the body by both mast cells and their related blood basophils. The highest concentration of histamine is produced in the lungs.

How does it effect human health?

Histamine exerts its effects or adverse reaction by interacting with receptors on cellular membranes; there are H1 and H2 receptors, which have different effects on the body. These receptors are also located in more than one organ of the body, which explains why histamine is responsible for numerous symptoms.

Subsequently a number of adverse reactions have been ascribed to histamine, including low blood pressure, facial flushing, nasal congestion and/or gastrointestinal and respiratory distress, as well as migraines.

Accordingly, those individuals who experience an adverse reaction when consuming wine frequently attribute their reaction to the histamine content of wine.

Histamine

Relationship?

Studies clearly demonstrate that histamine is a minor constituent of wine and that there is no relationship between its concentration in wine and histamine-mediated adverse reactions in either healthy tolerant or wine intolerant consumers.

One possible hypothesis is that a 'histamine-releasing' substance in wine such as acetaldehyde, in particular for consumers who have significantly reduced acetaldehyde dehydrogenase activity, causes the histamine-mediated adverse reaction.

Another possible hypothesis is that although the amount of histamine in individual foods is below the amount generally thought necessary to induce an adverse reaction, consumption of multiple histamine-containing foods on an occasion may result in ingestion of sufficient histamine to produce symptoms as the body's capacity to breakdown histamine is exceeded.

Sulfur dioxide

What is sulfur dioxide?

Sulfur dioxide and the inorganic sulfites that liberate sulfur dioxide are additives that are commonly considered by consumers to elicit an adverse reaction.

How does it effect human health?

Asthma is the adverse reactions to sulfur dioxide and, anecdotally, wine has been associated with induced-asthma adverse reactions.

In 2000, a community survey suggested that approximately 30% of asthmatic individuals believe that wine is associated with worsening asthma symptoms; approximately 2.2 million Australians have asthma.

Foods and food additives, however, are not common triggers for asthma (National Asthma Council of Australia 2005). Furthermore, adverse reactions to sulfite compounds in non-asthmatic and non-sensitive individuals are rare.

Sulfur dioxide

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Relationship?

Studies show that sulfur dioxide will generally only precipitate an adverse reaction in sulfite-sensitive asthmatics, which comprise approximately 1.7% of all asthmatics. Steroid-dependent asthmatics are most at risk of an adverse reaction.

The threshold for an adverse reaction varies between 5 to 200 mg sulfur dioxide, where foods containing greater than 100 mg/L sulfur dioxide may elicit no reaction in some sulfite-sensitive individuals.

Usually the minimum threshold is considered to be 10 mg/L, however, which reflects existing Australian and international legislation stipulating that "added sulphites in concentrations of 10 mg/kg or more" must be stated on the label of a food product such as wine.

In 2004, the mean concentration of total sulfur dioxide in red wine was *ca.* 55 mg/L and *ca.* 125 mg/L in white wine.

This implies that the influence or role of sulfur dioxide and/or wine in triggering asthmatic adverse reactions may have been *overestimated* in the community.

Processing aids

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What are the potentially allergenic processing aids?

Egg, fish and milk and their products are associated with allergic reactions in 4-8% of children and 1-2% of adults.

Casein, potassium caseinate and milk, egg white and isinglass are processing aids which are, or contain, proteins that are potentially allergenic.

The question of a reaction due to processing aids has not been specifically considered in severe adverse reactions to the consumption of wine.

HARDYS
SHIRAZ CABERNET

Established in 1853, Hardys is one of Australia's most respected and highly awarded winemakers.
Hardys Shiraz Cabernet combines the spicy warmth of Shiraz with the rich fruity characters of Cabernet.
The palate exhibits a superb balance of flavours complemented by soft vanillin oak characters.
An ideal wine to accompany beef, lamb, veal, game and pasta.

BOTTLED BY THOMAS HARDY & SONS
REYNELL RD. REYNELLA STH AUST 5161

CONTAINS SULPHITES EGG PRODUCTS AND MILK PRODUCTS

PRODUCT OF AUSTRALIA 13.5% ALC/VOL
APPROX 8.0 STANDARD DRINKS

00070

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Processing aids

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How do they effect human health?

The most common allergic symptoms are swelling of the face, lips and mouth, an itchy rash on the face, throat and chest, and gastrointestinal symptoms of nausea, vomiting, diarrhoea and severe colicky pains.

The most life-threatening symptoms, however, are asthma, swelling of the throat and anaphylaxis, which is a decrease in blood pressure, cardiac arrhythmia and multiple organ failure. If these symptoms are not treated immediately, death can occur within 15 minutes.

It has been difficult to determine a lower limit for the amount of a protein below which the risk of an allergic reaction is minimal, due to the numerous factors involved, such as age, gender, genetic constitution, dietary habits, the allergenicity of dietary components and as yet largely unidentified environmental factors.

Processing aids

Relationship?

The Alfred Hospital/Monash University in Melbourne and The Australian Wine Research Institute in Adelaide conducted a study to investigate whether individuals with a known allergy to eggs, fish, milk or nuts exhibit an allergic reaction on consumption of wine that was fined with food proteins such as casein and potassium caseinate, egg white, isinglass, milk and non-grape derived tannins that derived from chestnuts and oak galls.

Wine challenge

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Visit 1 → ≥ 7 days → **Visit 2**

baseline observations

- Blood pressure, pulse, respiratory rate
- Assessment of uvula, tongue and lips
- Assessment for any urticaria/angioedema
- Asculation of chest
- Lung function
- Data collection sheet filled in by subject (visual analogue score)

On one visit the subject was bled prior to challenge for laboratory tests

Subject consumed 100 mL wine over 10 min

On one visit the relevant fined wine was consumed and on the other, the unfined wine. Both the subject and the research nurse were blinded as to the ingested wine

Follow-up observations over 2 h at 15 min intervals

- Symptoms
- Visual analogue score
- Physical examination
- Lung function

Processing aids

Relationship?

