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USE OF EBULLIOMETER FOR ALCOHOL DETERMINATION IN COCONUT TODDY

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ABSTRACT

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Ebulliometers are used in the industry for estimation of alcohol in toddy. This method was compared with hydrometer and pycnometer methods for estimation of alcohol in toddy. The ebulliometer method appeared to be accurate for toddy containing 6 to 8%(v/v) alcohol. A calibration curve is presented for reading the actual alcohol content when the estimated value using the ebulliometer is known. The readings obtained by the hydrometer method did not vary significantly from those obtained by the ebulliometer method.

INTRODUCTION

The alcoholic strength of liquors is generally estimated using physical properties such as density, refractive index, surface tension or boiling point. It is not possible to apply the first three methods directly to fermenting toddy due to its turbid nature, the presence of solid matter, evolution of carbon dioxide and production of the various secondary products during fermentation. The toddy is therefore distilled to obtain a clear liquid phase and made to the original volume with water in applying the above methods. The density method using a pycnometer is generally accepted as the most accurate method. In experimental work both pycnometer and hydrometer methods are commonly employed.

In the arrack industry toddy is distilled to concentrate the alcohol. For this purpose toddy is bought at the distilleries through a large number of collectors. This demands a method for estimating the alcohol content in toddy in a few minutes as a large number of samples has to be handled within a few hours. Thus hydrometer and pycnometer methods cannot be used in the industry. Payments are made on the basis of the alcohol content of the toddy read in the ebulliometer. The principle underlying this instrument is the determination of the boiling point of the toddy which is a function of the composition of toddy. The alcohol percentage (v/v) is thus read on a scale against the boiling point. The method is convenient and rapid enabling 6 to 8 determinations per hour. The possibility of obtaining a reading directly without a distillation is the added advantage in the instrument.

However there are limiting parameters and conditions that should be carefully adopted in using ebulliometers for alcohol determination in undistilled liquors. The boiling points of alcohol-water mixtures are reported to be altered by the presence of invert sugar, high extract (solid matter) and cream of tartar (Joslyn *et. al.*, 1937). Natural solids content above 5g/100 ml had been shown to affect the ebulliometer readings for wines (Valaer, 1938). It is suggested that the wines be diluted to less than 5 g/100ml of solid matter before testing in an ebulliometer. Toddy contains high solid matter, invert sugar, tartaric acid and acidity, (Samarajeewa *et. al.*, 1976). Though ebulliometers are widely used in the toddy and arrack industries no reports are available regarding the limitations and accuracy of the instrument.

This study compares the ebulliometer method with density methods using pycnometer and hydrometer estimations and discusses the applicability of the former for alcohol determinations in toddy.

EXPERIMENTAL

Toddy : Samples of toddy collected from the field were allowed to ferment to different alcohol levels in earthenware collecting pots. Replicate samples were withdrawn without disturbing the bottom sediment for the estimations by the three methods given below.

Pycnometer method:—A pre-weighed 100 ml volumetric flask was placed in a water bath at 26.6 ± 0.1 °C and was made up to the mark using toddy at the same The flask was allowed to come to room temperature and was weighed. The todd ferred to a round bottom flask. The volumetric flask was rinsed thrice using volume) of distilled water. Washings were added to toddy in the round bottom toddy was next distilled using a vertical condenser. About 98 ml of the distillate directly into the volumetric flask used for weighing toddy. The flask was then 26.6 ± 0.1 °C and the distillate was made up to 100 ml. using water. The flas 100 ml of distilled water at 26.6 ± 0.1 °C was also weighed.

The specific gravity of the distillate was calculated and the percentage of read from the specific gravity tables for alcohol.

Hydrometer method:- 150 ml of toddy was distilled using the same distillatic as above, but without adding water. The total distillate was collected into a mea der. The specific gravity was determined using a Sike's hydrometer at thermal The percentage of alcohol was read from the tables.

Ebulliometer method:- 50 ml of toddy was used for the ebulliometer estima temperature was read at the lowest constant boiling point. The blank readin using distilled water. The zero of the scale was adjusted to the boiling point of w percentage of alcohol was read from the scale.

RESULTS

The readings obtained for different toddy samples using the ebulliometer a hydrometer and pycnometer are presented in Fig. 1 and 2 respectively.

(a) *Hydrometer vs. ebulliometer* (Fig.1)

The hydrometer readings differed from that of ebulliometer readings. Th equation for the curve is

$$y_1 = 0.38 + 0.92\,x$$
$$r = 0.99^{***}$$

However the correlation coefficient is high.

Using a paired t-test t values of 0.57 and 0.70 were obtained for all the read the readings in the range 6 to 8% alcohol respectively. Thus the differences values recorded by the two methods were not significant.

