

Preparation of an Alcoholic Beverage from Tea Leaves

J. W. K. K. Jayasundara¹, R. P. Phutela¹ and G. S. Kocher^{1,2}

ABSTRACT

J. Inst. Brew. 114(2), 111–113, 2008

The preparation of a fermented tea beverage from a Sri Lankan Broken Orange Pekoe (BOP) tea type is reported. The tea beverage was produced using 1–2.5% (w/v) Broken Orange Pekoe and was brewed using boiling sucrose sweetened (5–25°Brix) water (100°C for 3 min), followed by fermentation at 25°C, utilizing an 8.5% (v/v) inoculum of *Saccharomyces cerevisiae* G. A maximum ethanol of 14.91% (v/v) was obtained from an initial 25°Brix substrate with a 2.67°Brix drop per day. The tea beverage with an initial 15°Brix and 1.5% (w/v) tea yielded the best sensory score and was stable over a test period of 6 weeks at 15°C.

Key words: beverage, black tea, fermentation, *Saccharomyces cerevisiae*, sensory analysis, shelf life.

INTRODUCTION

Tea, mostly black tea, is the second most consumed drink in the world after water and well ahead of coffee, beer, wine and carbonated soft drinks⁸. Black tea is a good fermentation medium because the infusion contains proteins, amino acids, volatile compounds, lipids, enzymes and polyphenols¹¹. Microbial fermentation of black tea leads to value addition in terms of taste, flavour and health components. Fermented tea decoctions such as “Kombucha” have been prepared by cofermentation with yeast and acetic acid bacteria and are known to have health benefits^{7,12}. Black tea fermented with yeast accumulates the vitamins A, C and B complex, making it a nutritious and a therapeutic agent⁵, besides increasing shelf life¹⁰.

In spite of these benefits, reported works on the development of fermented tea beverages are few. Therefore, in the present study, efforts were made to develop alcoholic fermentations of black tea by *Saccharomyces cerevisiae* along with sensory evaluations of the resulting beverage.

MATERIALS AND METHODS

A Broken Orange Pekoe (BOP) tea type procured by one of the authors from Sri Lanka was used in the study. The inoculum was an isolate of the yeast *Saccharomyces cerevisiae* G, obtained from a local distillery.

¹Department of Microbiology, Punjab Agricultural University, Ludhiana-141004, India

²Corresponding author. E-mail: g_kocher@yahoo.com

Preparation of tea extract

The tea extract was prepared by brewing different tea concentrations from 1.0–2.5% (w/v) for 3 min in sucrose sweetened water (5–25°Brix) to near boiling (80–100°C). This product was sieve filtered and dispensed into loosely plugged sterile glass bottles (500 mL capacity with a 400 mL working volume). The extracts were cooled to 25°C before inoculation.

Fermentation

The fermentation of the tea infusion was conducted at five sucrose levels of 25, 20, 15, 10 and 5°Brix and four tea concentrations of 1, 1.5, 2 and 2.5% (w/v). The tea infusions (in triplicate) were inoculated with a 24 h culture of *S. cerevisiae* G at an already standardized inoculum concentration of 8.5% (v/v) and incubated at 25±2°C (BOD incubator, Yorco, India). Fermentation was monitored by periodically taking triplicate samples for the estimation of residual sugar. The °Brix was determined using an Erma Hand Refractometer, and total sugar⁶ and ethanol⁴ were determined. This was repeated until there was no further fall in Brix. The fermentation efficiency (F.E.) was calculated as:

$$\text{F.E.} = \frac{\text{Actual ethanol (v/v)}}{\text{Total sugars} \times 0.64} \times 100$$

Table I. Effect of temperature of extraction on fermentation of tea infusion.

Fermentation period (days)	°Brix at	
	100°C	80°C
0	10.0	10.0
1	6.5	6.5
2	4.25	4.5
3	3.0	-
4	2.5*	2.5*
5	2.5	2.5
Final (12 days)	2.5	2.5
°Brix drop/day for first 4 days	1.88	1.88
Further °Brix drop/day up to 12 days	0	0
Alcohol % (v/v)	5.74	5.72
Fermentation efficiency (%)		
Based on total sugars	90.59	90.27
Based on sugars utilized	94.4	95.48
Sensory score (out of 20)	11.5	11.5
Residual total sugars (%)	0.40	0.54
Final pH	2.91	3.21

*First record of lowest °Brix.

Fermentation parameters: Tea concentration 1.5% (w/v), Initial pH 4.5; Initial Brix of 10°; Temperature 25°C; Inoculum 8.5% (v/v).

Table II. Effect of tea concentration and initial °Brix on fermentation of tea infusion.

