



## FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

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*Cogent Food & Agriculture* (2016), 2: 1180660



Received: 25 February 2016  
Accepted: 16 April 2016  
First Published: 21 April 2016

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Reviewing editor:  
Fatih Yildiz, Middle East Technical  
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# Effect of maturation on physico-chemical and sensory quality characteristics of custard apple wine

Vikas Kumar<sup>1\*</sup>, Prakriti Jnawali<sup>1</sup>, P. Veeranna Goud<sup>2</sup> and Jasleen Kaur Bhasin<sup>1</sup>

**Abstract:** Recently, researchers have taken a shift to utilize the custard apple for wine preparation besides its major use in ice cream, confectionary and milk products. In the present study, an attempt has been made to study the effect of maturation on physico-chemical and sensory quality characteristics of custard apple wine. Custard apple wine was prepared as per the earlier standardized method. The wine so prepared was matured for six months. The physico-chemical analysis was conducted at every three months interval for six months and sensory evaluation was performed after six months of storage. With the maturation, a decrease in total soluble solids, total sugars, titratable acidity, ethanol, total phenols and tannins was observed, whereas, an increase in reducing sugars and pH was observed. All the sensory quality characteristics of custard apple wine increased with advancement of the maturation period except astringency. Cluster analysis of the data obtained from physico-chemical analysis revealed that there was no difference between three months and six months of storage. Physico-chemical characteristics of custard apple wine were reduced to two principal components using principal component analysis which accounted for 100% variation. In general, maturation for six months improved the quality of custard apple wine considerably.

**Subjects:** Beverages; Food Microbiology; Fruit & Vegetables; Sensory Science

**Keywords:** custard apple; wine; *Saccharomyces cerevisiae* var. *ellipsoideus*; maturation; sensory quality; cluster analysis; PCA



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### ABOUT THE AUTHOR

Vikas Kumar is an assistant professor at the Lovely Professional University, Phagwara, Punjab, India, since 2014. He holds a PhD in Food Technology (Fermentation Technology) from Dr. Y S Parmar UHF, Nauni, Solan, HP, India (2014). He is presently working in the area of food science, food fermentation, food biotechnology and waste utilization, with the major aim of functional food product development. The study, Effect of maturation on physico-chemical and sensory quality characteristics of custard apple wine, will definitely be helpful for the future works related to the maturation of custard apple wine and help the processors to improve the quality characteristics of it.

### PUBLIC INTEREST STATEMENT

Custard apple, a delicious and nutritionally valuable fruit is used for the preparation of juice, ice cream, confectionary and milk products. However, recently, researchers had shifted to make use of the custard apple for wine preparation. Wines have always been considered as safe and healthy drinks, besides an important adjunct to the diet. During winemaking, wine ageing, a most important and common technological procedure, which contributes to make the wine mellow in taste and fruity in flavour, is done. The ageing of wine is potentially able to improve the quality of wine. Till date there is no or few documentation on the maturation of custard apple wine. So in the present study, this aspect of custard apple wine has been explored.

## 1. Introduction

Custard apple (*Annona squamosa* L.) also known as sugar apple is one of the important hardy fruit crop growing wild on Deccan Plateau and some parts of Central India (Kumar, Goud, Babu, & Reddy, 2011) and different tropical areas around the world (Jagtap & Bapat, 2014). Custard apple, one of the delicious and nutritionally valuable fruit meant for table purpose has a soft granular, juicy and sugary pulp with mild flavour and slight acidity (Kumar et al., 2011). The shelf life of the custard apple is very short (Chadha, 2006) due to the climacteric nature of the fruit. Therefore, it is sold in local markets only. To utilize the large quantity of fruit produced during glut period, different researchers had reported the use of custard apple in preparation of juice, ice creams, milk shakes, soft drink and alcoholic beverages, i.e. wine (Jagtap & Bapat, 2014; Kumar et al., 2011; Luciana, Santos, Lúcia, & Maria Amélia, 2010).

