

# THE HISTORY OF VINEGAR PRODUCTION AND THE USE OF COCONUT TODDY AS A RAW MATERIAL

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## PART I: HISTORICAL INTRODUCTION

THE term vinegar literally signifies "sour wine," according to its derivation from the French words "vin aigre" (vin = "wine" plus aigre = "sour" or "sharp").

The use of vinegar as a food commodity is universal, and its importance as an article in food preparation and preservation cannot be over-estimated as it is undoubtedly indispensable in every household finding extensive use in the preservation of vegetables and fruits besides having a place of its own in the pickling industry as a whole.

In general terms, vinegar may be defined as a condiment made from watery solutions of sugar or starchy materials containing yeasts and bacteria, by alcoholic and subsequent acetous fermentations. Owing to the fact that a wide variety of saccharine liquids or starchy substances can be used for the production of vinegar, its exact composition depends to a certain extent on the nature of the raw material that has undergone these fermentations apart from the actual conditions of manufacture, aging and storage. Essentially, however, the finished product is a dilute solution of acetic acid containing salts and extracted matter from the source material.

Since sugar is the base of the acetic acid production, almost any solution containing sufficient sugar fermentable by yeast may be converted into vinegar under proper conditions. Thus different types of "natural vinegars" such as malt vinegar, cider vinegar, grape vinegar, sugar vinegar, glucose vinegar and various palm vinegars are known, but they are all to be distinguished from the so-called "artificial vinegar." The latter product is an "imitation" or "substitute" for vinegar, and is not wholly the product of successive alcoholic and acetic fermentations but is merely derived from preparations containing added acetic acid or by the simple dilution of glacial acetic acid itself, to 4 per cent. of the acid and coloured with burnt sugar (caramel) to give an amber coloured liquid. The term "wood-vinegar" is also sometimes applied to this artificial product, the name itself being derived from the fact that acetic acid was formerly produced by the dry distillation of wood. Commercially, vinegar may be marketed in various combinations of forms including flavoured or spiced products such as tarragon vinegar, and accordingly different countries have fixed legal definitions for various vinegars in order to ensure adequate standards of quality and strength, besides the prevention of possible fraud through adulteration of the respective forms.

## Vinegar in Early History

The origin of vinegar is remote, and as its name implies it was first obtained by the natural souring of wine, which certainly must have been an ancient procedure.

Biblical writers have mentioned vinegar and Hippocrates the "Father of Medicine" (460 B.C.) is supposed to have used it as a "physic." There are various allusions in the Classics to "*Acetum*" (Latin meaning acetic acid) including the fable of its use by Hannibal the Carthaginian General (247-183 B.C.) for dissolving the Alps. In passing over these records it will be obvious that vinegar had its recognized place among the products of the early Alchemists who used distinctive symbols for its denotation.

*Note.*—Though Alchemy in its wider and truer significance stands for the chemistry of the middle ages and also in a sense for the early phase of the development of systematic chemistry, yet it really arose in the early centuries of the Christian era and ended about the fifteenth century. During the beginning of the sixteenth century Paracelsus gave a new direction to Alchemy by causing the union of chemistry with medicine, thus marking its transition into "iatrochemistry" which dominated chemical thought for a while to give way ultimately to the new definition formulated by Robert Boyle in 1661, *viz.*, that the proper domain of chemistry should be the determination of the composition of substances.

## Vinegar Industry after the 16th Century

It was in the sixteenth century that wine-vinegar was first produced in France for home consumption and for export, and there is little doubt that the early processes of its proper manufacture originated there. In fact long before any vinegar makers were established in the British Isles, wine-vinegar appears to have been imported there from France.

The earliest description of a process for making vinegar appears to be that published in 1670 in the Transactions of the Royal Society under the heading: "The way of Making Vinegar in France,"<sup>1</sup> which was communicated to the publisher by an ingenious French physician who was actually living in the place where much of it was being manufactured. The account given by Boerhave<sup>2</sup> of the French method of manufacturing vinegar is substantially the same as the 1670 version and, therefore, there seems to be little doubt that many English manufacturers derived their information from one or other of the above sources.

