A PRIMER FOR WINE AND ALCOHOL PRODUCTION IN ANCIENT TIMES.

The use of the word "wine" in the Bible has been the subject of a great deal of misinformation due to the lack of scientific knowledge about the production of alcoholic beverages on the part of the authors of the numerous books put out by brethren. None of the books that I have seen show even a rudimentary understanding of the chemistry and microbiology surrounding wine making. I believe that a few scientific facts will help everyone in their understanding of the subject. I set down these few facts without reference; however, a short investigation with an elementary microbiology text and an organic chemistry text will suffice for showing that this review is based on fact and not on the fiction found in the books available on this subject mentioned above.

The production of alcohol by fermentation is most often accomplished by a yeast which is fed sugar. The definition of a few terms might well offer considerable insight into your understanding of this subject. You should bear in mind, however, that none of the following facts or terms were available to people in Bible times.

Fermentation was put on a rational basis during the lifetime of Louis Pasteur (middle 1800's), who was paid to work on the subject due to the extreme variability in the results normally obtained in the vineyards of France.

The word "must" refers to the juice of the grape before fermentation begins. That fermentation has begun is evident by the change of flavor in the juice. You cannot smell the alcohol in the juice, rather you smell a number of flavors that are also produced in the fermentation. Arndt and Gingerich state the Greek word for must is *trux* and the word for wine is *oinos*.

The word alcohol as used by the organic chemist refers to a class of chemical compounds; however, when used by the layman, it normally has reference to ethyl alcohol (also called ethanol). Other alcohols with which you may be familiar are methyl alcohol (methanol or wood alcohol) which may cause blindness when consumed and which may contaminate moonshine or other distilled liquors, and isopropyl alcohol (propanol or rubbing alcohol). All of the alcohols are toxic to humans; methyl alcohol is more toxic than ethyl which is more toxic than propyl. Both methyl and ethyl alcohols are common constituents of fruit juices and the concentration varies. Methyl and ethyl alcohols have very little odor. The "alcohol breath" that we are so familiar with is due to the other organic chemicals that are made during the fermentation, which give a wine, a liqueur or a whiskey its characteristic odor. The differences in these other chemicals are what makes one wine more valuable than another. The best wines have an exceptional taste due to a choice selection of the yeast and the fermentation conditions and not due to the amount of alcohol produced.

The term fermentation or ferment refers to the action of a microbe on a food source. Many valuable products are obtained by fermentation, including alcohol, penicillin, many other antibiotics and useful chemicals. Fermentation may take place either with or without air (i.e., oxygen) being present.

Yeast is a generic term for a group of microbes which includes the common bakers yeast

(Saccharomyces cerevisiae) as well as harmful microbes such as those that cause thrush (Candida albicans). These microbes are found wherever small amounts of sugar, water and a relatively warm temperature are found. One of the most common habitats is on the skin of fruits. Yeasts are especially common on the skin of grapes and most often on the puckers near the stem that tells when the grape is ripe. An average of 1500 yeasts are present on the unbroken skin of each ripe grape, and when the skin is broken, the yeast will multiply vigorously. In an over ripened grape, the skin will pucker near the stem and the yeast will very quickly multiply in the released juice. Yeasts are not the only type of microbe that may be used to ferment alcohol; however, they are the type commonly found in wine fermentations.

Strain is a microbiological term for a specific type of a yeast. Saccharomyces cerevisiae is the scientific genus and species for the yeast commonly used as baker's yeast and for wine fermentations. There are many different strains of Saccharomyces cerevisiae just as there are many differing characteristics to Homo sapiens. Although these strains are indistinguishable microscopically, each would impart slightly different characteristics to a fermentation including the level of alcohol produced or the taste of a particular wine. Mechanized grape picking has not been successfully applied as yet because the bruising of the grapes releases enough juice that bad flavors may be introduced by the fermentation which occurs prior to getting the grapes from the field to the winery, even with the help of modern transportation.

An inoculum is a quantity of microbe which is put into the prepared juice or feed solution. The purer the inoculum and the cleaner the conditions of the fermentation, the more reproducible the taste of the wine will be each year. Wild yeasts (the equivalent of a weed in a lawn) may impart off flavors or change the alcohol level of the fermentation.

Sugar refers to a broad class of compounds of which sucrose (common household sugar) is only one. To the microbiologist, the term sugar is usually split into two groups, the five carbon and the six carbon sugars (there are no five carbon sugars commonly available to the non-scientist). Some yeasts will ferment both types of sugars, while some will only ferment only one. The common yeast used to make wine, Saccharomyces cerevisiae, will ferment only the six carbon sugars. Although sucrose is the main type of sugar in sugar cane, fructose is the main type of sugar in fruits and in corn. The sweetness of these two different sugars varies, but their value as a food for the yeast is the same.

Distillation is a process used for concentrating alcohol. Ethyl alcohol may be removed from water by this method and concentrated to about 95%. It is necessary to add other organic solvents to raise the alcohol concentration above this level. This process was not discovered until the 14th century and thus was not available to increase the alcohol content of beverages beyond that obtained in normal fermentation.