Tea conc. (g/100 mL)	°Brix									
	25°Brix		20°Brix		15°Brix		10°Brix		5°Brix	
	Alc. % (F.E.) Final pH	Brix drop/day (Residual sugar)	Alc. % (F.E.) Final pH	Brix drop/day (Residual sugar)	Alc. % (F.E.) Final pH	Brix drop/day (Residual sugar)	Alc. % (F.E.) Final pH	Brix drop/day (Residual sugar)	Alc. % (F.E.) Final pH	Brix drop/day (Residual sugar)
1.0	14.01 (88.47) 3.39	1.63 (1.05)	9.81 (77.38) 3.09	1.25 (0.93)	8.73 (91.89) 2.98	1.38 (1.0)	4.69 (74.15) 3.11	1.5 (1.33)	2.04 (64.68) 3.75	0.83 (1.65)
1.5	14.91 (94.14) 3.18	2.67 (0.91)	12.05 (95.11) 3.23	1.5 (0.81)	9.01 (94.82) 3.14	1.57 (0.53)	5.72 (90.27) 3.04	1.88 (0.5)	2.45 (77.38) 3.65	1.25 (0.8)
2.0	14.12 (89.18) 3.19	2.34 (0.95)	11.31 (89.31) 3.21	2.14 (0.83)	8.77 (92.31) 3.17	2.2 (0.62)	4.82 (76.09) 3.0	1.88 (0.7)	2.28 (72.22) 3.98	1.25 (0.95)
2.5	14.21 (89.76) 3.39	1.68 (0.84)	11.84 (93.5) 3.3	1.34 (0.85)	8.81 (92.73) 3.22	1.38 (0.51)	5.11 (80.86) 3.12	1.5 (1.34)	2.24 (70.93) 3.88	0.83 (1.34)
CD _{5%} for % alcohol	0.16		0.15		0.17		0.16		NS	

Initial pH 4.5; Temperature 25°C; Inoculum 8.5% (v/v).

NS: Non significant.

Fermentation efficiency (F.E.) (%) on the basis of total sugars.

Table III. Effect of °Brix on sensory score of the tea beverage.

Character	Maximum score point	Accrued score points*		
		10°Brix	15°Brix	20°Brix
Appearance	2	0.3	1.0	1.0
Colour	2	1.3	1.3	1.4
Aroma and bouquet	4	2.4	2.3	2.0
Vinegary	2	1.4	1.4	1.6
Total acidity	2	1.4	1.3	0.8
Sweetness	1	0.3	0.3	0.4
Body	1	0.8	1.0	0.8
Flavour	2	1.6	1.6	1.3
Bitterness	2	1.3	1.6	1.6
General quality	2	0.8	1.8	1.0
Total	20	11.6	13.0	11.9

*Mean of 8 tasters as 2 tasters only expressed vague opinions.

Tasting parameters: 20 point sensory analysis scale, tea beverage bottles stored at room temperature, 50 mL glass tumblers used for tasting.

Sensory analysis

After completion of fermentation, the tea beverages produced were decanted by siphoning, filled into glass bottles of 200 mL capacity and presented for sensory analysis using a 20 point scale¹ to a panel (semi-untrained) of 10 tasters. The sensory scores were calculated and a mean was taken for each taster for every beverage.

Maturation studies

The tea beverage bottles were stored at 15°C and their chemical qualities (°Brix, alcohol % (v/v), volatile acidity (w/v), residual sugar %, and pH) were assessed over a period of 6 weeks.

RESULTS AND DISCUSSION

Preparation of tea infusion

The fermentation experiments on the two tea infusions prepared by brewing tea leaves at 10°Brix and 1.5% (w/v)

tea at 80 and 100°C revealed no significant difference with respect to the drop in °Brix, alcohol produced or sensory score (Table I). However, the tea infusion extracted at 100°C recorded lower post fermentative residual total sugars (0.4%) and a lower pH (2.91) when compared to the tea extracted at 80°C and thus was selected for further experimentation. Hot water is known to extract amino acids, vitamins etc. from tea leaves and these nutrients are used for yeast fermentation¹⁵. Therefore, greater extraction at 100° could have resulted in better fermentation and the resultant lower residual sugars. Aroyeun et al.³ have also reported on experiments with hot water for preparing tea infusions for tea wine production.

Fermentation

The results revealed 14.91% (v/v) ethanol with 1.5% (w/v) tea and 25°Brix sugar recording a maximum drop of 2.67°Brix per day⁻¹ (Table II). The fermentation efficiencies were highest with a 1.5% (w/v) infusion at all sugar levels tested. Panchal and Stewart¹³ have suggested increased osmotic pressure as reason for decreased fermentation efficiency. Higher tea concentrations in the present study, in general, led to a decrease in the Brix drop rate, although changes in fermentation efficiency were marginal. This could be due to the inhibitory action of tea polyphenols on the yeast. This has been reported for plant polyphenols against yeast⁹ and for chestnut shell extract polyphenols against bacteria¹⁶.

Furthermore, at 10, 15 and 20°Brix with a 1.5% (w/v) tea infusion, the fermentation efficiencies were above 90% and alcohol obtained ranged from 5.72 to 12.05% (v/v) suggesting that the tea beverage could be suitable for different segments of society, as per their preference for different levels of alcohol content. The beverages prepared with these three sugar levels were subjected to sensory analysis.

Table IV. Effect of aging on the chemical quality of the tea beverage.

