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Full Length Research Paper

Impact of *Saccharomyces bayanus* Inoculum Levels on the Fermentation Dynamics and Chemical Composition of Tomato Juice

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The influence of two inocula levels of the yeast *Saccharomyces bayanus,* BV 818, 0.01 (w/v) and 0.02% (w/v) on physico-chemical properties of fermented tomato juice was investigated. The properties studied include alcoholic strength, dry extract, residual sugar, pH, titratable acidity and volatile acidity. During fermentation, the pH, titratable acidity, brix, CO_2 production and changes in phenolic composition of the fermented juice were monitored. Both pH and titratable acidity showed an upward trend for the fermented juices. Alcoholic strength of the fermented juice produced with 0.01% (w/v) inoculum level was significantly higher ($p<0.05$) than that produced with 0.02% (w/v). The total phenolics and pH for wine obtained from 0.02% (w/v) inoculum level were significantly higher ($p<0.05$) than that from 0.01%. Volatile acidity values of both wines were below the permitted levels. During ageing, most colour parameters showed higher values in both fermented juices. Inoculum level 0.01% (w/v) gave better physico-chemical qualities and was therefore found to be better than 0.02% (w/v) in producing fermented tomato juice. The 0.01% (w/v) inoculum-fermented tomato juice scored higher for overall acceptance than that of 0.02% (w/v) inoculum-fermented tomato juice, but the acceptance levels were not significant.

Key words: Tomato, inoculum level, wine, fermentation.

INTRODUCTION

Wine is usually made through fermentation of grape juice. However, juices of many fruits are reported to have been used for making wine. This includes African bush mango (Akubor, 1996), guava (Anderson and Badrie, 2005; Sevda and Rodrigues, 2011), jamun fruit (Chowdhury and Ray, 2007), litchi fruit (Singh and Kaur, 2009), amla fruit (Soni et al., 2009), kinnow fruit (Panesar et al., 2009), apples (Enidiok and Attah, 2010), papaya (Lee et al., 2010), raspberry (Duarte et al., 2010), and tomato 2009), apples (Enidiok and Attah, 2010), papaya (Lee et al., 2010), raspberry (Duarte et al., 2010), and tomato (Mathapati et al., 2010). Many fruits and vegetables are known to be good sources of vitamins, minerals, fibre and phytochemicals. The fermentation of juices of most of these fruits is likely to produce wines of varied nutritional, phytochemical and sensory qualities.

The production of any alcoholic beverage involves alcoholic fermentation, which may start spontaneously either by wild yeast or by inoculation of must or juice with

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yeast of known characteristics (Jackson, 2008). The strain of the yeast and the level of yeast inoculated are among the most important factors in determining the quality of the alcoholic beverage produced. The inoculum level, which is the quantity of starter culture added to must or juice to initiate fermentation, is known to influence the duration of lag phase, specific growth rate, biomass yield, and the quality of final product in com-mercial industrial fermentation (Sen and Swaminathan, 2004). An inoculum level of 7.5% (v/v) is reported to be the optimum in producing 11% (v/v) ethanol from kinnow fruit (Panesar et al., 2009). The use of inappropriate ino-culum levels may lead to problems such as competition among yeast cells leading to premature death and hence large quantities of residual sugar, etc. Therefore, it is important that the right level of inoculum is utilized in fermentation to make maximum use of the available fermentable sugar.

Tomato is one of the most important crops of the world. It is the most prominent source of lycopene (von Elbe and Schwartz, 1996), the carotenoid known to be the most powerful antioxidant of all carotenoids (Di Mascio et al., 1989). In addition to lycopene, tomato is endowed with other types of antioxidants, including ascorbic acid, vitamin E, carotenoids and flavonoids (USDA, 2009). Epidemiological studies have suggested that con-sumption of tomato and tomato products is closely linked with lower incidence of cardiovascular disease, prostate, gastrointestinal, and epithelial cell cancer (Rao and Rao, 2007). Tomato is a perishable commodity and has to be processed to extend its shelf life. The well known existing processed forms of tomato include juice, paste, puree, soup, ketchup, sauce and canned tomatoes (Motamedzadegan and Tabarestani, 2011). Winemaking could help to broaden the processing avenues of tomato. Mathapati et al. (2010) have reported the production of wine from tomato juice using 2% (v/v) *Saccharomyces cerevisiae* 3282. However, in the present study *Saccharomyces bayanus* was used, because it is known to conduct equally effective alcoholic fermentation (Jackson, 2008), produce little volatile acidity, and give more aromatic alcohols and ethyl esters (Antonelli et al., 1999). The use of different levels of inocula in fermen-tation of tomato juice has not received any attention by any author. Against this background, this study was con-ducted to investigate the effect of two inocula levels (0.01 (w/v) and 0.02% (w/v)) of *S. bayanus*, BV 818 at 20±1°C on the physico-chemical properties of fermented tomato juice.