The Microbiology of Wine

The most natural place to find a yeast is growing on the skin of a grape. In ancient times the grape

skins were scattered on the ground of the vineyard in order to improve the taste of the wine the following year. The higher the concentration of the good tasting yeast, the better the inoculation of the wine the next year. Thus, an individual vineyard obtained a reputation for the finest wines as a result of having inoculated its grapes with the same strain of yeast for many years.

In order to start a fermentation, the grapes must be crushed and an inoculum of yeast added. In modern wineries, the grapes are washed with a sterilizing solution, the grapes are crushed in a sterile roller and the fermentation is done in large polished stainless steel vats. None of these things existed in New Testament times. The grapes might have been washed with river or well water. Such a wash would have had at least 3.75 million microbes per gallon and perhaps 1000 times that many. The skin of the grapes contains at least 7 million yeasts per pound. The crushing of the grapes may have been by foot in an open vat or in a stone roller, which was also open to the air. These conditions, although seemingly extremely dirty by our standards, are quite suitable for making a drinkable wine. Everything necessary for the fermentation was present: the grape juice or must, the yeast and air. To the ancients, it must have seemed nearly miraculous that grape juice would ferment overnight and that the taste would continue to change over the following year or years without their ever having done anything to the juice. This explains why the ancients could refer to the wine being in the grape (Isa 65:8).

Once crushed, the must would have been put into wineskins. A closed vessel is necessary to make a wine. Where air (oxygen) is allowed to come into contact with the yeast, the yeast grows by an aerobic metabolism. That is, the yeast mainly continues to reproduce vociferously and consumes as much sugar as possible. If this process is allowed to continue, the must will become very thick and heavy with the growing yeast (which is a good source of the B vitamins), but will spoil very quickly once all the sugar is used up. Other microbes will begin to ferment the yeast and other proteins that are present.

Where oxygen is not present, the yeast very quickly stops growing and begins an anaerobic metabolism. Under these conditions, the yeast begins to produce alcohol and carbon dioxide. Carbon dioxide is heavier than air and yeast fermentation left undisturbed in a jar or a vat with high sides will quickly become anaerobic and alcohol production will begin. The alcohol level is dependent on the total amount of sugar available and the amount of oxygen that is stirred into the mixture.

A high level of alcohol (5-12%) is desired in order to prevent contamination of the fermentation by slower growing microorganisms. The main value of fermentation is to preserve the food without harmful microbes being allowed to grow. Harmful microbes that will grow readily but more slowly on grape juice can cause such things as food poisoning, liver damage and even St. Elmo's fire. The byproducts that bacteria, fungi and molds produce can be extremely harmful.

Once fermentation has ceased, wine has to be protected from additional oxygen (air), since this readily allowed the introduction of microbes which would turn the wine into vinegar (generally Acetobacter vinlandii). Vinegar was also a valuable preservative for pickles and other very acidic foods. Again, all the ancients had to do to make vinegar is to stir air into wine or pour the wine over

a bed of wood chips (which will naturally hold the Acetobacter).

In ancient times, wine was an extremely healthy drink and an important source of nutrition. Although the water was reasonably safe, it could also be a source of disease. Warnings about the water are not unusual today for travellers in countries where modern hygiene is not practiced. Milk was very rarely consumed unless cooked, fermented (to yogurt by Lactobacillus) or made into cheese. Raw milk is often contaminated by tuberculosis bacteria and is highly dangerous even today.

Preservation of Grape Juice in NT Times

If you have ever tried keeping a fruit juice which you prepared by hand squeezing, you already know that about a week in the refrigerator is the limit. If you tried squeezing your own grapes and did not know about home canning or the addition of sugar to make a jelly and didn't have access to a refrigerator, you were probably not successful in keeping the juice over one or two days. The reason for this is explained by the information above. Yeast naturally inhabit the skin of the fruit and fermentation will start immediately when the fruit is crushed. Depending on the type of container you will either get a lot of yeast or wine. Since distillation was not invented until around 1400 A.D., home canning was not invented until 1810 (Napoleon gave a 10,000 Franc prize for the first demonstration), and pasteurization (the process of heating a liquid for a short period to semi-sterilize it) was not invented until around 1850, only refrigeration and fermentation could have been available to people in the NT period. Pliny tells us that you could place the juice in a sealed jar and put it in a river (56°F) or in a cave (56°F) and have fresh juice on a year around basis. However, you can disprove this by your own experience with your refrigerator (40°F), which is much better at preserving things than keeping them the higher temperature of caves or rivers. That leaves fermentation as a method of preservation and the ancients used the method even though they did not know what was going on (Pasteur found out about yeasts in the 1850-1860's). The first person to see bacteria was Anton van Leeuwenhoek, the inventor of the microscope, in the seventeenth century.

