The effects of various storage conditions on changes in the colour of an alcoholic drink known as “tuzemák”

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Abstract: The present work examines the effects of storage conditions on the colour stability of Tuzemák, a typical Czech alcoholic drink. The measurements were carried out over a period of 24 months. Samples were stored in bottles made of dark and clear glass and were stored in two different temperature modes, 20 °C and 6 °C, with light allowed in, light not allowed in, and lighting with an LED bulb. During the storage period, the dynamics of the colour changes were determined using a Konica Minolta CM 3500d spectrophotometer. The measured value was lightness L*(D65). The results confirmed that storage conditions have a significant influence and effect on the stability and permanence of the colour of alcoholic drinks. In the samples, the parameter L*(D65) ranged between 83.32 and 92.22. Storage with no light (in the dark) at a low temperature (± 6 °C) and using a dark bottle as a container was found to be the best combination for ensuring maximum colour stability. The influence of light and temperature on storage was less pronounced in dark bottles than in the clear bottles where the lightening of the product was more obvious.

Key Words: Tuzemák (an alcoholic drink), storage conditions, colour stability, lightness L * (D65)

INTRODUCTION

Colour is the first sign by which people decide whether to buy a given food or drink or not and its stability is a consumer requirement. It is as an important indicator of the quality of a product (Šottníková et al. 2014). Today, in order to appeal to customers, alcoholic drinks are distributed and sold in clear bottles. This imposes higher demands on their colour stability. Most colours are sensitive to being exposed to light, which contributes to the lightening of coloured alcoholic drinks and the products´ often limited the shelf life (Refsgaard et al. 1993). Colourants are added to food and drinks for the purpose of raising their attractiveness to the customer, renewing the original colour or enhancing the colourfulness if a partial loss of colour occurred during the processing.

Caramel is a natural colourant of dark brown to black colour and, globally, it is among the most widely available and most used colourants in the whole world. It is made by the caramelisation of sugars (sucrose, glucose) and from a legislative point of view, it is divided into four groups according to its use and the production methods (Socaciu 2008). Caramelisation is one of the reactions linked to sugar–containing foods turning brown. Reactions that turn food brown occur mainly during processing and storage. Two non-enzymatic reactions that belong in this group are ascorbic acid decomposition and Maillard’s reaction.

Non-enzymatic browning reactions are often responsible for important changes in quality which occur when storing food, which limits their shelf life (Koca et al. 2003). Tuzemák is one of the most popular alcoholic drinks in the Czech Republic, and its popularity continues to increase every year. It is also part of many hot and cold mixed drinks as well as of many confectionery and bakery products. It is distinguished by its distinct smell and taste, which are the product of a rum aroma with its main constituent, the ethyl acetate. Its content varies from about 38.5 to about 75 g/hl (Grégr and Uher 1974).

MATERIAL AND METHODS

The samples for testing colour changes in Tuzemák during storage were provided by the company AROMKA BRNO, Ltd. The original standard based on the Technical and Commercial Standards from 1985 was used as a basis for its manufacturing (Hauser et al. 1985). The only alteration was the alcohol content, which was changed to 37.5% by volume in order to comply with the current legislation (Regulation 248/2018). The Tuzemák was manufactured from fine alcohol, softened water, rum and vanilla aromas, and an addition of caramel E150a. This alcoholic drink was manufactured using the cold method that is just by mixing the individual ingredients together. The caramel dosing was 0.5 g per 100 ml of the product. The caramel colourant was manufactured by the company AROMKA BRNO, Ltd., which manufactures and sells this colourant. For the purposes of this experiment, samplers made of clear and coloured glass with a volume of 200 ml were filled up to ¾ with Tuzemák. Different storage methods were then put in place (Table 1). These storage conditions were meant to simulate a variety of storage methods. The samples were stored under these conditions for 24 months.

Table 1 Scheme of the experiment

Variant	Colour of glass	Temperature mode	Lighting mode
no.1	clear	20 °C	daylight
no.2	dark	20 °C	daylight
no.3	clear	20 °C	darkness
no.4	dark	20 °C	darkness
no.5	clear	20 °C	LED light
no.6	dark	20 °C	LED light
no.7	clear	6 °C	darkness
no.8	dark	6 °C	darkness

Samples were taken before the containers were placed in the storage rooms and then every two months from each storage mode in order to monitor the changes of colour. For determining the colours and their changes during the storage of the samples, a Konica Minolta CM 3500d (KONICA, Japan) spectrophotometer was used in a transmittance mode at a wavelength of 380–780 nm, along with a CM-A98 glass cuvette (glass, 10 mm). The measurement parameters were: D65 and the value of L* (D65), was the measured indicator of lightness.

The results were evaluated by means of the Microsoft Excel 2010 and Statistica 12 programs using a multiple factor analysis of variance and further post-hoc Tukey test at a significance level of 95% ($p < 0.05$).