MATERIALS AND METHODS

Preparation of yeast culture

The dry yeast used for tomato juice fermentation was *S. bayanus* BV 818 (Angel Yeast Company Ltd, Hubei Province, China). This was kept in a refrigerator at 5°C according to the manufacturer's instructions. The media used to culture the yeast was yeast peptone dextrose (YPD) (yeast extract – 0.5% (w/v), peptone - 1.0% (w/v), and glucose - 2% (w/v)). The pH of the culture media was adjusted to 5.0 using tartaric acid. The culture was put into a-250 Erlenmeyer flask, sterilized in an autoclave at 121°C for 20 min, and allowed to cool. Dry yeast of 0.3 g was then suspended in the 100 ml sterilized medium to obtain yeast concentration of 3 g/L. The suspension was heated to 40°C for 20 min to rehydrate the yeast (Kraus et al., 1981), then cooled to 25°C for adaptation (Jackson, 2008) before it was incubated in an incubator shaker (QYC 211 Incubator Shaker, Shanghai Test Equipment Co. Ltd.) at 30°C for 24 h using a speed of 160 rpm.

Preparation and inoculation of tomato must

The tomato was washed thoroughly with tap water. It was then sterilized with 2% potassium metabisulphite (KSM), and rinsed with distilled water. The tomatoes were cut into smaller pieces and blended using a Kenwood blender (Philips HR 2006, China). Ammonium phosphate and pectic enzyme concentrations of 0.5 g/L each was added to the must. Table sugar of a concentration of 200 g/L was added (Ribereau-Gayon et al., 2006) to raise the total soluble solids (TSS) from 4.9±0.1 to 15.5±0.2 °Brix. The pH of the mixture was adjusted from 4.22±0.11 to 3.21±0.01 using equal amounts of tartaric and citric acids, thereby raising the titratable acidity (TA) from 2.8±0.1 to 4.9±0.1 g/L (citric acid). The must was pasteurized at 40°C in a water bath for 1 h. It was then allowed to cool to room temperature and inoculated with the 24-h yeast culture (*S. bayanus* BV 818).

Inocula levels

Must of volume 0.9 L, which weighed 1.06 kg and had dry matter content of 5% was inoculated with 30 and 60 ml of the 24-h yeast culture of concentration 3.0 g/L. The must contained 855 ml of water and the resulting yeast concentrations were 0.1 (0.01% w/v) and 0.2 g/L (0.02% w/v) for the 30 and 60 ml inocula respectively. The wine produced with 0.01% w/v inoculum level was designated as fermented tomato juice Lo (FTJ Lo) while the one from 0.02% w/v was designated as fermented tomato juice Hi (FTJ Hi).

Fermentation of tomato must

The mixture was incubated at 20±1°C for seven days. During fermentation, the pH, titratable acidity (TA), total soluble solids (TSS), weight loss of fermentor as a measure of the rate of carbon dioxide (CO_2) production (El Haloui et al., 1988), total phenols and colour parameters were monitored starting from the second day up to the seventh day. After fermentation, the wine was cold stabilized at 5°C for 24 h and centrifuged at 5000 rpm for 10 min. It was then filtered and kept at 5°C until needed for analysis.

Analysis of fermented tomato juice

The method of Sadler and Murphy (2010) was used to determine TA and the results were expressed in g/L citric acid. The pH was measured using a pH meter (PHS-2C Precision pH/mV meter, China) after calibration with solutions of pH 7 and 4, respectively according to the AOAC (1984). The acid taste index (ATI) was calculated using the formula: ATI = TA (g/L) - pH (Plane et al., 1980). The TSS was determined with the Abbe Refractometer with temperature compensation (WAY-2S, Germany) and the values expressed in degree brix (°Brix). Alcoholic strength was measured using the spectrophotometric method after distillation of the alcohol as in Caputi et al. (1968). The residual sugar content was mixed determined by the dinitrosalicyclic (DNS) method (Miller, 1972). Total phenolics were monitored during fermentation by spectral analysis as described by Somers and Ziemelis (1985). Volatile acidity was determined by AOAC (1960). Dry extract was determined by AOAC (1995) and the results expressed in g/L. Colour parameters were measured following the method of Glories (1984). Absorbance was measured at 420 (A_{420}), 520 (A_{520}) and 620 nm (A_{620}) and the values used for calculating colour density, intensity, tint, and % yellow colour, % red colour and % blue colour are as follows:

Colour density (CD) = $A_{420} + A_{520}$, colour intensity (CI) = $A_{420} + A_{520} + A_{620}$, colour tint or hue (CT) = A_{420}/A_{520}, % yellow = 100 x (A_{420}/CI), % red = 100 x (A_{520}/CI), % blue =100 x (A_{620}/CI).