Wine and Social Drinking Today

An amateur wine maker will not usually get above 6% alcohol content even with all of the information and yeast cultures available to him today. This is probably (no one knows for sure) equivalent to strong drink in the Bible. The maximum alcohol content of a wine is 15.5%, however, this is with a very specially selected strain of yeast for alcohol for fuel production with optimized sugar content. Most yeasts are killed when the level of alcohol reaches 12 %. In contrast with that, the distilled beverages that are sold today contain up to 95% alcohol. Two of the largest selling fortified wines contain 18% alcohol. Such concentrations were not possible until the 14th century when distillation was discovered. There should be no question that any fortified wine or distilled beverage (liqueur, whiskey, gin, vodka, whiskey, etc.) is stronger than the strongest "strong drink" of bible times. One shot of whiskey is equal to nearly a pint of strong drink in Bible times. Rom 14:20 ff teaches us that our abstinence from wine (not strong drink) is a wise idea if we are trying to influence a weaker brother. At the same time, we must admit that Jesus drank wine and turned water into wine. The only time that grape juice was available in Bible times was when the grapes

were harvested and freshly squeezed. This would not have been for more than the harvest period of June to October, depending on the location in Israel. There can be no question that the wine used at the Passover supper (in the spring) would have been fermented. Our Lord, however, used the term "gennematos tes ampelou" (Matt 26:29 and corresponding passages in the other gospels) which translates as the generic "fruit of the vine", thus allowing the use of grape juice at the Lord's Supper.

From our study, I believe that we can conclude certain things. The moderate consumption of mild wine is not a sin, since our Lord was known to drink wine (Matt 11:19). It would appear that to say that it is a sin to drink without further explanation is, in itself, a sin, since in such a statement we condemn the Lord's actions. I cringe whenever I hear someone say that it wrong to take even the first drink because he is that much closer to being drunk. The Scriptures do condemn drunkenness (Gal 5:21); however, they do not condemn drinking. Nevertheless, a Christian in the US (and perhaps elsewhere) may have a problem if he drinks wine because of the effect it might have on his influence (Rom 14:21). The use of wine at the Lord's table is not wrong nor is it necessary, rather the Lord left the decision up to the assembly.

The Qualifications of the Author

Its always wise to ascertain the authority by which one speaks. Wine is a technical subject and the Bible refers to it. We will not find the details of a technical subject in the Bible but in a science book.

The author is an internationally recognized authority in the areas of organic chemistry, biochemistry and microbiology. He holds high positions in both academia and industry. He has spoken by invitation at international symposiums in all of these areas in numerous countries of the world and is the author of numerous scientific publications in these areas. He is a Christian, an evangelist and a teacher. He does not drink alcoholic beverages unless they are used at the Lord's Supper.

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Recently (1/93) a copy of the following article printed in a bulletin in 1983 was sent to me asking for comment. I give the scientific facts following the questions and answers given. Remember, science and the Bible do not contradict. The article is reproduced in its entirety. My replies are based on the science of chemistry and microbiology are give in italics. Written by Jerry Moffitt and published in Sound Words, Oran Rhodes, Ed. Curry St Church of Christ, PO Box 558, West Plains, MO 65775

QUESTIONS & ANSWERS CONCERNING SOCIAL DRINKING

Q: Doesn't the word *wine* in the Bible always refer to alcoholic wine?

A: No. The word *wine* translates about five words in Hebrew and Greek, all of which refer to grape juice as well as fermented wine, as in the following verses: *chemer* (Isa 27:2), *yayin* (Isa 10:10), *tirosh* (Prov 3:10), and finally, *gleukos* and *oinos* (both of which translate the three Hebrew words which are often used of grape juice).

Scientific Facts: Since preservation by canning was discovered in 1812 in France, there was no method of preservation available to the people of the Old and New Testaments. The most common place for yeasts to be found is on the skin of fruits. In addition, overripe fruits will ferment on the vine or tree as small quantities of the juices ooze from the fruit at the stem or from insect punctures of the skin. When Isaiah writes "a vineyard of wine," we must remember that the only way to get fresh juice in that time was to squeeze it and drink it within less than four hours. It simply was not possible to preserve grape juice as such and thus the ancients thought of vineyards as containing wine. In modern wineries in California, mechanized grape picking is not used since it would bruise and crush a small number of grapes, which would in turn start to ferment before the grapes reached the winery, yielding an off flavor wine due to the "wild" yeasts contained on the skins of the grapes. In Prov 3:10, it speaks of new wine, which would not have the fully developed flavor of a wine that had been given time for the organic chemicals formed in fermentation to completely react. Further, the wine may have been sweet due to the quantity of sugar present and a low quantity of yeast. There is a direct correlation between the amount of sugar present, the amount of yeast present and the amount of time available. Given enough time, the yeast after having passed from its growth (aerobic) phase due to using all the available oxygen, would change over to its alcohol producing (anaerobic) phase and produce a wine of much higher alcoholic content.

All grape juice in the NT and OT was alcoholic except when it was freshly pressed; i.e. 4-8 hours after being squeezed from the grape.

Q: Didn't Jesus make fermented wine at the wedding in Cana (Jn 2)? Didn't the ruler say it was the "best wine"?

A: Albert Barnes observes that the ancients considered the "best wine" that which was harmless. We could give quotes from Pliny, Plutarch, and Horace to prove that. The fact is the ancients PREFERRED GRAPE JUICE.

