THE COMMERCIAL POSSIBILITIES OF MANUFACTURING HIGH GRADE VINEGAR FROM COCONUT TODDY

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1. Introduction

Nearly every writer who has dealt with the subject of the useful products of the coconut, alludes to the vinegar prepared from the juice. Coconut toddy vinegar when well made is reported to be of good strength and colour, of the highest keeping qualities and very superior flavour. According to Dr. Gibbs, ' Its excellence is so pronounced that upon its merits it would readily find sale in the world's market '. In my opinion, I very much regret to say that this statement does not seem to apply to any of the local brands of coconut vinegar in their present form as marketed in Ceylon. I would however modify the above statement and endorse the fact that coconut toddy is certainly an excellent raw material for the manufacture of high grade vinegar.

2. 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 doubtless be associated with the introduction of the coconut palm itself to the island. The earliest recorded reference to the coconut dates back to 300 B.C., but authentic historical references to coconut products like toddy and arrack do not appear till about the fifth century A.D.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 coconuts in Ceylon, resulting in the preparation and export of several coconut products.

Though doubtless 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 statistics 2,066 palms were licensed for this purpose, which yielded 73,577 gallons of toddy from which 63,568 gallons of vinegar were produced and sold at sixty cents per gallon. In 1954, 2,797 palms were licensed which yielded 120,694 gallons of toddy, yielding 55,685 gallons of vinegar which were sold at Rs. 2/40 per gallon. It will thus be evident that the vinegar industry in Ceylon has made little or no progress during the past twenty-five years, the total production remaining more or less static.

3. Principles Involved in Vinegar Manufacture

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.

Two distinct stages both associated with living vegetable micro-organisms are involved in the process of vinegar production from the raw 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 carbon dioxide through the action of microscopical plants called yeasts (Saccharomyces). The second stage consists of the slower process of acetification or oxidative fermentation, whereby the alcohol produced during yeast fermentation is gradually converted to acetic acid 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. When the raw material used is a starchy product, (grains or potatoes) then an extra stage (viz. saccharification) would be involved in its conversion to vinegar. The starch must first be converted by enzymic or acid hydrolysis into a readily fermentable sugar, before alcoholic followed by acetic fermentations can take place.

4. Disabilities of the Present Industry

A survey of the quality of vinegar produced by the existing industry, has revealed that much improvement is necessary both in methods of production and the quality of the manufactured product. In my opinion, the chief difficulty experienced by vinegar makers, appears to be their inability to get proper acetification of their toddy, due partly to lack of control during processing, and partly to the fact that the present method of manufacture is not very suitable for commercial production.

As a home industry vinegar may be made by simply providing an air supply and allowing small barrels or vats of the ' gyle ' (or alcoholic wash) to acetify spontaneously. This method even on a small scale does not always produce a high grade product. The commercial method which is still in vogue in Ceylon is purely an adaptation of this household process, the only difference being that bigger volumes and bigger vats are handled. This discontinuous ' vat ' process requires 3-6 months for maximum acetification and is by no means efficient or economical. In addition the vinegar produced is of irregular strength and poor quality, and in extreme cases characterised by off tastes and rank ' mousey ' flavours.

It has also come to light that in a number of factories wasteful loss of alcohol and acid takes place owing to injudicious handling of the raw material during the various stages of manufacture. Where producers are unable to get their product to contain over 4 per cent acid of biological origin by genuine brewing, then they resort to malpractices and wilful sophistication for the purpose of compliance with legal definitions of standard. The highest acid strength for genuine coconut toddy vinegar (made by the present method) claimed by any vinegar maker in the island is 4.5 per cent. This means that bottled samples on the market containing more acid than this are in most cases likely to be fortified with synthetic acetic acid.