The absorbance at 280 and 420 nm is a measure of total phenols (Somers and Ziemelis, 1985) and browning index (Jackson, 2008), respectively.

Ageing

The wines produced were aged in bottles at 5±2°C for eight months. During this period the following parameters were monitored: pH, TA, TSS, alcoholic strength, residual sugar, volatile acidity, dry extract, acid taste index, colour intensity, tint, density, % yellow, % red, % blue, absorbance at 280 and 420 nm.

Sensory evaluation

A 10-member semi-trained panel was used to assess the taste, colour, aroma, and the overall acceptance of the two fermented tomato juices on a 5-point hedonic scale. On the scale: 1, dislike very much; 2, dislike much; 3, neither like nor dislike; 4, like much; 5, like very much. The mean scores of the panelists were analyzed.

Statistical analysis

The data was analyzed using one-way analysis of variance (ANOVA). The statistical package used for the analysis was SPSS Statistics 17.0. Differences between means were separated using least significance difference (LSD).

RESULTS AND DISCUSSION

Fermentation monitoring

The results on fermentation monitoring are shown in Figures 1a, b, 2a, b and 3. In the present study, FTJ Hi achieved maximum CO_2 production (1.6 g/L/h) at about 30 h while FTJ Lo had maximum CO_2 production of 1.4 g/L/h at about 50 h after commencement of fermentation (Figure 1b). The maximum CO_2 production figures recorded in this study were within the range of those reported for raspberry wine, produced from TSS of 16 °Brix (Duarte et al., 2010). The CO_2 production assumed a constant value which was earlier for FTJ Hi than FTJ Lo. This is an indication that fermentation of FTJ Hi came to completion earlier than FTJ Lo. A sharp drop in TSS for both inocula levels was associated with a large CO_2 production (Figures 1a and b). This agrees with what was reported for papaya juice fermentation in which both culture of *S. cerevisiae* and *Williopsis saturnus* and monoculture of *S. cerevisiae* experienced a sharp fall in brix with time (Lee et al., 2010).

In the course of fermentation, both pH and TA showed upward trend (Figures 2a and b) for the two fermented tomato juices. Generally, the increase in TA was slightly higher for FTJ Lo than FTJ Hi. Increase in TA with fermentation time has been reported for African bush mango wine (Akubor, 1996). The increase in TA with fermentation time may be due to the production of acids by yeast during fermentation (Ribereau-Gayon et al., 2006). Titratable acidity increase in the course of fermentation is desirable because it can help prevent spoilage by microorganisms. The pH of the tomato must used for producing the fermented juices was ameliorated with citric and tartaric acids, so the increase in pH may be caused by crystallization of tartrate (Jackson, 2008). At the end of fermentation on the seventh day, the pH of FTJ Lo was lower than that of FTJ Hi (Figure 2b). Figure 2b shows the variation of total phenolics, expressed in absorbance units (AU) during fermentation. There was an initial fall in total phenolics up to the second day, followed by gradual increase with sharp increase in pH with fermentation time. The total phenolics of FTJ Hi were slightly higher than that of FTJ Lo from the first day of fermentation to the last day. Increased phenolics content with fermentation time may be attributed to increased dissolution of phenols in increasing ethanol concentration from the tomato pomace (Ribereau-Gayon et al., 2006). The results show that increasing pH may be a contributory factor in the extraction of phenolics during fermentation.

Colour density of the fermenting must fluctuated over the fermentation period with increasing phenolic content (Figure 3). This may be due to changes in anthocyanin from one form to another with pH changes (Ribereau-Gayon et al., 2006).

Physico-chemical properties of fermented tomato juice before and after ageing

The physico-chemical properties of the fermented tomato juices produced are shown in Table 1. FTJ Lo had a significantly lower ($p<0.05$) pH than FTJ Hi, both before and after ageing. Since FTJ Hi was produced by using a higher inoculum level than FTJ Lo, higher competition and more yeast deaths, leading to low acid production in the case of the former than the latter, may account for the pH variation observed (Ribereau-Gayon et al., 2006). The pH of the two FTJ Lo and FTJ Hi (Table 1) was around 3.5 (Ribereau-Gayon et al., 2006). The favourable pH range for white wine is 3.1 to 3.4, and that of red wine is 3.3 to 3.6 (Jackson, 2008). Enidiok and Attah (2010) reported pH value of 3.68 and 3.79, respectively for *Syzygium malaccensis* and *Eugenia owariensis* apple wines. Ribereau-Gayon et al. (2006) have observed that low pH values in wines enhance microbiological and physicochemical stability. Before ageing, the TA of both