Wines have always been considered as safe and healthy drinks, besides an important adjunct to the diet (Stockley, 2011). A typical wine contains ethyl alcohol, sugar, acids, higher alcohols, tannins, aldehydes esters, amino acids, minerals, vitamins, anthocyanins and flavouring compounds (Joshi & Kumar, 2011; Kumar et al., 2016). Alcohol, a macronutrient present in wine acts as an energy source and provides calories for all the essential biological activities in the human cells (Bisson, Butzke, & Ebeler, 1995). Different studies have shown the beneficial effects of wine consumption due to the presence of phenolics and alcohol in wine, which protects human body from free radical attack and increases high-density lipid level in the body (Joshi, 1997; Joshi, Sharma, & Parmar, 2011). Maturation of wine is a most important and common technological procedure used in winemaking which contributes to make the wine mellow in taste and fruity in flavour besides the clarification. The period of maturation may extend up to 6 months to 2–3 years. It is characterized by changes in overall bouquet of wine. The changes occur mainly in the colour, flavour and taste of the maturity product (Bhushan & Sharma, 2011). The process of maturation is complex, involves several independent events and improves the wine quality (Sharma & Joshi, 2003; Singleton, 1995) and the formation of esters takes place, thus improving the flavour of such beverages (Joshi, Attri, Singh, & Abrol, 2011). A number of alcohols and acids in the wine may unite to form esters during ageing which is responsible for the improvement of the wine flavour (Amerine et al., 1980). Decrease in tannins due to complexing of tannins with proteins as well as their polymerization resulted in slow smoothening of taste (Amerine et al., 1980; Ribereau-Gayon, Glories, Maujean, & Dubourdieu, 2001). Sharma and Joshi (2003) reported that ageing of strawberry wine for nine months improved the palatability and quality characteristics. Due to the lacking of documentation on the effect of maturation on the quality characteristics of custard apple wine, the present study was undertaken. The results obtained are discussed in this communication.

## 2. Materials and methods

### 2.1. Experimental

Custard apple wine was prepared as per the method as standardized during our previous attempt (Kumar et al., 2011) using 1:4 dilution of pulp ameliorated with sugar syrup (70°B) to raise the total soluble solids (TSS) to 24°B. After amelioration, diammonium hydrogen orthophosphate (DAHP) at 0.1% (as a nitrogen source) and sulphur dioxide (SO<sub>2</sub>) at 125 ppm (parts per million) in the form of potassium metabisulphite were added to kill the wild micro-organisms. After 2 h, the musts were inoculated with 5% of 24-h-old *Saccharomyces cerevisiae* var. *ellipsoideus* and kept for the fermentation at room temperature (24 ± 1°C). The wine, so prepared was clarified using bentonite (0.1%) and matured for 6 months at 10°C. During maturation, the wine was racked regularly.

### 2.2. Analysis

During maturation, all the physico-chemical analyses were performed after every 3 months. In order to study the effect of multiple replicate maturations on the quality characteristics of custard apple wine, analysis of the wine was carried out in replications. The wine was analysed for different physico-chemical properties, viz. TSS, reducing and total sugars, titratable acidity (as citric acid) and pH as described in AOAC methods (1980); ethanol was measured colorimetrically by potassium

dichromate method (Caputi, Ueda, & Brown, 1968). The total phenols content in custard apple wine was determined by Folin–Ciocalteu procedure as described by Singleton and Rossi (1965). Tannins in wine were determined by the method as described by Amerine and Joslyn (1951).

### 2.3. Sensory analysis

For sensory evaluation, numerical scoring of 0 and 6 months matured wine was conducted. Chilled and coded samples of custard apple wine were served to the semi-trained panel of judges to evaluate sensory characteristics on a prescribed performa as described by Amerine et al. (1980) and Joshi (2006). Each sample was evaluated for various quality attributes, viz. colour, aroma, flavour and taste, astringency and overall acceptability.