Chemical characteristics	Duration of storage (weeks)*			
	0	2	4	6
°Brix	5.0	5.0	4.5	4.5
Alcohol % (v/v)	7.33	7.35	7.38	7.0
Volatile acidity % (w/v)	0.003	0.002	0.003	0.003
Residual sugar (%)	0.53	0.50	0.45	0.40
pH	3.14	3.14	3.14	3.15

*Storage was in glass bottles at 15°C.

Sensory analysis

Accrued data indicated that 15°Brix was the best in terms of a total sensory score. It is worth mentioning that this elevation of score points (13/20) emanated from the general quality character (1.8/2) and it was much ahead of the 0.8/2 and 1.0/2 in the 10°Brix and 20°Brix, respectively (Table III). Additionally, the taste of the tea beverage compared well with that of grape wines being produced in this laboratory and found as much favour with the tasters. Aroyeum et al.³ also reported good acceptability of the sensory parameters of their tea wine preparation. The tea beverage exhibited a low bitterness, in contrast to what is typical of tea. This could be due to a reduction of the polyphenol levels by the yeast during fermentation¹⁴.

Maturation studies

A reduction in °Brix and total residual sugars was observed (Table IV) which was expected, due to the metabolic activity of the small number of yeast cells that escape in the final product during siphoning. The consistent alcohol levels however indicate that the residual yeast cells (10–100 cells/mL) did not contribute to significant alcohol production at the low storage temperature. Also, there were insignificant changes in pH and volatile acidity of the beverage, suggesting low or no contamination by acid producing microorganisms or at least little activity at the storage temperature of 15°C.

This study reports on the preparation of a series of alcoholic beverages from the fermentation of sucrose based (10–20°Brix) 1.5% (w/v) tea infusions with a reasonably good sensory score. These beverages may be used as an alternate tea drink as well as a tea wine, however scale up studies before commercialization must still be undertaken.

REFERENCES

1. Amerine, M. A. and Roessler, E. B., Wines and their sensory evaluation. Freeman, W. H. & Co: USA, 1976.
2. Amerine, M. A., Kunkee, R. E., Ough, C. S., Singleton, V. L. and Webb, A. D., The Technology of Wine Making. Fourth edition. AVI Publishing Co: Westport, CT, 1980.
3. Aroyeun, S. O., Olubamiwa O. and Ogunjobi, A. A. K., Development of wine from infused tea leaves. *British Food J.*, 2005, **107**(1), 34-41.
4. Caputi, A., and Wright, D., Collaborative study of the determination of ethanol in wine by chemical oxidation. *Journal of AOAC International* 1969, **52**, 85-88.
5. Chand, P. and Gopal, R., Nutritional and medicinal improvement of black tea by yeast fermentation. *Food Chem.*, 2005, **89**(3), 449-453.
6. Dubois, M., Gills, K. A., Hamilton, J. K., Roberts, P. A. and Smith, F., Colorimetric method for determination of sugars and related substances. *Anal. Chem.*, 1956, **28**, 350-356.
7. Guttapadu, S., Yang, Z. and Knol, W., Kombucha fermentation and its antimicrobial activity. *J. Agric. Food Chem.*, 2000, **48**(6), 2589-2594.
8. Hui, Y. H., Tea. In: Encyclopedia of Food Science and Technology. Vol 4, John Wiley and Sons: USA, 1992, pp. 2525-2537.
9. Hwang, E., Ahn, B., Lee, H., Kim, Y. and Lee, K., Inhibitory activity of chitin synthase II from *Saccharomyces cerevisiae* by tannins and related compounds. *Planta-Medica*, 2001, **67**(6), 501-504.
10. Liyanage, A. C., Silva, M. J. and Ekanayaka, A., Analysis of major fatty acids in tea. *Sri Lanka J. Tea Sci.*, 1988, **3**, 46-49.
11. Martin, S. P. and Arnold, H. J., Tannins. In: Encyclopedia of Food Science. Vol. 3, John Wiley and Sons: USA, 1978, pp. 732-734.
12. Malabasa, R. V., Loncar, E. S. and Kolarov, L. J. A., Sucrose and inulin balance during tea fungus fermentation. *Romanian Biotechnological Letters*, 2002, **7**(1), 573-576.
13. Panchal, C. J. and Stewart, G. G., The effect of osmotic pressure on the production and excretion of ethanol and glycerol by brewing yeast strain. *J. Inst. Brew.*, 1980, **86**, 207-210.
14. Pasha, C. and Reddy, G., Nutritional and medicinal improvement of black tea by yeast fermentation. *Food Chem.*, 2005, **89**(3), 449-453.
15. Stagg, G. V., and Millin, D. J., The nutritional and therapeutic value of tea. *J. Sci. Food Agri.*, 1975, **26**, 1439-1459.
16. Yunyan, L., and Kwang, S., Study on bacteriostasis of chestnut shell extract. *Chem. Ind. Forest Products*, 2004, **24**(4), 61-64. (in Chinese).

(Manuscript accepted for publication May 2008)