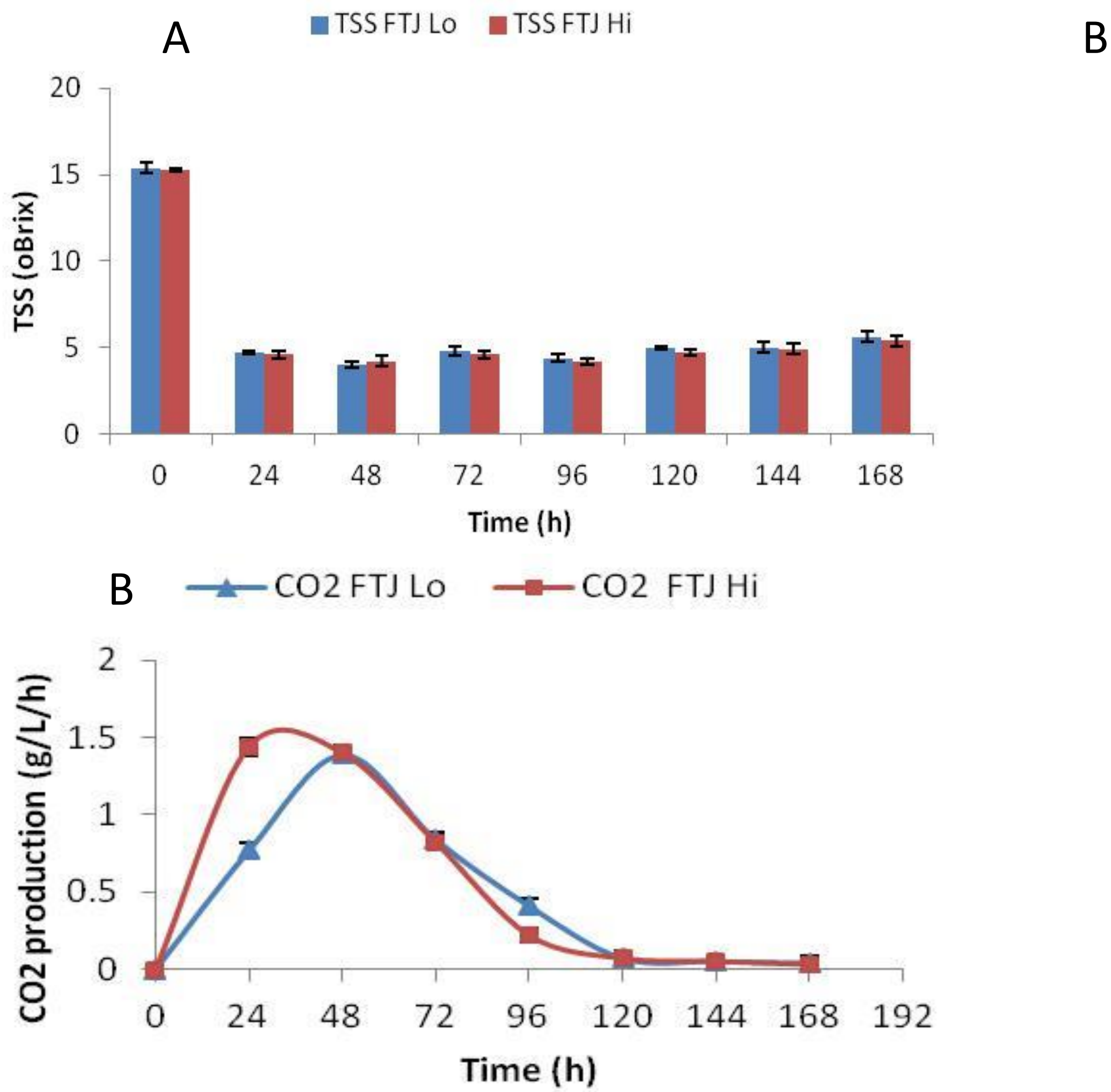

Figure 1. Variation in (a) TSS and (b) CO_2 production with fermentation time for the two fermented tomato juices.

wines was almost the same, but after ageing, the values were the same (Table 1). In addition, the TA values for both wines after ageing were significantly higher ($p<0.05$) than those before ageing. Increase in TA after fermentation has been reported for jamun wine by Chowdhury and Ray (2007). Also, an increase in acidity during a six month ageing period had been reported for wines aged in bottles (Garde-Cerdan et al., 2008). The TA figures recorded in the present study fall within the range 5.5 to 8.5 g/L in most wines (Jackson, 2008). The acid taste index values of FTJ Lo was not significantly different ($p>0.05$) from that of FTJ Hi, both before and after ageing. However, each fermented tomato juice recorded a significantly higher acid taste index values after ageing than before ageing (Table 1). Dry red wines have acid taste index values of two to three and dry white wines have 2.7 to 3.7, and values too far below these levels make wine flabby while those too above make the wine sharp and acidic (Iland et al., 2000). In the present study, the acid taste index values before ageing fell within the reported figures but were higher after ageing (Table 1). This gives an indication that the fermented tomato juices would taste a bit acidic after ageing than before.