### 2.4. Statistical analysis

The data obtained from the physico-chemical properties of the custard apple wine were subjected to analysis of variance using a completely randomized design and the means with critical differences have been reported. Cluster analyses of data were performed to get comparative comprehensive overview of physico-chemical properties of the custard apple wine. The output obtained was plotted as a dendrogram and the interpretation of data was made, accordingly. Physico-chemical data were subjected to principal component analysis (PCA) to group the related variables into smaller components for the interpretation of their relationship. PCA and cluster analysis was performed using SPSS 16.0 software. The statistical analysis of the data obtained from sensory evaluation of the custard apple wine was done by Randomized Block Design (Cockrane & Cox, 1963).

## 3. Results and discussion

Data related to effect of maturation on physico-chemical characteristics of custard apple wine are presented in Table 1. It is evident from the statistical analysis of the data that with advancement in the maturation period, a gradual decrease was observed in all the parameters under study except reducing sugars and pH. A decrease in TSS during maturation might be due to precipitation of soluble solids during interaction of various components which might have resulted in a decreased TSS during maturation (Joshi, Sandhu, & Thakur, 1999; Sharma & Joshi, 2003; Sharma, Joshi, & Abrol, 2009). Similar results were reported by Sharma and Joshi (2003) in strawberry wine and Joshi, Sharma, Girdher, and Abrol (2012) in jamun wine. An increase in reducing sugar was observed with advancement of maturation period (Table 1). The increasing trend of reducing sugar is apparently the result of hydrolysis of non-reducing sugar into reducing sugar during maturation (Amerine et al., 1980; Sharma & Joshi, 2003), which is one of the desirable effects of the maturation of wine from taste point of view (Joshi et al., 2012). Decrease in total sugar might be due to the Maillard reaction resulting in non-enzymatic browning due to reaction of sugar with amino acid during maturation (Zoecklein, Fugelsang, Gump, & Nury, 1995). Similar results have been reported for total sugar for strawberry wine, low-alcoholic plum wine (Gill, Joshi, & Rana, 2009; Sharma et al., 2009).

**Table 1. Effect of maturation on physico-chemical characteristics of custard apple wine**

Parameters	Maturation period			
	0 month	3 months	6 months	CD ( $p \leq 0.05$ )
TSS (°B)	10.13	9.87	9.63	0.05
Reducing sugars (%)	1.95	2.04	2.11	0.03
Total sugars (%)	5.70	5.41	5.36	0.14
Titrateable acidity (% citric acid)	0.53	0.50	0.49	0.01
pH	3.66	3.71	3.81	0.14
Ethanol (%)	7.96	7.77	7.42	NS
Total phenols (mg/l)	226	194	175	3.80
Tannins (%)	0.019	0.014	0.011	0.002

Notes:  $n = 3$ .

NS = Non-significant.

It is also revealed from the data (Table 1) that during advancement of maturation, titratable acidity decreased significantly and in the absolute term which was not appreciable. The possible reason for the decrease in acidity could be the precipitation of different acids in terms of their respective salts (Amerine et al., 1980; Joshi et al., 2012). The decrease in titratable acidity is desirable in wines from more acidic fruits during maturation as it increases the palatability of wine (Joshi et al., 1999; Zoecklein et al., 1995). Similar results were reported by Sharma and Joshi (2003) in strawberry wine and Joshi et al. (2012) in jamun wine. These results were corroborated by changes in pH which increased with advancement of maturation time (Table 1). Similar results have been reported in strawberry wine (Sharma & Joshi, 2003). Decrease in ethanol content during maturation is apparently the result of interaction between alcohols and acids to form esters (Amerine et al., 1980; Zoecklein et al., 1995); however, the decrease was non-significant. It is desirable as total ester formation results in higher fruity flavour in wine. Similar trend of decrease in alcohol content was also observed by Sharma and Joshi (2003) in strawberry wine and Joshi et al. (2012) in jamun wine. Another significant effect of maturation was decrease in total phenols or tannins (Table 1). Decrease in phenol concentration might be due to the susceptibility of phenolic constituents to degradation, condensation and polymerization, and subsequent precipitation (Beridze, 1948; Somers, 1987; Zoecklein et al., 1995). The decrease in total phenols is desirable as after their polymerization, palatability of the wine increases (Sharma & Joshi, 2003). During ageing, tannin levels in wines decreased as a result of oxidation and precipitation with proteins (Zoecklein et al., 1995). Similar results were reported by Shukla, Joshi, Yadav, and Bisht (1991) and Joshi et al. (2012) in jamun wine.

