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PALM SAP VINEGAR

P. M. JAYATISSA

Ceylon Institute of Scientific and Industrial Research, Colombo

Historical

From the very early days of civilisation it has been customary to acidify food where it was thought desirable to do so in order to preserve it or perhaps merely to modify its flavour or off-set its fattyness. Probably the earliest means of doing so was by the use of fruit juices such as from citrus fruits, crab, apples etc. After the discovery of vinegar the use of fruit juices for this purpose gradually declined and in modern times vinegar is preferred over fruit juice in the preparation of many foods and preserves.

It is probable that vinegar owes its origin to the accidental fermentation of alcoholic beverages by the action of microorganisms. This is reflected in the name which derives from "Vini Aigre" which means sour wine. Therefore, from its inception vinegar has been associated with a double fermentation by yeast and acetous fermentation by acetic bacteria.

Definition

For technical purposes natural vinegar is defined as the "liquid produced from a suitable raw material containing starch or sugar or starch and sugar by the process of double fermentaton, alcoholic and acetous and which contains not less than 4% w/v acetic acid". It is customary to name a vinegar immediately preceded by the name of the starting material or alternatively, of the alcoholic product of the first fermentation, e.g. malt vinegar, coconut toddy vinegar.

Raw materials

Among the many raw materials used for the preparation of natural vinegars are cereals and cereal malts, grape juice and wine, sugar cane juice and molasses, and palm saps. Among the palms of which the saps are used for the manufacture of vinegar are the following : coconut (*Cocos nucifera*), kitul (*Caryota Urens*), palmyrah (*Borassus flabellifer*) oil palm (*Elaeis guineensis*) and Raphia palm (*Raphia hookeri*). In Sri Lanka the major part of the natural vinegar is produced using coconut sap.

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The Process

Coconut sap is the exudate obtained by tapping the young inflorescence of the palm. This contains about 14—18% w/v sugar (mainly sucrose) and undergoes spontaneous fermentation in the collecting pot by a variety of wild yeast. The fermented sap (coconut-toddy) contains about 7% v/v ethyl alcohol and is used as the basic raw material for the preparation of coconut toddy vinegar. In the preparation of vinegar the ethanol in the toddy is subjected to a bacterial oxidation in the presence of air to give vinegar which contains about 4–5 % w/v of acetic acid and a number of minor components which are by-products of the double fermentation.

The Mechanism

The conversion of sugar to ethanol by yeast is strictly an anaerobic process where sucrose is converted through a number of intermediate compounds to pyruvic acid and finally to ethanol. The main pathway through which this conversion takes place is called the Embden-Mayerhof -Paranas glycolytic pathway. This involves a number of enzyme catalysed biochemical reactions which can be summarized as in figure 1.

The second stage of the converson, ethanol to acetic acid, is brought about by a group of bacteria known as the acetic acid bacteria under highly aerobic conditions. There are two proposed mechanisms for this reaction (Fig. 2).

The Microbiology

The group of bacteria known as "Vinegar bacteria" are members of the *Acetobactor* group. Some of the species reported in palm sap vinegar are *A. aceti*, *A. xylinum*, *A. kiitzingianuum*, *A. curvum*, *A. pasteurianum* and *A. scheiizenbachii* (Kuboye & Akinrele, 1971).

In an assessment of the classification of the *Acetobacter* species the bacteria are now divided into two genera. Those bacteria which oxidize ethanol first to acetic acid and then to carbon dioxide and water are called *Acetobacter* while the species responsible for the oxidation of ethanol to acetic acid only are included in a new genus *Acetomonas*. Therefore, vinegar bacteria must now be considered as mainly belonging to the *Acetomonas* group (Amerine & Kunkee, 1968).

The Technology of Production

There are two general methods available for use in the preparation of natural vinegar from alcoholic liquids. One of these is the *slow process* of which there are several modifications and the second is the generator or the *quick process*. Both these processes can be successfully used in the manufacture of Palm Sap Vinegar.

Slow Process (let alone process)

This process is commonly used in Sri Lanka for the manufacture of coconut vinegar on a cottage industry scale. Here the alcoholic liquid is allowed to undergo spontaneous fermentation in wooden vats which are left partially filled until the liquid changes to vinegar on its own accord.

In a modified process the alcoholic liquid is placed in vats which are filled about $\frac{1}{4}$, with holes bored above the surface of the liquid and the vat is kept open. The alcoholic liquid is inoculated with about 25% of its volume of fresh vinegar. This acidifies the liquid to a point where growth of *Candida mycoderma* (undesirable yeast) is prevented and the growth of vinegar bacteria is promoted. When the vinegar is ripe, one quarter of it is drawn and is replaced with the same volume of fresh alcoholic liquid.