Scientific Fact: The ancients may have preferred that which was harmless, however, rarity itself is prized. The fact is that grape juice would have been available only in the months of September and possibly October. We must also remember that the ancients would not have been able to discern any harmful effects of a single glass of wine even if it had been fermented to its maximum extent. The best wines are those that taste the best. In wines, this taste is acquired as a result of the other chemicals produced by the yeast during fermentation. Ethyl alcohol has virtually no taste or odor. As those who have been involved in taste testing know, even a small amount of a juice or a sweetener will require time to be removed from the tongue in order to once again restore the senses of taste. Thus, a poorly flavored wine would not have been served at the first but at the last. Wines and beers, due to the many flavor constituents, in addition to the alcohol, are especially desensitizing to the taste buds. You may see wine tester spitting the wines out and then eating crackers or cheese to keep from desensitizing their taste buds. Continued swallowing of the wine will lead to a decrease in the ability to sense the taste long before the taster is inebriated. We might point out that there is no indication that Jesus contributed to inebriation because the people had previously "drunk freely," since within the Hebrew culture, drunkenness at any time is considered a shame. To this day, Israelis rarely get drunk. Hotel bars close at 9, unless an American is present. The words "drunk freely" indicate that the palates would have been jaded by the previous wine consumed.

The scientific works of Pliny, Plutarch and Horace are so filled with error than no scientist of reputation cites them as being accurate on anything. It fact, accuracy is so rare in their works, that an accurate statement is normally cited with absolute amazement. The rest of the citations are given to display their lack of knowledge and their penchant for overstatement. Pliny is cited in the field of marine toxinology in order to show the toxicity of a sea hare (a marine arthropod). Pliny says that the sea hare is so toxic that if a pregnant woman looks at it, she will abort. If you, as a non-scientist believe that one, I know some people who would like to talk to you about a bridge.

Q: Doesn't I Tim 3:3, 8 say the elder cannot be given to wine, while the deacon needs only not to be given to much wine?

A: The Greek words used as synonyms: *paroinon* and *prosecho*. Both mean "to be addicted to." Would you argue that the elder is not to be addicted to wine, but the deacon may be addicted a little?

Before I get to the scientific facts, I wish to point out that the correct answer to the question is "Yes." That is indeed what the accepted versions say in every instance. The KJV, ASV, RSV, NEB, NASV, NIV and many others all make a distinction in the two words and the NASV translates the terms as addicted. One may easily quit drinking coffee because the addition is light. (If you drink over three cups of coffee a day, you are addicted. You will find that on days on which you do not get your coffee, you will have a headache and feel lethargic. These are the withdrawal symptoms.)

To those who think that the Holy Spirit uses words in which no distinction can be made, note that even the plural serves as an argument for every nuance being important in Gal 3:16-17.

Scientific Facts: The question of the use of wine as a drink with meals is accepted in nearly every foreign culture, even among Christians. Many of these cultures severely criticize drunks. They do

not, as the American culture does, think that drunks are funny and cute. They are pitiful and despicable humans who seek a crutch to help them get through the day.

But you should also realize that there is a distinction between drinking and drunkenness. You may have heard the "old saw" that one drink makes you one part drunk, however, there are a number of very toxic drugs that you may take, which in sufficient quantity will kill you, but which taken in the appropriate dosage will not "make you one part dead." For instance, let us move to the question of medicines such as valium and librium. There are recognized medical uses and abuses of these materials. They replace alcohol in their ability to calm a nervous or disturbed person. Do not let anyone tell you that there is no need for such drugs. A physician or a scientist may tell you that there are superior drugs to these which are now on the market, however, no person who is competently trained will tell you that there is no use at all for such a class of drugs. For many years, I worked on the discovery of new drugs for treating cancer. I followed the aphorism, "All drugs are toxic and all toxins are potential drugs." The theory works very well. Virtually every drug available will kill you in the right dosage, but in the appropriate dosage, approved drugs are safe and effective.

Looking at the self-prescribed over the counter drug, aspirin, we find the same thing to be true. Aspirin is a painkiller (alcohol also functions as a painkiller). Which of you will not take an aspirin, realizing that if you take the whole bottle, there will be serious consequences. And none of you would refrain from taking aspirin because you would be one part dead. The Holy Spirit recognized this same thing and in the case of "given to wine" vs. "given to much wine," makes a distinction between the differing pressures and levels of responsibility that might be placed on one who serves in physical things and one who serves in spiritual things. We may disagree with the Holy Spirit, but let us not say that there is no differentiation.

Q: Since the ancients could not preserve grape juice, was not all they drank really fermented?

A: The ancients had four ways of preserving grape juice: (1) Boiling. This left too much sugar to ferment. (2) Filtration. This got rid of the yeast. (3) Subsidence. This allowed yeast to settle at the bottom and the grape juice was then skimmed off. (4) Fumigation. Here sulphur was used to absorb the oxygen.

Scientific Facts: You could not get more nonsense in one short answer if you tried. There are a number of collections of impossible ways to preserve grape juice but this is the worst of the lot. The collected works of Jeffcoat and Patton, the authors of two books used by preachers and which are riddled with errors on this subject, could not incorporate more errors. A college freshman in microbiology would receive a failing grade for any of the answers given above. If preachers, teachers and Bible students take no more time than this to find out about the science of a scientific subject, the derision they receive is well justified.