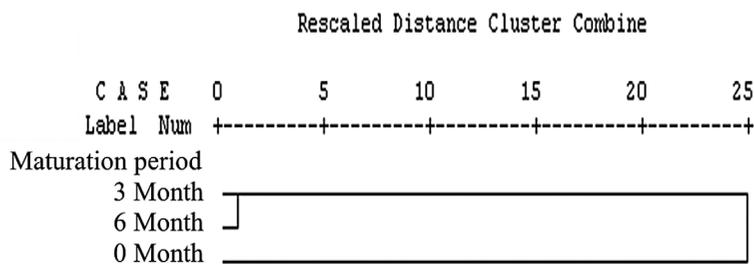
#### 4. Cluster analysis

The data obtained from physico-chemical analysis of custard apple wine during storage were analysed using cluster analysis with rescaled distance cluster analysis and shown in Figure 1. It is evident from the figure that there was formation of two major clusters. First cluster comprises the custard apple wine stored at zero day of maturation. Whereas, the second cluster comprises the custard apple wine at 3 and 6 months of maturation, which indicated that these latter stages of the maturation do not affect the quality characteristics of the wine significantly.

#### 5. Principal components analysis

Using PCA, eight physico-chemical characteristics of custard apple wine were reduced to two principal components (PC1 and PC2) and retained for rotation (Hair, Anderson, Tatham, & Black, 1998; Panda, Sahu, Behera, & Ray, 2014). PC1 and PC2 accounted for 96.57 and 3.43% of variance, respectively, and the total variations were 100% (Table 2). To assist interpretation of dimensions, the factor pattern was rotated using the varimax method (Panda et al., 2014). An attribute correlated to load heavily on a given component if the factor loading is greater than 0.72 (Stevens, 1992). Out of the eight physico-chemical characteristics, four physico-chemical characteristics (total sugars, titratable acidity, total phenols and tannins) loaded heavily on PC1 indicating a strong correlation among them during maturation. On PC2, TSS and ethanol were loaded heavily. Graphical representation of principal components (PC1 vs. PC2) of physico-chemical characteristics is presented in Figure 2.

**Figure 1. Dendrogram of different maturation periods analysed based on rescaled distance.**

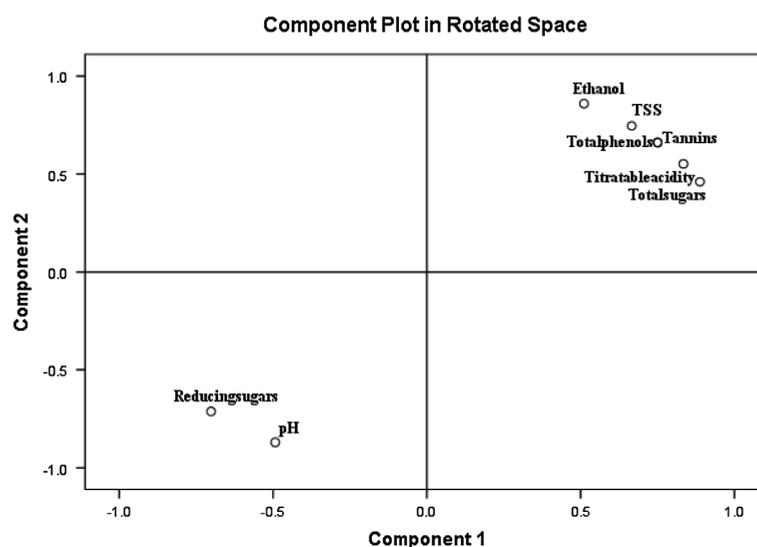


**Table 2. Physico-chemical characteristics loadings scores and percentage variance for two analytical principal components of custard apple wine (PC1 and PC2) using varimax rotation**

