

## SUMMARY (ABSTRACT)

Palmyrah palm (Borassus flabellifer L.) grows naturally in the drier regions of Sri Lanka and the greatest concentration is found in the Jaffna peninsula. A mild alcoholic beverage popularly known as palmyrah 'toddy' or palmyrah wine is obtained from this palm. This is one of the many useful products of this palm.

The palmyrah toddy, a traditional beverage of Northern Sri Lanka and other palmyrah growing countries, is the spontaneously fermented sap of the young and mature inflorescences of both male and female palms. The unfermented sap, commonly referred to as 'sweet toddy', contains 10 - 16% w/v sugar and it is mainly in the form of sucrose. Young male inflorescences yield more toddy than matured male inflorescences. In the case of female palms, toddy yield from matured inflorescences was greater than young inflorescences. The mean total toddy yield /palm/day for young male, mature male, young female and matured female inflorescences were 5.019, 3.162, 5.915 and 8.04 litres respectively. In a high yielding inflorescence, the rate of flow of sap was found to be 2.86 ml per min.

Total sugar content of the sap varied. There was no significant difference between young male and matured male sap. But this differed from the female. The sap from young female inflorescence had significantly more sugar than the male inflorescences. However the sap from the matured female inflorescence showed significantly lower sugar content than the others.

Analysis of the sap by thin layer chromatography showed that the major sugar was sucrose with varying amounts of glucose and fructose. There was traces of raffinose in the sap.

The organisms involved in this spontaneous fermentation were isolated and identified. Four yeast species, namely Saccharomyces cerevisiae, Saccharomyces chevalieri, Kloeckera apiculata and Schizosaccharomyces pombe and three bacterial species, Bacillus cereus, B. sphaericus and B. firmus were found to be closely associated with this fermentation. Of the yeasts most predominant one is S. cerevisiae. Among the bacteria most common ones were Bacillus cereus and B. sphaericus.

The alcohol content of naturally fermented toddy from inflorescences of different ages were analysed and it was found that the toddy from matured female inflorescence had a mean alcohol content of 6.5% v/v and differed significantly from the others which had around 5% v/v. In spite of lower concentration of sugar, the matured female inflorescence had given more alcohol. This increased efficiency may be due to the presence of other fermentable substrates other than sucrose or to the presence of a superior yeast strain.

The alcohol production of the four yeast strains on autoclaved sweet toddy sample, when compared showed that Saccharomyces cerevisiae to be more superior to the others. Kloeckera apiculata was found to be a poor fermentor.

The addition of salts such as  $MgSO_4$ ,  $NH_4Cl$  and  $KH_2PO_4$  increased the yield of alcohol significantly over the control when sap was fermented with the superior strain S. cerevisiae. The addition of  $KNO_3$  and  $NH_4NO_3$  was found to suppress alcohol production.

The efficiency of fermentation of naturally fermented toddy was found to be 56%. However the addition of pure, denser inoculum of S. cerevisiae isolated in this study, into

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the collection pots greatly improved this fermentation. The efficiency was increased from 56% to 69%. Also the experiments showed that this could be maintained upto 2 weeks. Later another fresh inoculum could be added into the collection pots. This is a very easy practical method to improve the alcohol production.

The efficiency was further increased to nearly 89% when sterilized, unfermented palmyrah sap was fermented under controlled conditions in the laboratory using pure S. cerevisiae inoculum. An alcohol content of 9.5% v/v was obtained from this sap while the natural toddy has only 5% v/v of alcohol. Under laboratory conditions the fermentation can be completed within 48 hours with a starting yeast density of  $10^7$  cells/ml.

The acid produced in this natural fermentation was found to be acetic acid. The analysis of toddy distillates by gas liquid chromatography revealed that the major product of this fermentation is ethanol with trace amounts of methanol, n-propanol, isobutanol, ethylacetate and n-amyl alcohol. The ester, ethyl acetate was present in all the samples of toddy analysed and this could be the cause of the characteristic aroma of the toddy distillate.