The English being a beer drinking nation it is to be expected that the development of the vinegar industry in England, should have come by way of beer rather than of wine. In fact this was so, and by analogy the product derived from beer "was called" "alegar" which stood in the same relation to ale as vinegar to wine. The term "alegar" is still to be found in glossaries of English words but its use is practically obsolete. It is thus obvious that the English vinegar manufacturer evolved out of the brewer, and it is probable that the earliest English products were nothing more than sour beer or ale partly converted into vinegar by long exposure to air.

In the Revenue Act of Charles II (1673) the "alegar" or "vinegar beer" produced as a waste product in "common-breweries" had to pay a duty of sixpence per barrel which gradually led to the establishment of an industry applying improved French methods of production. Though the probable year of commencement of proper vinegar manufacture in England as distinct from the "common brew-house" method is uncertain, yet by 1700 many vinegar yards had started large scale production, and in fact one name included in the excise list of vinegar makers for 1764,

which is still connected with the industry is that of Beaufoy. By 1844 there were forty-four vinegar makers (excluding manufacturers of acetic acid) and they produced in that year nearly three million gallons of vinegar. At the present time, in the British Isles malt vinegar is the standard product, whereas in the U.S.A., it is cider vinegar and on the continent (including France) it is grape vinegar.

### Origin of Coconut Vinegar Industry

In tracing the history of the preparation of coconut toddy vinegar in Ceylon, it is to be expected that it will doubtlessly be associated with the introduction of the Coconut palm itself to

the island. Though the earliest recorded reference to the coconut dates back to 300 B.C., authentic historical references to coconut products like toddy and arrack do not appear till about the 5th century A.D.

Though it is an established fact that small coconut plantations did exist during the times of the Sinhalese Kings, yet it is really after the advent of the Dutch in 1658 followed by the British in 1802 that a distinct fillip was given to the cultivation of coconut in Ceylon, resulting in the preparation and export of several coconut products.

Though, doubtlessly the method of fermenting coconut toddy for vinegar production in the household must have been known for many years, yet according to excise records a minor vinegar industry appears to have been established only after 1920. About this time special licences were issued

to reliable producers in the Panadura, Kalutara and Galle districts, and in 1929, according to available statistical data 2,066 trees were licensed for this purpose, which yielded 73,557 gallons of toddy from which 63,568 gallons of vinegar were produced and sold at sixty cents per gallon. In 1951, 3,403 trees were licensed, which yielded a gallonage of 113,598 toddy yielding 112,118 gallons of vinegar which were sold at Rs. 2.33 a gallon.

### Principles Involved in Manufacture

Although vinegar has been known for thousands of years and the conditions necessary for the successful acetification of alcoholic liquids known empirically for a long time, yet its microbiological nature was not realized until a little more than 125 years ago. Before this period nobody appears to have understood the fact that the conversion of alcohol to acetic acid was of a process analogous to the fermentation of sugar into alcohol. Various phenomena in the manufacture of vinegar appear to have been recorded but not until the 19th century was there any plausible attempt to explain their significance.



Coconut Toddy in wooden casks being brought in to a Vinegar Factory, with a tapper on the right.

## Early Theories of Acetification

In 1822 Persoon made a microscopical study of the films that formed on liquids in which acetic fermentation was taking place and observed their resemblance to yeast cells. He was the first to give the general name of *Mycoderma* (mucinous skin) to these pellicles, but he did not associate them with the development of acidity in the liquids.

Berzelius, in 1829, theorised that the function of the "mother of vinegar" (*Mycoderma*) was entirely catalytic in the process of acetification, and did not attribute this fermentation to any living cell or product of a living cell. It was Kützing in 1837 who first reported that the conversion of ethyl alcohol to acetic acid was brought about by living organisms, but regarded them as algae (*Uvula aceti*). In the year 1839 Liebig<sup>3</sup> published his views, and extended the theory of the nature of alcoholic fermentation to cover also the process of acetification. In a later paper<sup>4</sup> he expressed the opinion that the "mother of vinegar" was not essential to acetic fermentation, but that its place could be taken by dead vegetable matter. He maintained that alcohol requires for its conversion into acetic acid only oxygen from the air, and the "mother-of-vinegar" merely promotes this absorption.