In order (1) Boiling. Boiling to a paste may or may not result in a high sugar content depending on the year and the moisture level, but the powers of sugar as a preservative are nowhere near absolute. If you don't believe that, ask someone who makes preserves what would happen if the jars

were not boiled and paraffin or a lid were not quickly placed on the preserves while still hot. They will tell you that a number of the jars will probably have mold on them. Further, ask them not to use any additional sugar for these jellies. You will find that the best way to preserve fruits is as dried fruits. Remember, moldy food results in a number of diseases. Liver cancers, hepatitis, and even gangrene can be caused by mycotoxins, which are formed most prevalently by the Aspergillus and Penicillium molds. In fact, maple syrup may be contaminated by mold growth, especially Penicillium and Aspergillus. Soft centered chocolate candies are more often contaminated by Clostridium. Once boiling was complete, if the juice was still in a liquid state, the materials would have to be stored in a container which had been similarly treated, thus ruling out porous jars or animal skins such as used by all but the rich in Biblical times. The pores of clay jars would contain large quantities of microbes. To get some idea of the quantities of microbes found in water, imagine a slightly cloudy solution of a yeast and you would have approximately 300 million microbes in a 12 oz. glass. Further boiling kills only the growing microbes; in those microbes which produce spores, such as the common Bakers Yeast, Saccharomyces cerevisiae, the spores are highly resistent to heat and may produce spoilage of heat treated foods. By the way, in the desert, you wouldn't have as many problems due to the lack of humidity and the further drying of the foods. But then too, you would not have a drink, you would have dried fruit.

(2) Filtration. Filtration through the cloths available in Biblical times would have only removed materials which were visible to the naked eye. Yeasts are from 1 to 5 microns in width and 5 to 30 microns in length. To prevent a yeast from passing through a filter, you would need a filter of less than 1 micron in pore size. To illustrate, the type on this page is approximately 1 mm in the width of the line in an "l." This is the size that a coarse cloth might filter out. This width is large enough to lay 1000 yeast cells end to end across the "l." Such filters are available in laboratories now, but they were not in 1960. They certainly were not in 1500 B.C. or in 50 A.D. In fact, no one could even see these microbes until van Leeuwenhoek first saw them with his microscope and described them in 1674. The problems associated with putting a fruit juice through such a filter are also associated only with the technology of this century, since gravity was the only way to filter in Biblical times. Grape juice as the ancients knew it is much like an apple juice produced from a press dating from 1900. The juice is thick with bits of plant tissue which are broken up in crushing the grapes. The juice is not clear, but very cloudy and does not clear readily. Although the large particles of skin will easily settle out, the microscopic debris will quickly clog a filter. The yeast are much, much smaller than these bits of plant tissue, however. In order to remove yeast from the fermentation medium used today, large cylinders (6 feet in diameter and 12 feet wide) on which starch (like the corn starch you might buy at the grocery) has been coated (1 or more inches thick) are used to remove the yeast cells for further use in bread making. Filtration of the crushed grapes using materials available to the ancients would have removed only those yeasts which were stuck on larger pieces of debris.

(3) Subsidence. The length of time necessary for the yeast to have settled to the bottom (given 24 hours or more of absolute stillness since the slightest current would have stirred the microscopic yeast more than enough to thoroughly distribute them again) would have been plenty of time for the yeast to consume the available oxygen and to have begun alcohol production. The yeast distribute themselves thoroughly in a juice due to the carbon dioxide which they produce and which will cause

them to rise through the juice. When sufficient carbon dioxide has been produced to form a bubble, the bubble will break away and rise to the top of the juice. If no air current disturbs the juice, the carbon dioxide will layer on the surface of the juice, thus limiting the amount of oxygen and inducing the anaerobic phase of the yeast which will result in alcohol production. The amount of yeast commonly placed in bread will cause the bread to double in size in 20 minutes to an hour depending on the temperature. If you watch the bread, the impressive power of fermentation by yeast is easily visible. (In Biblical times, the yeast was passed from loaf to loaf by a pinch of dough. Thus, for the passover, the leaven, which might cause a delay in departure, had to be put out of the house. The word leaven and yeast are thus not synonymous terms as used in the Bible. The delay was not true of wine which could have been carried in skins without delay. The carbon dioxide which would have stretched the skin to the point at which a twice used or old skin would have ruptured. The Israelites would not have recognized that wine was caused by yeast because that was determined by Louis Pasteur in the 1880's. The removal of yeasts by filtration was first accomplished by Buchner, who showed that yeast free juice contained active enzymes, called "ferments" due to their similarity to yeast fermentation. The Buchner funnel is a porcelain funnel with a flat bottom, over which fibers of asbestos could be matted, thus providing a tortuous pathway and entrapping the yeast cells due to their own size and the length of the path. Liebig, a famous German chemist, thought that fermentation was due to chemicals which were not associated with living cells and was proved wrong by Buchner.