Generator Method (Quick Process)

The conversion of ethanol to acetic acid is a highly aerobic process and therefore, the rate at which the reaction takes place is proportional to the amount of oxygen or air available. This principle is made use of in the Generator method. The Generator consist essentially of 3 compartments. The first (top) compartment which is fairly shallow is to ensure that the raw alcoholic liquid is evenly distributed into the second compartment in thin films. The central compartment occupies most of the Generator and is losely packed with wood shavings, corn cobs or some such porous material. This material provides a large surface area for the alcoholic liquid to come in contact with the air in thin films. It also acts as a support for the growth of vinegar bacteria. The third compartment acts as a reservoir for collecting the fermented liquid.

Prior to use, the Generator is charged with the vinegar bacteria by circulating fresh vinegar through the Generator. When the vinegar bacteria is actively growing in the Generator it is ready for use. The acetification process of the alcoholic liquid is carried out by circulating it several times through the Generator at a slow rate. An acetic acid concentration of 4% w/v is achieved in about 4—5 days (Nathanael, 1958).

Composition of a Palm Sap Vinegar

Natural vinegars contain, in addition to acetic acid and residual ethanol a number of minor components which contribute to their characteristic flavour. Among these are acetyl methyl carbinol, diacetyl, ethyl acetate and other esters.

These minor components which contribute to the flavour of natural vinegar are important in distinguishing natural vinegars from each other and also from artificial vinegar. The parameters used for this purpose are the

permanganate oxidation value (OV) alkaline oxidation value (AOA), iodine value (IV) and the ester value (EV). The OV is largely a measure of ethanol and acetyl methyl carbinol. The AOV indicates mainly the acetyl methyl carbinol content. Diacetyl and acetyl methyl carbinol contents are reflected in the IV while EV gives a measure of the ethyl acetate and other esters.

Minimum requirements for coconut vinegar as specified by the Bureau of Ceylon Standards are given below.

Total acid as acetic, percent m/v	4
Total solids percent m/v	1
OV	500
AOV	100
IV	160

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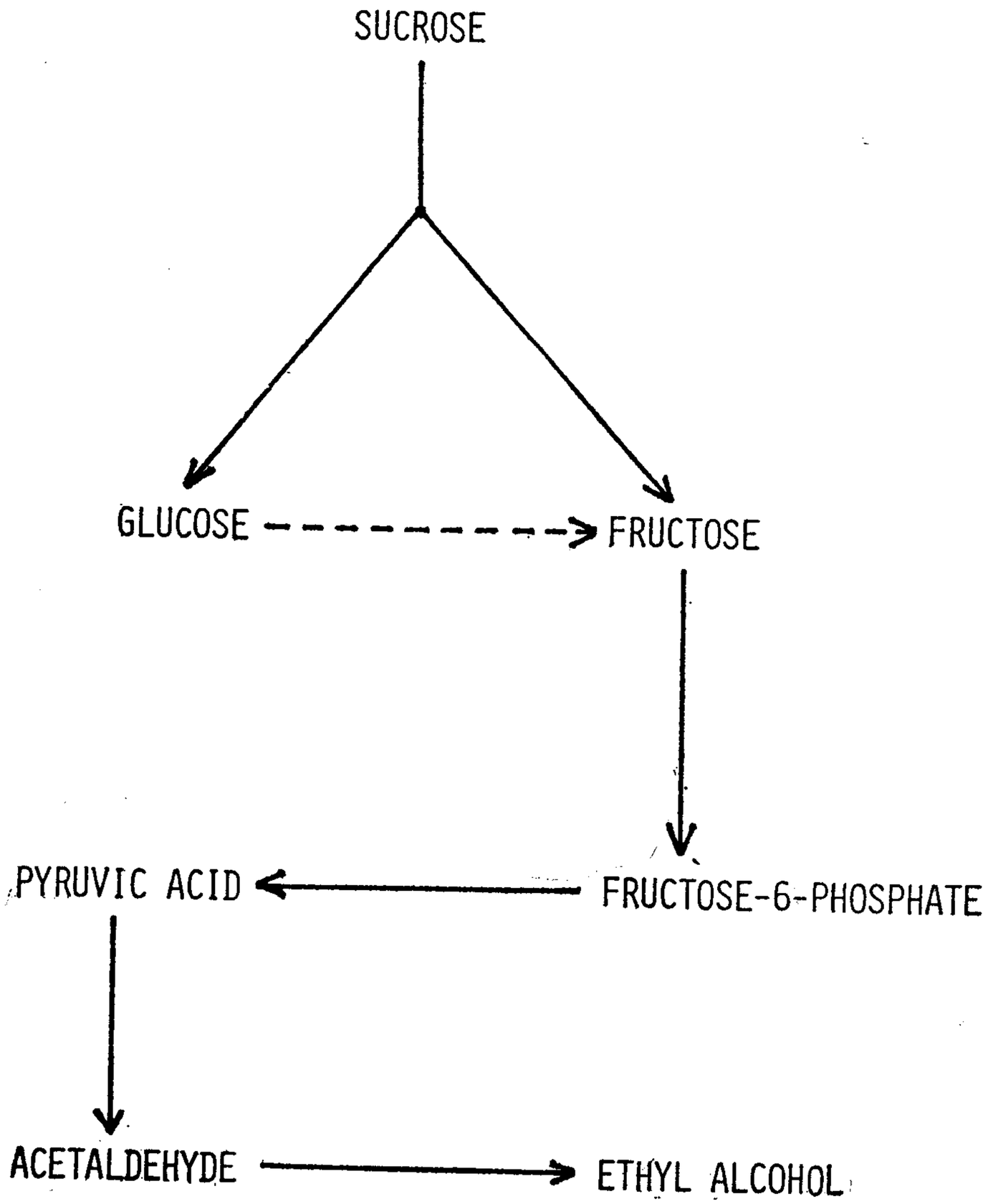