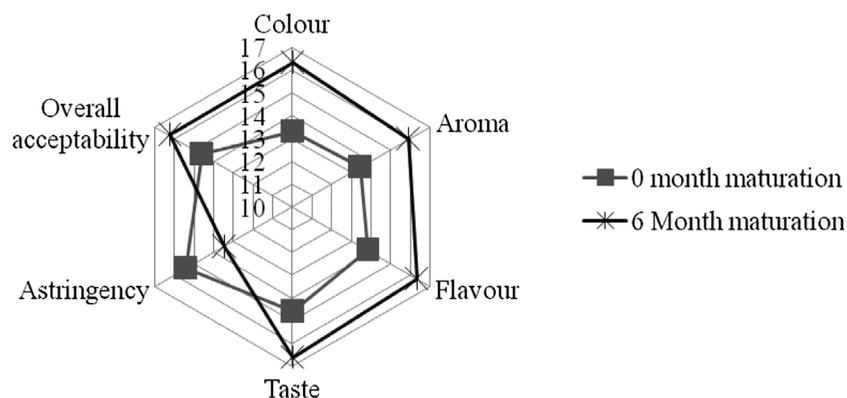
	Principal components of custard apple wine	
	PC1	PC2
TSS	0.666	0.746
Reducing sugars	-0.702	-0.713
Total sugars	0.888	0.460
Titrateable acidity	0.834	0.552
pH	-0.493	-0.870
Ethanol	0.511	0.860
Total phenols	0.749	0.662
Tannins	0.751	0.661
Total variance explained (%)	96.57	3.43

Notes: Extraction method: Principal component analysis.  
 Rotation method: Varimax with Kaiser normalization.

**Figure 2. Graphical representation of principal components (PC 1 vs. PC 2) of physico-chemical characteristics.**



**Figure 3. Effect of maturation on sensory characteristics of custard apple wine.**



## 6. Sensory evaluation

The changes in physico-chemical characteristics of custard apple wine during maturation reflected in sensory quality characteristics. Out of these two samples, custard apple wine matured for 6 months was preferred by the judges (Figure 3). A gradual increase in all the sensory characteristics was observed with the advancement of maturation period except astringency which is desirable also. The improvement in the colour might be due to the precipitation of the TSS during the maturation as discussed earlier which resulted in the clarified wine after 6 months of maturation. During maturation, tannins, total phenols and total sugars decreased, whereas, an increase was observed in reducing sugars and pH. Improvement in the aroma, taste and flavour might be due to the hydrolysis of non-reducing sugar into reducing sugar which is one of the desirable effects from taste point of view and formation of esters which is responsible for fruity flavour in wine. The decrease in astringency is correlated with decrease in total phenols and tannins which decreased during the maturation and is responsible for the improvement of palatability of the wine.

## 7. Conclusions

Maturation involved the several independent events that improve the wine quality. The maturation altered the various components of custard apple wine which is highly desirable for the wine quality and these reflected in the sensorial characteristics also. Cluster analysis reflected that the changes in physico-chemical characteristics of custard apple wine during 3 and 6 months of storage were almost similar. In a nutshell, it is concluded that maturation for six months improved the quality of custard apple wine considerably.

### Funding

The authors received no direct funding for this research.

### Competing Interests

The authors declare no competing interest.

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### Citation information

Cite this article as: Effect of maturation on physico-chemical and sensory quality characteristics of custard apple wine, Vikas Kumar, Prakriti Jnawali, P. Veeranna Goud & Jasleen Kaur Bhasin, *Cogent Food & Agriculture* (2016), 2: 1180660.

### Cover image

Source: <http://mbg.com.my/MBG/news-a-updates/weekly-info/1497-custard-apple-good-for-skin.html>.

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