(4) Fumigation. Sulfur does not absorb oxygen. When sulfur is heated in the presence of oxygen, it forms sulfur dioxide which may be trapped by water to form sulfurous acid. Sulfur dioxide will indeed kill microbes, but when sulfur is burned to make sulfur dioxide, the vapor is extremely toxic and the amount required to kill the microbes without giving a rotten egg flavor to the juice is an extremely delicate proposition. I found the use of sulfur burnings in the winery vats to date to the middle ages. This was probably done to prevent inoculation of the vats with <u>Acetobacter</u> <u>vinlandii</u> which inhabits wood very nicely and which converts alcohol to acetic acid (vinegar). In addition, once the vessel and the juice had been sterilized, it could not be poured into any other vessel since it would have been contaminated with the other microbes and have spoiled immediately. Remember, canning was not discovered until 1810. The method of making a sterile seal was not available to the ancients. Nor was the use of a retort something that was within the technology of the ancients. Retorts were used in the middle ages as metallurgy and metal fabrication became better. This allowed the invention of distillation in the 14th century, leading to major problems with increased alcohol content in whiskeys, brandies and other liqueurs having alcohol contents of 12.5% to 95%. Until that time, no alcohol content was above 12.5%. Currently, one major producer of alcohol for fuels has a strain that will tolerate 15% alcohol. This was developed accidentally over a period of 30 years in one yeast factory in which the fermentation had been overfed with molasses during the final 4 hours of the fermentation.

Q: On the day of Pentecost the apostles were accused of being drunk. Would they be accused if all Jews didn't drink?

A: The word used is *gleukos*. Authorities and lexicons which think *gleukos* was unfermented are: Connegan, Green, Robinson, Kitto, Thayer and Arndt and Gingrich. Notice also the text says they

were "mocking" the apostles, evidently saying they were drunk on grape juice.

From the words of this author, there was no way for them to get drunk anyway since alcoholic beverages do not seem to exist anywhere. If Peter had believed what the author of the article believes, he would have said "You know its not possible to get drunk on gleukos. Instead, Peter said that the men were not drunk, since it was only the third hour of the day. It is evident from Peter's statement that one could get drunk on gleukos if one stayed at it long enough. Again, we need to go to science in order to determine what was going on rather than to authorities on the Greek language, many of whom appear not to know anything about the science of microbiology.

Scientific Fact: The preparation of wine in Biblical times depended a natural inoculum of yeast. This inoculum level would vary from time to time, as would the sugar content. The number of yeasts present and the amount of oxygen contained in the must would limit the aerobic propagation of yeasts. Assuming that this inoculum was suboptimal, the amount of sugar left when the yeast stopped growing and switched to the anaerobic phase would be small. Therefore, the time to complete the fermentation of the wine (i.e., to use up all the sugars) would be prolonged and the wine would be sweet. This new wine would, in time, complete the oxidation of the sugars based on the principles established by Buchner, explained above. That the alcohol level was low in such "new wine" is born out by Peter's remark.

Q: Didn't Paul tell Timothy to drink a little wine for his stomach's sake?

A: Grape juice worked well to replace bad water. Pliny (1st century Roman) said the wine used for the sick was that which had "its forces broken by the strainer."

Scientific Fact: A strainer (filter?) did not have the ability to remove alcohol. In fact, such filters still don't. There have been some studies on the recovery of alcohol by membrane processes, but in fact these still do not work well and distillation is the method of recovery. The alcohol molecule is more than 1000 times smaller than the yeast cell. This illustrates the overstatement of the scientific prowess of Pliny once again. In addition, grape juice is rather upsetting to the queasy stomach. It is far more likely, based on the statement, that Paul was advising Timothy to have a glass of wine in order to relax and thus relieve the stress that he was evidently under. Based on the properties of wine, Timothy might also have gotten a helpful dose of B vitamins by drinking wine which contained the sediment of the fermentation.

As far as drinking grape juice which was somehow rendered free of yeast, it would be unwise due to the proliferation of other microbes which would be present due to changes in the container. Remember, your refrigerator is at 40°F and the minimum temperature obtainable in 3/4 of the year in Israel was 56°F. At normal daytime temperatures and the relatively filthy conditions of that day, the combination of sugar and water would make an excellent medium for fermentation of the other microbes present. Many of these are decidedly deleterious to humans. Essentially the same as eating spoiled meat or other moldy or bacterially contaminated foods.

Yeasts are able to predominate in the presence of the "relative filth" I mentioned above, because of

their rapid growth and the high concentration on the skin of the fruit and provide a healthy drink, when taken in moderation. The presence of high levels of yeast, carbon dioxide and alcohol combine to prevent bacterial spoilage. If other microbes were allowed to grow, the chances of botulism would have been present due to the acidic nature of the juice. In addition the molds would grow well on possibly produce mycotoxins.

Q: Didn't Jesus show they used alcoholic wine when He said new wine would, when fermented, rend old bottles made from skins?

A: No, they used new skins to keep it from fermenting. Old skins would, as short while after being emptied, develop yeast on the sides. Having absorbed oxygen the fermented matter would be communicated to the entire mass and eventually rend the skin. So they put it in clean bottles to keep it from fermenting.

Scientific Fact: The answer to the question is yes. As shown above the container had nothing to do with where the yeast was. It was on the skin of the grape and so ready as an inoculum when the skin of the grape was broken. When the freshly pressed grape juice was placed in an animal skin, the aerobic phase of the fermentation would produce carbon dioxide which would stretch the animal skin. The skin had to be new in order to take the strain of the gas pressure. An old skin would have had the oils removed by the alcohol and thus would have been more likely to burst under pressure. It would make no difference at all if there were yeasts already in the skin since they would have been added by the juice. There was no such thing as a clean bottle in Biblical times. The chlorination of water to make it safe to drink and transport was pioneered by a scientist at Johns Hopkins who died two years ago. The skins and the water would have been river or well water. It would be something like drinking water in a small village in India or Pakistan today; inadvisable.