Fig. 1—Steps in the biochemical conversion of sucrose to ethyl alcohol.

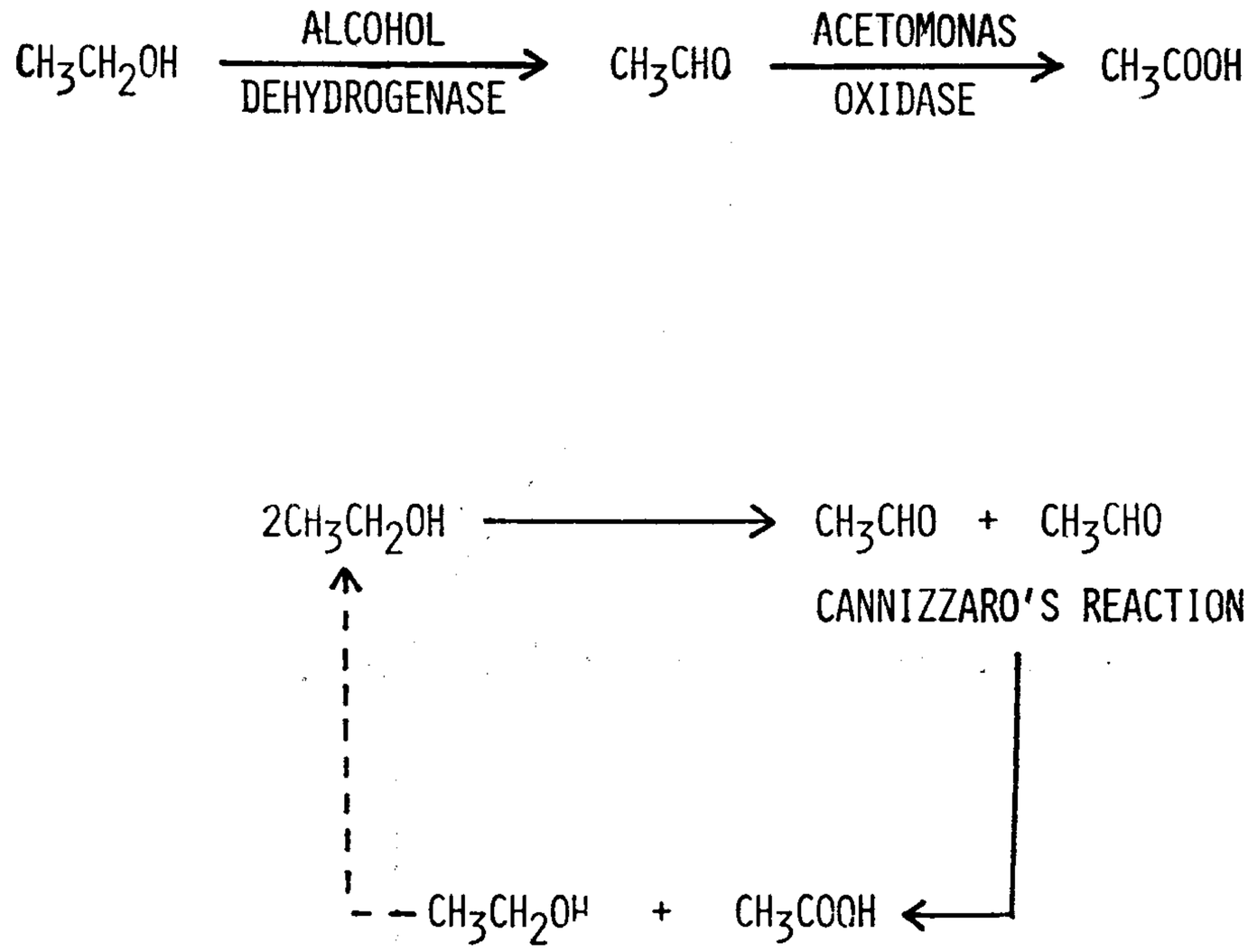

Fig. 2—Proposed mechanism for biochemical conversion of ethyl alcohol to acetic acid.