The study showed that these subjects did not exhibit a significant allergic reaction (anaphylaxis) to a double-blind, placebo-controlled challenge of fined wines that could be attributed to residual food protein in wine made according to good manufacturing practice. Moreover, no clinical symptoms requiring treatment were exhibited by any food allergic subject following consumption of wine that was fined with food proteins.

The rarity of IgE-mediated milk allergy in adults prevented a statistical analysis for casein and milk-fined white wines, but this rarity makes potential allergic reactions to residual of these food proteins in wine a theoretical rather than an actual problem.

Processing aids

Thus, for Australian food-allergic adult consumers the current prescribed winemaking process presents an extremely low risk of a significant allergic reaction from the use of food protein processing aids.

Furthermore, from the winemaker's perspective it is important that little protein remains in the wine after clarification, as the presence of relatively large amounts of residual food protein leads to visible protein precipitates that require remedial practices.

It is also important to note the difference between wine products containing egg such as egg marsala, and egg white-fined wines. Wines that are intended to contain food proteins should be clearly labelled, avoided by allergic individuals, and were not the focus of this study.

3. Consumption of the final product

Bottom line…

wine in moderation

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Relative risk of mortality from different causes related to alcohol consumption - a 12 year study of 276,802 US men aged 40-59 years.

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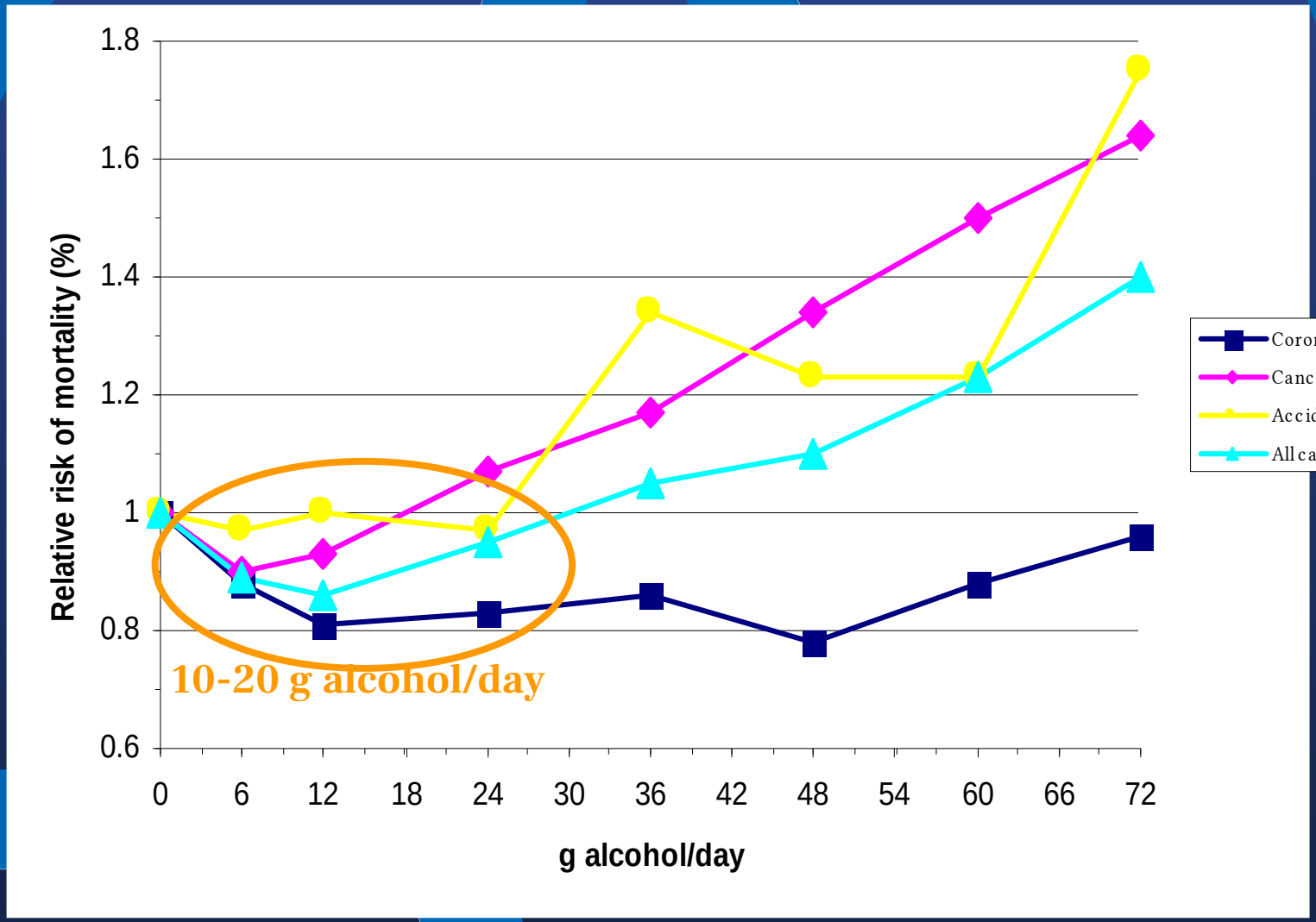

Adapted from Boffetta and Garfinkel (1990) Alcohol drinking and mortality among men enrolled in an American Cancer Society prospective study. Epidemiology **1**, 342–8.