5. Coconut Toddy as Raw Material for the Manufacture of High Grade Vinegar

In considering the composition of the sap from the coconut palm it is important to distinguish between the fresh unfermented juice usually referred to as ' Sweet Toddy ' and the sap in various stages of fermentation called ' Toddy '. Variations in the quality of sweet toddy (especially with regard to sugar content) have been observed by many workers. The weather perhaps is the principal factor affecting its composition, because it is known that during the rainy season the sap is more dilute. Young palms are also supposed to give a weaker juice than the older ones, and the first juice which commences to flow on tapping is not reckoned to be so rich as that obtained from the lower part of the spathe. Unless there is gross contamination with rain water, none of these fluctuations in sugar content could prove serious enough to make the sap unsuitable for vinegar making.

The juice of the palm really compares very favourably with that of the sugar cane, not only regarding its sugar content but also in purity, and is superior to that of sugar beet because the latter contains a large amount of foreign matter in proportion to the sugars.

Workers in the Philippines and India have been quoted in the literature to have found 16.5 and 14.6 per cent of cane sugar respectively in coconut toddy. These figures have been confirmed by observations made at the Coconut Research Institute which have shown sugar concentrations averaging 15 per cent in the unfermented sap.

Besides sugar, coconut toddy also contains some proteins and about 0.5 per cent of ash representing the total mineral constituents. The mineral matter remains unaltered throughout the fermentation processes and is notably rich in potash salts which are present to the extent of about 2 parts per thousand. Certain other agreeable minor constituents, (some of which are highly aromatic) are produced *in situ* during fermentation, and are responsible for the bouquet of the distilled and brewed products derived from fermented toddy.

One other very important minor constituent which should receive mention in this connection is ascorbic acid or vitamin C. This occurs in sweet toddy to as great an extent as 3 parts per thousand and does not appear to be affected by alcoholic fermentation. Besides this, fermented toddy is also stated to provide supplies of the complex of vitamins now grouped under the letter B, particularly B_2. Their presence has not been demonstrated in the unfermented sap, but probably they are derived from the growing yeasts which cause the fermentation. The distinctive characters of toddy and the palatability of its derivatives must certainly be associated with even another class of minor constituents which are not amenable to chemical analysis, and perhaps even of unknown chemical nature.

With a knowledge of the composition of toddy it should not be difficult to appreciate what a suitable raw material it is for vinegar manufacture. It has an ideal composition for the preparation of vinegar stock, that is the alcoholic wash or ' gyle ' (the first step in vinegar manufacture). Unlike most other raw materials it needs no fortification with adventitious sugar or salts, and it possesses the over-riding advantage of being a well balanced medium containing sufficient nutriment for the growth and activity of yeasts and bacteria. Its composition is so favourable that the process of alcoholization is spontaneous and quick, taking only 24-48 hours. In fact, no sooner the sap falls from the palm, fermentation commences owing to the action of micro-organisms collected from its surroundings, unless special prior precautions are taken to arrest it.

6. The 'Generator' Process for the Commercial Production of Coconut Toddy Vinegar

From what I have already stated, two facts which emerge should be abundantly clear. Firstly coconut toddy is doubtlessly an excellent raw material for the manufacture of vinegar. Secondly, the present method of vinegar making employed in Ceylon is not very suitable for commercial production. It does not exploit to a maximum the potentialities of coconut toddy for the manufacture of high grade vinegar, and therefore leaves considerable room for improvement.

With a view to overcoming the disabilities of the existing industry and manufacturing a quality product experiments have been carried out at this Institute, with very promising results, on the continuous 'Generator' Process. The vinegar generator is designed to provide the maximum surface exposure for a volume of vinegar stock in order to supply enough air for the acetic acid bacteria to efficiently and quickly oxidise the alcohol to acetic acid.

The experimental generator designed for the laboratory trials was a small one of the re-circulating type, cylindrical and straight sided in construction with the following overall dimensions (3' 10" high × 9" external diameter, 7.5" internal diameter).