The TSS of tomato juice was 4.9±0.1 °Brix, but was ameliorated to 15.5±0.1 °Brix. The TSS of FTJ Lo and FTJ Hi were not significantly different ($p>0.05$) before and after ageing. Even though the residual sugar values recorded for FTJ Lo was lower than that of FTJ Hi, the difference was not significant ($p>0.05$) both before and after ageing. Both fermented tomato juices gave residual sugar levels lower than 2 g/L and this agrees with what was reported by Torija et al. (2003). Residual sugar

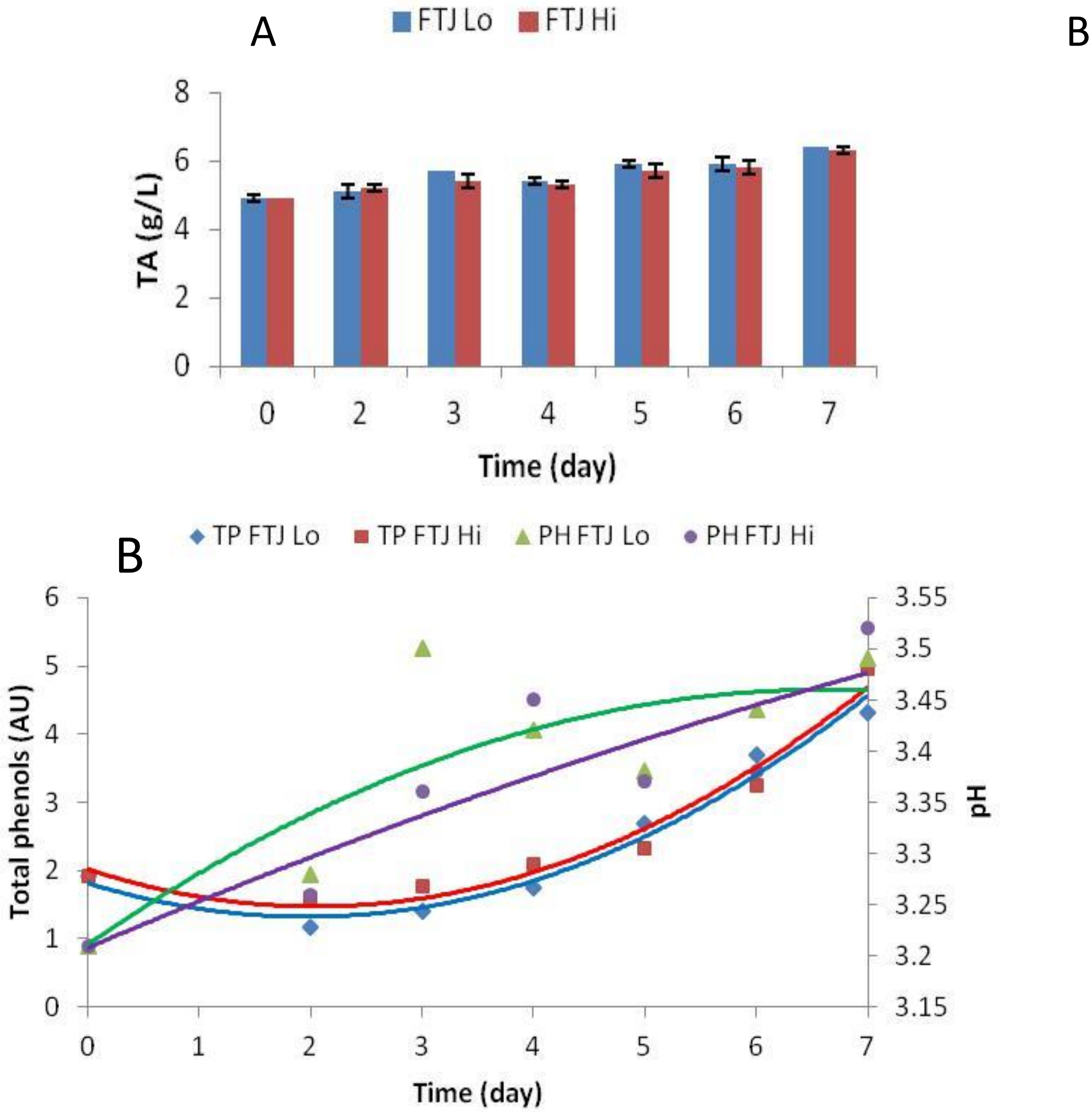

Figure 2. a) Variation in TA, and b) total phenols (TP) and pH with fermentation time.