The truth is, there is no passage in the Bible which shows saints approved while drinking fermented wine. Social drinking is not sustained Biblically!

Scientific Fact: We have clearly established that not only the saints, but Jesus himself, drank alcoholic beverages. The answers given in this short article on wine have been shown to be wrong in every case. They are a collection that any beginning student of microbiology should be able to refute. Unfortunately, the author of the article trusted not in a science book but in articles of ancient history. This is not a question of whether the Bible is correct because we have shown that there is no conflict between what the Bible says and what scientific evidence shows.

If we, as children of God, are to retain our credibility, we must not be guilty of pseudoscience and poor scholarship. Let us say that the Scriptures condemn drunkenness (Gal 5:21) and proscribe drinking on the basis of influence (Rom 14:21). Let us never say that it is a sin to drink wine because Jesus came "eating and drinking" and they called him "gluttonous and a winebibber." My Lord did no sin nor was guile found in his mouth. I do not believe that anyone wants to be guilty of blasphemy.

In addition to being wrong, there are two major problems in a teacher taking the position given by

the author of the questions and answers: first, the nurses, physicians and occasional scientist in the audience will assume the evangelist is incompetent and begin to suspect all that he says; and second, the audience in being given a correct conclusion based on incorrect reasoning will accept the conclusion and then when pressed by someone knowledgeable, will be pressed to fall back and will normally give up more faith as a result of the defeat. We must do everything possible to prevent either of these occurrences. Remember, science may draw the wrong conclusions, but the Bible must be true in every aspect. The Mormon's are laughed at because the Book of Mormon has steel in the bronze age and a boat with a hole in the bottom. The Bible is not a book of men, but of God and everything present in the Scriptures will fit with Science when properly understood.

Let us be certain of one thing, however, and that is the correct position taken by the author in his last sentence. Social drinking is not sustained Biblically! This is based on Rom 14:21 and the fact that drinking of distilled alcoholic beverages cannot be condoned at any time because they undoubtedly constitute strong drink.

The following question was asked in an on-line discussion of wine in the Bible, 1995.

David Willis : Question Wouldn't a scientifically valid 1st Century method be to boil off the alcohol just before drinking it? (This is done with cooking wines) The normal fermentation would occur and the alcohol would remain in the wine while it is stored, but removed befroe consumed. I have no evidence that this was done, nor do I know what that would have done to the taste...but I would think it would allow non-alcoholic wine to be drunk at any time of the year.

Distillation was discovered in the 14th century. No evidence exists that a first century person knew that the alcohol as such was present or that it could be removed by distillation. With even a basic scientific education, e.g., high school, you take advantage of science that was completely unknown in the 1st century. For instance, nearly everyone in our society knows that alcohol is responsible for the intoxicating effects of wine, yet the person you are speaking of in the first century would not have known what he was taking off the wine nor how much. It would have been the subject of a great experiment, but would have taken hours of drinking the differerent products by different people to determine how much cooking was needed to remove the alcohol.

In short, the answer is no, they would not have done this in Biblical times.

A portion of a longer article against drunkeness and drinking. The first part of the article deals with drunkeness and is true. I have copied this article by OCR from Shanks' publication, corrected certain misspellings and I continue to disginguish between my work and Kevin Campbell's by italicizing my answers.

Sadly, there are some even in the church who want to defend the "right" of a Christian to use alcohol in a "social" fashion. One of the most popular means of defending the practice of social drinking is to refer to John 2 where Jesus turned water into wine. This overlooks the fact that the term "wine" was often used to refer to the pure, fresh and unfermented juice of the grape (Isa.65:8; Prov. 3:10; Joel 1 :10). A careful study of the text of John 2 will establish that the wine that Jesus made was of this nature and thus not intoxicating. In addition, if Jesus did make intoxicating drink, then he would have been in violation of Habakkuk 2:15 which says, "Woe unto him that giveth his neighbor drink, that puttest thy bottle to him, and makest him drunken also, that thou mayest look on their nakedness!" (KJV) Those who contend that Jesus made intoxicating drink and then gave it to those who were already intoxicated have established the right of Christians to not only drink alcohol, but also to share it with their friends, even those who are already drunk. They have also established their right to own a liquor store and to sell it. Who can believe such! ?

Furthermore, Peter condemned the "sipping of the wine," or social drinking in I Peter 4:3. The term "banquetings" is the word potos in Greek, which simply means "to drink" without reference to the amount. R.C.Trench says of the word that it is "not of necessity excessive" (Synonyms of the N.T., p. 211). The three terms "excess of wine," "revellings," and "banquetings" all denote different levels of drinking. The term "excess of wine is defined by Strong as "an overflow (or surplus) of wine." This is the concept of the down and out drunk. The next word "revellings" is
defined as "a revel, carousal, the concomitant and consequence of drunkenness" (Vine's Expository Dictionary). The person defined by this term is the "live wire" or "life of the party." He's not the down and out drunk but has consumed enough to where it adversely affects his behavior. The third word banquetings, as we have already seen, does not necessarily address the "excessive" use of alcoholic drink. One can be guilty of banqueting simply by "sipping the wine" or participating in social drinking.