The central bore of the tower was divided internally into three compartments by means of two sets of perforated discs, dividing the generator column into a top distributing chamber, a middle packing chamber and a bottom sump or collection chamber. The upper compartment was the smallest of the three (about 5" high) containing the distribution funnel and three perforated dispersion discs placed one on top of the other (2 with 1/8" and one with 1/4" perforations all drilled 3/4" apart). The middle packing chamber was the biggest (about 2' 4" high) packed fairly closely with maize cobs of different sizes. The collection chamber (about 1' high) had a capacity of 1.9 gallons (= 8.6 litres). The false bottom separating the packing and collection chambers and supporting the cobs was in the form of a perforated disc with 1" holes drilled ½" apart.

The generator was provided with a loose-fitting cover on top, an exit cock or faucet at the bottom and 24 air inlets or ports complete with rubber bungs in 3 whorls of eight each located around the generator at three levels. I might mention that in constructing non-experimental generators it would be necessary to have only one set of vents in the bottom compartment.

The vinegar stock (i.e. the settled fermented toddy after yeast fermentation) was stored in a 10 litre aspirator bottle fitted with a glass tap and was allowed to run in dropwise into a 'thistle' funnel connected to the distribution apparatus in the top chamber. The oxidation of the alcohol was accomplished by droplet dispersion of the vinegar stock which was applied to the upper surface of the packing medium (maize cobs in this case) combined with its counter-current flow against the air entering at the bottom. The acetic bacteria present on the generator packing find conditions satisfactory for rapid oxidation of the alcohol. The acetification taking place simultaneously and rapidly throughout most of the exposed surface of the generator medium as the vinegar stock trickles through the packing. Being assured by the heat generated by acetification of the vinegar stock the air which enters through the lower vents and false perforated bottom, passes up through the packing and out through the loose-fitting top.

This small experimental generator has been in continuous operation since 15th June, 1954 and is working with great efficiency giving very satisfactory results.

The results of 36 experimental charges of fermented toddy put through this generator convincingly show that complete acetification of fermented toddy can be effected by this 'Generator' Process. The overall average acidity of these 36 charges was found to be 7.20 per cent, which is a satisfactory recovery. As against 3 to 6 months by the existing method, which produces a vinegar containing a maximum of only 4.5 per cent of acetic acid, complete acetification took place in 144 hours (6 days) by the 'Generator' process.

The majority of the local vinegars examined in these studies were characterised by off tastes and flavours in spite of their storage for protracted periods of time in wooden vats. No such objectionable characteristics were evident, in any of the 'Generator' samples even in their raw unmatured state. They compared very favourably with reputed imported vinegars in regard both to quality and analytical characters. A maturation experiment on a sample of generator vinegar has shown that the product becomes quite clear in appearance, acquires a mellow agreeable taste, and improves further in flavour, when aged in wood.

Conclusion

Every country in the world has its own distinctive liquor industry and in Ceylon coconut toddy forms the base of an alcoholic beverage which we know is arrack. In considering the economics of vinegar production it is important to note that this industry has always been of subsidiary importance in comparison with arrack manufacture.

Though under existing conditions the chances for increasing the production of coconut vinegar are rather remote, yet these experiments have revealed that there is ample scope for improving the methods of production and quality of the vinegar turned out by the existing industry. The experiments on the 'Generator' process conclusively demonstrate the potential possibilities of producing a high grade vinegar from the sap of the coconut palm. This method shows promise of removing the principal disabilities of the industry by combining speed of action with economy and ease of operation. It prevents wasteful loss of valuable alcohol and acetic acid during processing and ensures a standard product of superior quality. The saving of factory floor space could be estimated from the fact that a Generator with an output of 50 gallons per day will produce the same amount of vinegar per year as nine 1,000 gallon acetifying vats. As the conversion of vats into generators does not present much difficulty, producers already in the industry would not be involved in any heavy expenditure in adopting the new process.

I am pleased to report that two vinegar makers have already taken steps for a change-over and the results obtained so far are quite encouraging.

The Coconut Research Institute is always prepared to assist on the technical side with recommendations for the advancement of the industry. However, it should also be remembered that the mutual honest co-operation of interested parties, including the manufacturer, wholesaler and retailer is a *sine qua non* in any efforts for the improvement and maintenance of high standards for coconut toddy vinegar.