affects the microbial stability of wines (Jackson, 2008). FTJ Lo recorded a significantly higher ($p<0.05$) alcoholic strength value than FTJ Hi before ageing, and this difference may be attributed to a more efficient sugar consumption in FTJ Lo than FTJ Hi. Much residual sugar was left in FTJ Hi than FTJ Lo after fermentation, though this difference was not significant. The alcoholic strength values reported for icewines produced with 0.2 and 0.5 g active dried wine yeast/L are 7.8 and 12.0%, respectively (Kontkanen et al., 2004). Alcoholic strength values of 11.00±0.04 and 10.50±0.03 (%v/v) have been reported for *S. malaccensis* and *E. owariensis* apple wines (Enidiok and Attah, 2010). An inoculum level of 10% (v/v) is reported to produce 9% (v/v) ethanol from Amla *(Emblica officinalis Gaertn.*) fruit wine (Soni et al., 2009).

Mathapati et al. (2010) have reported a value of 7.88% alcoholic strength for tomato wine by using 2% (v/v) *S. cerevisiae* inoculum level. In the fermentation of kinnow sera, cane and kinnow-cane juice involving three inocula levels, 5, 7 and 9% (v/v), Pratima et al. (2006) reported maximum ethanol production for 5% (v/v) inoculum level. The optimum inoculum level for ethanol production in guava wine was reported as 8% (v/v) for *S. cerevisiae* NCIM 3095 (Sevda and Rodrigues, 2011). After ageing, even though both fermented juices recorded significant reduction ($p<0.05$) in alcoholic strength, FTJ Hi had a significantly higher value than FTJ Lo. Soni et al. (2009) reported a reduction in ethanol content during ageing for amla wine. The reduction in ethanol content during ageing may be due to oxidation of ethanol to acetal-

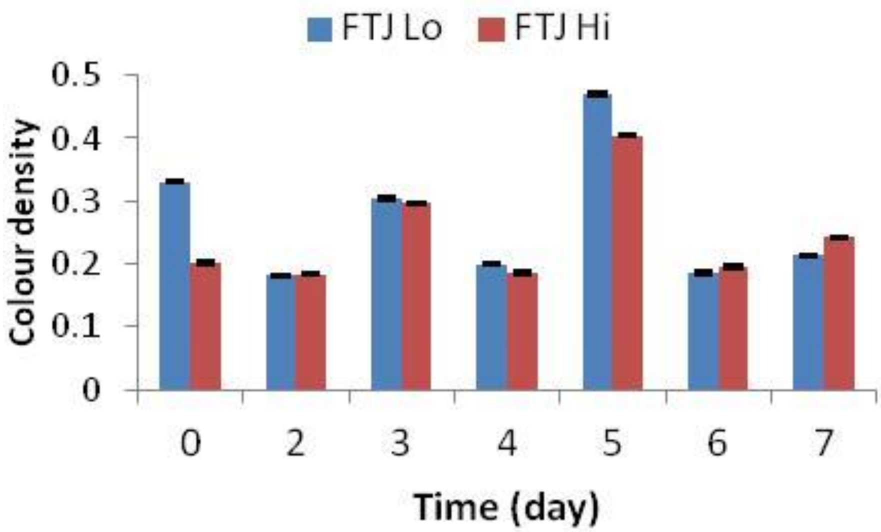

Figure 3. Variation in colour density with fermentation time.

Table 1. Physico-chemical properties of fermented tomato juice before and after ageing.