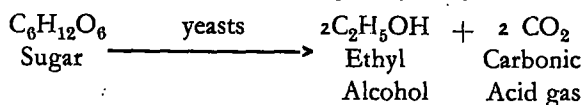
It remained for Louis Pasteur (1868) to confirm Kützing's opinion and to prove the physiological nature of the acetic acid fermentation. As a result of his experiments the vitalistic theory of acetification began to prevail and acetic fermentation was recognized as being inseparably connected with the presence of living organisms. Pasteur was really the first to prove that no acetic fermentation could take place in the absence of the so-called fungus *Mycoderma*. He was the first to suggest that a distinction should be made between the pellicle forming upon fermenting wine and that upon souring wine, and that the name of *Mycoderma vini* should be given to the former, and that of *Mycoderma aceti* to the latter.

For many years these names were generally accepted, but the work of Hansen in 1878 proved that the organisms composing "mother-of-vinegar" were in reality bacteria and should therefore be distinguished from the yeasts which composed the pellicle of *Mycoderma vini*. Whereas Pasteur believed that acetic fermentation was caused by a single species of bacteria (*M. Aceti*), Hansen showed that more than one species could bring about the oxidation of ethyl alcohol to acetic acid.

In later modifications of these theories the discovery of certain enzymes in yeast and the acetic bacteria led to the view that it was these ferments or enzymes produced by the living organisms which really induced fermentation. It was in 1906 that Buchner and Gaunt<sup>5</sup> successfully demonstrated the presence and function of the alcoholic and acetic enzymes. More recently in 1913 Wieland used extracts of these enzymes as catalytic agents instead of palladium black for the conversion of alcohol into acetic acid, thus proving the enzymic theory of fermentation.

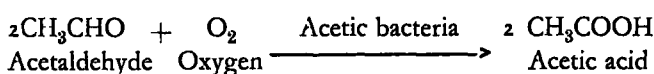
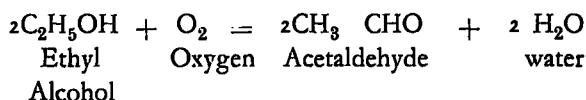
## Chemical Reactions in Acetification

It will now be evident that two distinct stages both associated with living vegetable micro-organisms are involved in the process of vinegar production from the source material. These are firstly alcoholization and secondly acetification. The former process consists in the conversion of the sugar in the raw material into alcohol and carbonic acid gas through the action of microscopical plants called yeasts (*Saccharomyces*). The following chemical reaction actually takes place, when the sugar of the fermenting solution is acted upon by the yeasts :—



Chemically this means that 100 parts of sugar should give theoretically 51 parts of alcohol and 49 parts of Carbonic acid gas. Practical tests, however, show that a yield of only 48.5 to 50 parts of alcohol are obtained.

The second stage consists of the slower process of acetification or oxidative fermentation. This is the oldest and best known of the fermentations brought about by the acetic acid bacteria (Acetobacter or Mycoderma). Since the conversion of ethyl alcohol to acetic acid is primarily an oxidation process, the success of this fermentation will depend to a great extent on the ready availability of large quantities of oxygen. The chemical formulations illustrating this change could be represented in two stages as follows :—



The alcohol is changed by oxidation into a product called acetaldehyde, and the aldehyde is acted upon by the acetic bacteria to form acetic acid. Under natural conditions this aerobic bacterial oxidation of alcohol to dilute acetic acid is extremely slow taking from three to six months.

It should now be clear that both steps involved in natural vinegar manufacture are chemico-physiological in nature, and cannot be dissociated from the living micro-organisms. As a rule yeast fermentation produces a percentage of alcohol equal to about one-half the percentage of sugar being fermented, and the acetic fermentation should theoretically yield more acetic acid than the alcohol in the feed liquor since oxygen is being added during the process. In actual practice, however, the yield is about the same, because some of the alcohol is used by the Acetobacter and some of it is lost by evaporation.

It might be appropriate to repeat Hanson's work (*supra*) in stating that various members of the genus *Acetobacter*, such as *A. aceti*, *A. pasteurianum*, *A. acetosum*, *A. xylinum*, *A. rancens*, *A. industrium* and others could all bring about acetification of alcoholic liquids. In practice, however, the isolation of particular species most suitable for the preparation of different kinds of vinegar, and their use as pure cultures for acetic fermentation, should probably give very satisfactory results in producing vinegars with different flavours, and be advantageous for the rapid working of various types of vinegar plants.

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(To be continued)