The Bible says, "By their fruits ye shall know them" (Matt. 7:20). The fruits of intoxicating drink are easily seen by the honest of heart. The beer companies like to portray those who use their products as young, energetic and filled with happiness. What they don't show you is the broken homes, broken bodies and broken minds of those who have used their products to thcir own ruin. Don't be fooled. Be not deceived. Beer and wine as well as other intoxicating drink can wreck your physical life and destroy your spiritual life. You need to seriously ask yourself the question?
"Can my beer do this?"

By Kevin Campbell (unknown to me, but distributed by Ricky Shanks)

Please see page 2 of my Primer to answer the first question on the meaning of the term "wine"

Please see Q&A, p 5, for the answer to the question of Jn 2.

Concerning Hab 2:15, the author needs to be aware that he is settin the Scriptures in conflict against each other just as the denominalist does with faith and works. For example Num 15:6-7, wine is to be used as an offering to the Lord. Ps 104:15 tells us that wine is good for man and Hos 2:8 says it is a gift from God. David, a man after God's own heart was sent by his father Jesse with wine to his brothers (I Sam 16:20). Thus, drunkeness and encouraging others to drunkeness is condemned in Hab 2:15 and not the giving of wine by Jesse to his sons. I also note that the apostle Paul, by the guidance of the Holy Spirit (I Cor 14:37) told Timothy to do just what our author is arguing against.

In I Pet 4:3, Peter condemns drunkeness, "For you have spent enough time in the past doing what pagans choose to do--living in debauchery, lust, drunkenness, orgies, carousing and detestable idolatry. " (NIV), and the evils associated with it. Nowhere is the phrase "sipping of wine" used nor is it indicated unless the sipping be such that it brings about a state of drunkeness. Campbell then makes up his own definitions for the words used in this passage which of course, fit his theory.

As to the last paragraph, unfortunately, for both K.C. and for me, it turns out that a number of medical studies have just been published which that moderate use, defined as 1-2 glasses per day, of wine is beneficial in preventing circulatory and heart problems. As a life long abstainer, but one who monitors the medical literature (not the lay press accounts of such), I have chosen not to extend my life by this method, but continue to rely on moderate exercise, a diet low in both saturated and unsaturated fat, and additional doses of Vitamins C, E, beta carotene and aspirin to keep me fit for many years of service to the Lord. The most common cause of heart disease is worry, which I try to avoid, finding that when I pillow my head, I can lay my burdens in the hand of the Lord as he advised (Mt 6:25-34), neither needing tranquilizers nor "a little wine for my stomach's sake."

Added Nov 2002 from New Scientist, 26 Oct, 2002
It has recently come to my attention that in the period 1770-1850 a number of German brewers found a way to preserve India Pale Ale (IPA) for a year [also porter or Imperial Stout to Russia in the 19th century- L. Mousson, Berne Switzerland]. By adding large quantities of hops which have bacteriostatic qualitites (do not kill bacteria but keep bacteria from growing) as a result of boiling the hops to convert insoluble humulones to the water soluble isohumulones. These isohumulones coupled with the high alcoholic content obtained by adding additional grain and sugar [to 10% - Mousson] reduced the amount of spoilage considerably. The drink was said to be exceedingly bitter (S. Winkler, Vice Consul Science and Technology, British Consulate).

A young IPA is said to taste something like "paint stripper." The one year voyage to India moderated the taste to something "not overpoweringly bitter." "The ale was vented before the long voyage to prevent serious explosions during the crossing and this may have introduced bacteria. It was also not easy to sterilise [sic] the casks before filling them. However, it was a trade worth pursuing because of the huge volume of empty cargo ships returning to the colonies and the cost of carriage was very low." (Clive La Pensee, Author of Homebrew Classics IPA, CAMRA Books 2001, Beverley, East Yorkshire, UK)

The use of filtration by the ancients has been claimed as a way to reduce alcohol in wine - Kyle Pope,

Biblical Insights, March 2010, p 21-21. "Pliny the Elder wrote that the most suitable for all men was wine, 'with strength reduced by the filter,' even explaining the difference between 'must' and fermented wine (Natural History, 23.24) Plutarch devotes an entire discussion to whether wine should be strained, declaring wine 'cleansed' by a strainer, has its 'strike and madness taken away' leaving one in a 'mild and healthy state of mind' (Symposiacs, 693b 3-5)

Pope is aware of internet sites that claim that most yeasts are removed by a 0.45 micron filter, but appears to be unaware of the size of the ethanol molecule by comparison - or for that matter with the filtration size of a good modern filter paper, a coffee filter or a papyrus mat. A filter from biblical times, whether a mat, a woven cloth or the like would have been able to remove sand and gravel, sticks and stones. Coffee filters have holes about 75-2000 microns, better than anything available at the time of Christ. Bacteria are removed by filters of 0.2 to 0.45 microns. To separate water from alcohol, filters are ineffective since they must use something besides pore size. The water molecule has an effective radius of 0.15 nm (that's 0.00015 microns) whereas the ethanol molecule has an effective radius of 0.16 nm (that's 0.00016 microns). We can't do that separation today, it's just worse than splitting hairs (17-180 micron diameter). Pliny and Plutarch didn't have any idea of what a weaker or stronger wine was, other than by tasting it because they had no concept of molecules or sizes that we have today.