Parameter	Before ageing		After ageing	
	Fermented tomato juice Lo	Fermented tomato juice Hi	Fermented tomato juice Lo	Fermented tomato juice Hi
pH	3.49±0.02[a]	3.52±0.02[b]	3.41±0.01[c]	3.44±0.02[d]
TA (g/L citric acid)	6.3±0.0[a]	6.1±0.0[a]	7.5±0.2[b]	7.5±0.2[b]
Acid taste index	2.83±0.04[a]	2.60±0.05[a]	4.12±0.17[b]	4.03±0.18[b]
TSS (°Brix)	5.6±0.1[a]	5.5±0.1[a]	5.0±0.1[b]	4.9±0.1[b]
Ethanol (%v/v)	10.4±0.5[a]	8.9±0.5[b]	6.9±0.1[c]	7.5±0.2[d]
Residual sugar (g/L)	1.47±0.01[a]	1.53±0.02[a]	1.73±0.17[b]	1.77±0.07[b]
Volatile acidity(g/L)	0.03±0.01[a]	0.06±0.00[b]	0.03±0.01[a]	0.06±0.00[b]
Dry extract (g/L)	19.6±0.1[a]	20.1±0.1[a]	17.3±0.9[b]	17.0±0.5[b]
A_{420}	0.174±0.001[a]	0.194±0.001[b]	0.218±0.001[c]	0.216±0.000[d]
CI (A_{420}+A_{520}+A_{620})	0.230±0.002[a]	0.260±0.004[b]	0.276±0.002[c]	0.269±0.001[d]
CT (A_{420}/A_{520})	4.350±0.097[a]	4.042±0.080[b]	5.883±0.031[c]	6.292±0.105[d]
CD (A_{420}+A_{520})	0.214±0.002[a]	0.242±0.002[b]	0.255±0.001[c]	0.250±0.001[d]
% Yellow colour	75.5±0.5[a]	73.5±0.6[b]	78.8± 0.2[c]	80.2± 0.2[d]
% Red colour	17.4±0.3[a]	18.2±0.3[a]	13.4±0.1[b]	12.7±0.2[c]
% Blue colour	6.9±0.2[a]	8.3±0.6[b]	7.8±0.2[b]	7.1±0.1[a]
A_{280} (AU)	4.31±0.01[a]	4.96±0.01[b]	1.47±0.00[c]	1.61±0.00[c]

Means in the same row with different superscripts are significantly different (p<0.05). Means were obtained from triplicate measurements.

dehyde (Jackson, 2008). Much oxidation of ethanol to acetaldehyde might have occurred in FTJ Lo more than in FTJ Hi.

The dry extract values recorded for FTJ Lo before and after ageing, was not significantly different (p>0.05) from that of FTJ Hi (Table 1). Dry extract values for dry white wines are less than 25 g/L (Ribereau-Gayon et al., 2006). Losada et al. (2011) reported dry extract ranges of 12.90 to 13.40 g/L for godello white wines. Dry extract is important as a measure of body of wine. Significant reduction in dry extract was recorded after ageing for the two fermented tomato juices. Reduction in dry extract is reported for sherry wine during biological aging (Martinez De la ossa et al., 1987). Dry extract is reported to have a significant association with alcoholic content of wine (Mironeasa et al., 2011), so, reduction in alcohol level in the present study may account for the reduction in dry extract after ageing.

FTJ Lo gave significantly (p<0.05) lower volatile acidity values, both before and after ageing than FTJ Hi. Also, the volatile acidity values of each wine remained the same after ageing. The results on volatile acidity (Table1)

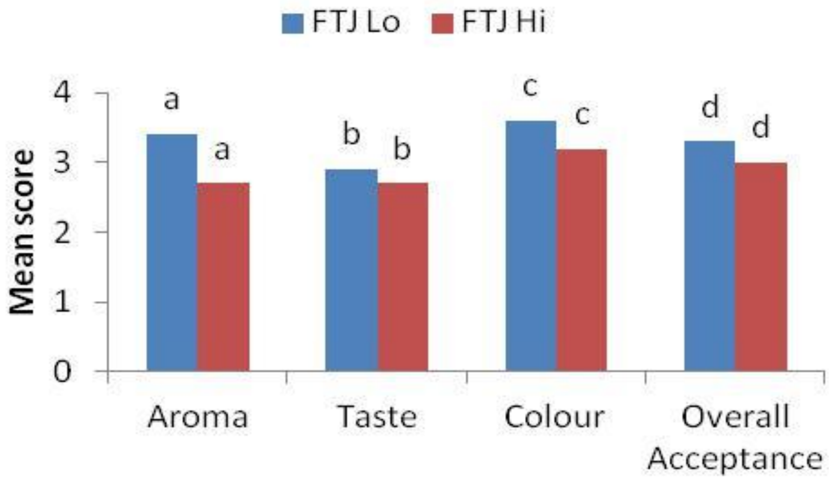

Figure 4. Mean scores of taste, aroma, colour and overall acceptance of fermented tomato juice based on a 5-point hedonic scale. Means with the same alphabets are not significantly different.

of the present study are below the range of 0.56 to 1.5 g/L reported by Bely et al. (2003). More acetic acid production in FTJ Hi than FTJ Lo may account for the difference in volatile acidity values of the wines. Volatile acidity gives an indication of possible microbial spoilage, and is used as an indicator of wine quality (Ribereau-Gayon et al., 2006). No difference in acetic acid concentration for icewines produced with 0.2 and 0.5 g of active dried wine yeast/L has been reported (Kontkanen et al., 2004). The fact that volatile acidity values remained the same after ageing may be attributed to the absence of malolactic fermentation (Ribereau-Gayon et al., 2006).