(b) *Pycnometer vs. ebulliometer* (Fig. 2)

The ebulliometer readings were higher than the pycnometer readings. Th equation for the curve is

$$y_2 = -0.64 + 1.02\,x$$
$$r = 0.98^{***}$$

Here too the correlation coefficient was high.

The paired t-test value for all readings was 4.3013 indicating that the ebulli dings were significantly higher than the pycnometer readings. However in th 6 to 8% alcohol the t-test gave a value of 1.3 Thus in this range the ebulliome

Pycnometer method:—A pre-weighed 100 ml volumetric flask was placed in a thermostat water bath at 26.6 ± 0.1 ° C and was made up to the mark using toddy at the same temperature. The flask was allowed to come to room temperature and was weighed. The toddy was transferred to a round bottom flask. The volumetric flask was rinsed thrice using 25 ml (total volume) of distilled water. Washings were added to toddy in the round bottom flask. The toddy was next distilled using a vertical condenser. About 98 ml of the distillate was collected directly into the volumetric flask used for weighing toddy. The flask was thermostated at 26.6 ± 0.1 °C and the distillate was made up to 100 ml. using water. The flask filled with 100 ml of distilled water at 26.6 ± 0.1 °C was also weighed.

The specific gravity of the distillate was calculated and the percentage of alcohol was read from the specific gravity tables for alcohol.

Hydrometer method:- 150 ml of toddy was distilled using the same distillation apparatus as above, but without adding water. The total distillate was collected into a measuring cylinder. The specific gravity was determined using a Sike's hydrometer at thermal equilibrium. The percentage of alcohol was read from the tables.

Ebulliometer method:- 50 ml of toddy was used for the ebulliometer estimations. The temperature was read at the lowest constant boiling point. The blank reading was taken using distilled water. The zero of the scale was adjusted to the boiling point of water and the percentage of alcohol was read from the scale.

RESULTS

The readings obtained for different toddy samples using the ebulliometer as against the hydrometer and pycnometer are presented in Fig. 1 and 2 respectively.

(a) *Hydrometer vs. ebulliometer* (Fig.1)

The hydrometer readings differed from that of ebulliometer readings. The regression equation for the curve is

$$y_1 = 0.38 + 0.92\,x$$
$$r = 0.99^{***}$$

However the correlation coefficient is high.

Using a paired t-test t values of 0.57 and 0.70 were obtained for all the readings and for the readings in the range 6 to 8% alcohol respectively. Thus the differences among the values recorded by the two methods were not significant.

(b) *Pycnometer vs. ebulliometer* (Fig. 2)

The ebulliometer readings were higher than the pycnometer readings. The regression equation for the curve is

$$y_2 = -0.64 + 1.02\,x$$
$$r = 0.98^{***}$$

Here too the correlation coefficient was high.

The paired t-test value for all readings was 4.3013 indicating that the ebulliometer readings were significantly higher than the pycnometer readings. However in the range of 6 to 8% alcohol the t-test gave a value of 1.37. Thus in this range the ebulliometer readings are not significantly different from the pycnometer values.

DISCUSSION

The pycnometer method was the most accurate out of the three methods used for estimation of alcohol in toddy. However, ebulliometers are used widely in industry due to convenience. The results indicated that the ebulliometer readings were generally higher than that of the pycnometer. It is now possible to obtain the actual alcohol content (as read by the pycnometer) using the curve (figure 2) if the ebulliometer readings are known.

Special attention was drawn to alcohol values of 6 to 8% (v/v) as the toddy bought at the distilleries contain alcohol in this range. The paired t-test showed that the differences in the readings between pycnometer and ebulliometer methods were insignificant in the above range. Thus it is possible to apply the ebulliometer method reliably in estimating alcohol in toddy in the range of 6 to 8% (v/v).

For experimental and research purposes it is advisable to use the pycnometer method for determination of alcohol as ebulliometer readings are reliable only within a limited range.

Generally the hydrometer method is used in industry in checking the ebulliometers when there is a doubt regarding its accuracy. The hydrometer readings do not differ significantly from ebulliometer estimations. This sort of calibration will only correct any discrepancies that may occur among the ebulliometers due to faulty thermometers or scales.

The solid matter content of the toddy at its maximum alcohol concentration lies around 5% (Samarajeewa, 1976). The same factors that were reported to create errors in using ebulliometer for alcohols in wines may be interfering with toddy too. A detailed study of the contributions by other constituents in toddy causing errors in ebulliometer estimations of alcohol is beyond the scope of this paper.

CONCLUSIONS

Though toddy contains high extract and secondary products the ebulliometer could be employed without leading to serious errors in alcohol estimations in industry where the alcohol content generally lies between 6–8% (v/v).

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