The colour parameters of the two fermented juices are shown in Table 1. Colour intensity (CI) and colour tint (CT) for FTJ Hi were significantly higher ($p<0.05$) than those of FTJ Lo, both before ageing and after ageing. In addition, each fermented tomato juice recorded significantly higher CI and CT after ageing than before ageing. In the case of colour density (CD), even though a significantly higher value ($p<0.05$) was reported for FTJ Hi than FTJ Lo before ageing, the trend showed otherwise after ageing. Browning index (BI) measured as absorbance at 420 nm (A_{420}) (Jackson, 2008), before ageing, was significantly higher ($p<0.05$) in FTJ Hi than FTJ Lo, but after ageing, the trend was otherwise (Table 1). Also, both fermented tomato juices registered significantly higher ($p<0.05$) BI values after ageing than before ageing. Increased BI is an indication of ageing (Jackson, 2008). The total phenolics measured as absorbance at 280 nm (A_{280}) (Somers and Ziemelis, 1985) for both fermented tomato juices were significantly lower after ageing than before ageing. In addition, before ageing, FTJ Hi recorded a significantly higher ($p<0.05$) A_{280} value than FTJ Lo, but after ageing, the difference in A_{280} values were not significant. Colour density gives an indication of colour depth, that is, how dark it is; colour tint shows a mixture of colour with white, which increases lightness, and colour intensity gives an idea about the brightness or dullness of a colour. In the present study, before ageing, FTJ Lo had a higher colour tint due to its lower colour density, but in FTJ Hi, a higher colour density gave a lower colour tint. This resulted in higher colour brightness for FTJ Hi than FTJ Lo. The A_{420} and A_{280} values of FTJ Hi which were higher than FTJ Lo might have given a higher colour density, and hence, a lower colour tint in FTJ Hi than FTJ Lo (Jackson, 2008). After ageing, though the A_{280} values of the two fermented tomato juices were not significantly different, A_{420} values were significantly higher for FTJ Lo than FTJ Hi. This might have resulted in a higher colour density, a lower colour tint and a higher colour intensity (brightness) for FTJ Lo than FTJ Hi. In the present study, both FTJ Lo and FTJ Hi recorded increase in colour density, intensity, tint, and % yellow colour after eight months of ageing. Also, a decrease in % red colour and total polyphenolic content for the two fermented tomato juices was observed. Well-balanced and properly aged wines exhibit increase in colour intensity (Ribereau-Gayon et al., 2006). Increase in colour tint, % blue and % yellow colours, a decrease in % red colour and polyphenolic content after eight months of bottle aging had been reported (Bautista-Ortin et al., 2007). Soni et al. (2009) also reported a reduction in phenolic content of amla wine after ageing in glass bottles for 30 days. The phenols lost during ageing might have contributed to the increased browning index values of the two fermented tomato juices (Ribereau-Gayon et al., 2006).

Sensory evaluation

The taste, aroma, colour and overall acceptance of the two fermented tomato juices were evaluated by a 10– member semi-trained panel. The results indicate that even though the FTJ Lo scored higher than FTJ Hi in all parameters, the differences were not significant ($p>0.05$) (Figure 4). The pH difference might have contributed to the differences in aroma and taste (Jackson, 2008), even though those differences were not significant.

Conclusion

Inoculum levels of 0.01 and 0.02% (w/v) were used to produce FTJ Lo and FTJ Hi respectively. Alcoholic fermentation in FTJ Hi came to completion earlier than FTJ Lo. FTJ Lo recorded a significantly lower pH ($p<0.05$) than FTJ Hi, but the difference in their titratable acidity values was not significant. FTJ Lo may have a better microbiological and physicochemical stability than FTJ Hi. FTJ Lo registered a significantly higher alcoholic content than FTJ Hi, but the dry extract values of the two fermented tomato juices were not significantly different. The residual sugar value of FTJ Lo was lower than that of FTJ Hi, but the difference was not significant ($p>0.05$). Volatile acidity content of FTJ Lo was significantly lower ($p<0.05$) than FTJ Hi, but both values were lower than the permitted. Ageing generally led to increased colour parameters for both fermented tomato juices. After ageing, the browning index value of FTJ Lo was significantly higher ($p<0.05$) than FTJ Hi. The inoculum level 0.01% (w/v) generally produced a fermented tomato juice of better quality than the inoculum level 0.02% (w/v). Sensory evaluation results showed that FTJ Lo had a higher overall acceptance than FTJ Hi, even though there was no significant difference in the acceptance levels.

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