RESULTS AND DISCUSSION

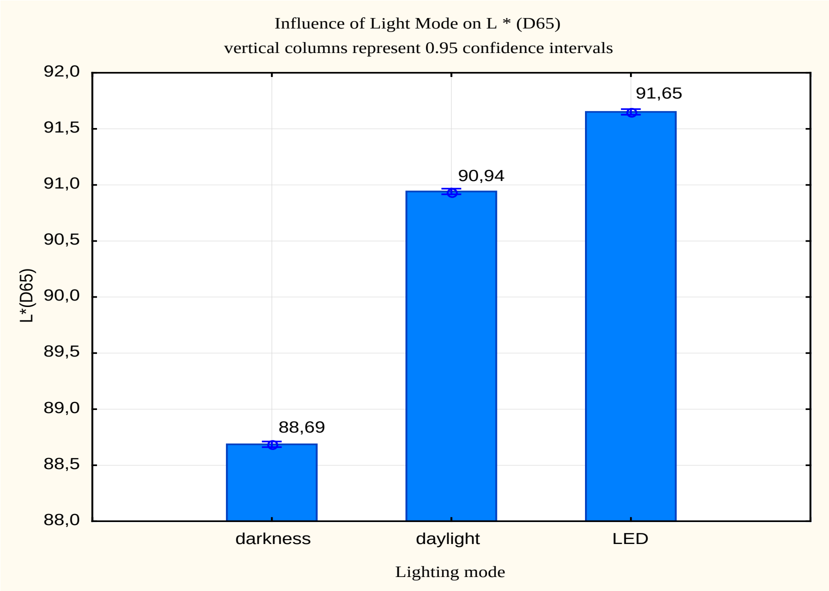
During the experiment, we concentrated on evaluating the effects of the storage temperature, the lighting mode and the colour of the container on the dynamics of colour change during storage.

The results confirmed that the colour of the spirits changed quite significantly during storage. A gradual lightening of the product occurred, which was reflected in the increase of the value of L*(D65). The most important decrease and difference in the measurements occurred in the first stage, right at the start of the minimum shelf life. The other values did not show similar differences.

The effects of the lighting mode

If we concentrate on the evaluation of the effect of lighting on the changes of colour during storage (Figure 1), then we can safely say that the lighting conditions contribute to the reduction in colour intensity. Demonstrably smaller changes ($p < 0.05$) were recorded for products stored without any presence of light (L*(D65) = 88.69). On the other hand, the daylight mode and in particular the light bulb mode showed the most important changes of colour (L*(D65) = 91.65). In their study carried out on Amaretto liqueur, Castaneda-Olivares et al. (2010) also confirmed that the greatest colour stability occurred when storing in the absence of light. The sensitivity of spirits coloured by caramel to lighting conditions in storage was also confirmed by Refsgaard et al. (1993). In their study, which dealt with the stability of the caramel colour in alcohol, they concluded that the caramel colour is broken down in ethanol-based solutions due to the absorption of light. This corresponds with our results.

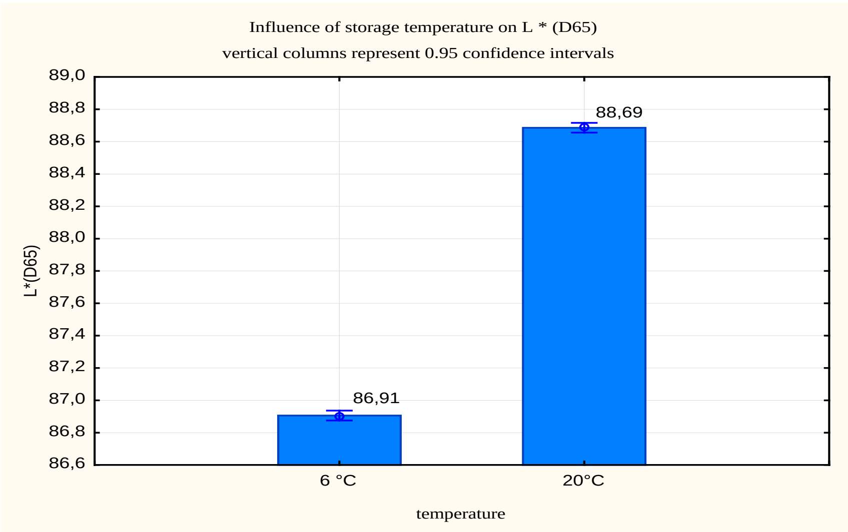
Figure 1 The effects of the lighting mode on L(D65)*



The effects of the temperature mode

Our results confirmed that storage at a low temperature contributes to better colourant stability than storage at a room temperature (Figure 2). In an earlier study by Espejo and Armada (2014) it was found that higher temperatures (25–45 °C) negatively influenced colour, which is also confirmed by our results, where the level of change at lower storage temperatures was demonstrably lower ($p < 0.05$) than at higher temperatures. Hellström et al. (2013) came to a similar conclusion when they studied the stability of anthocyanins in fruit drinks and proved that a higher temperature (21 °C) accelerates the breakdown of anthocyanins. Laleh et al. (2006) also came to a similar conclusion when they found that the presence of light during storage leads to a faster breakdown of anthocyanins by up to 26% depending on type.

Figure 2 The effects of storage temperatures on the value of L(D65)*



The effects of the of the container colour

Storage in dark bottles showed demonstrably ($p < 0.05$) better colour stability than storage in clear bottles (Figure 3). The effect the colour of the glass is more pronounced at higher storage temperatures where the breakdown is faster. As we can see in Figure 4, the colour of the bottle plays a significant role when storing in daylight and under a LED bulb. While samples stored under a LED bulb in dark bottles showed values of L* (D65) = 90, for clear bottles it was demonstrably higher ($p < 0.05$) and had values of more than L* (D65) = 93. Maury et al. (2010) considered the colour of glass as critical to the stability of the colour of the spirit. This is confirmed by the results obtained by Tamuno and Onyedikachi (2015), who found that samples stored in green or brown bottles had more stable colour than samples stored in clear glass bottles. For longer term storage it is more advantageous to store alcoholic drinks in darker bottles, or to prevent the entry of light by using other methods. This principle is applied to certain spirits that are bought as investments, where carton or wooden containers are used as packaging (https://www.whiskylover.cz).

Figure 3 The effects of the colour of the bottle on the value of L(D65)*

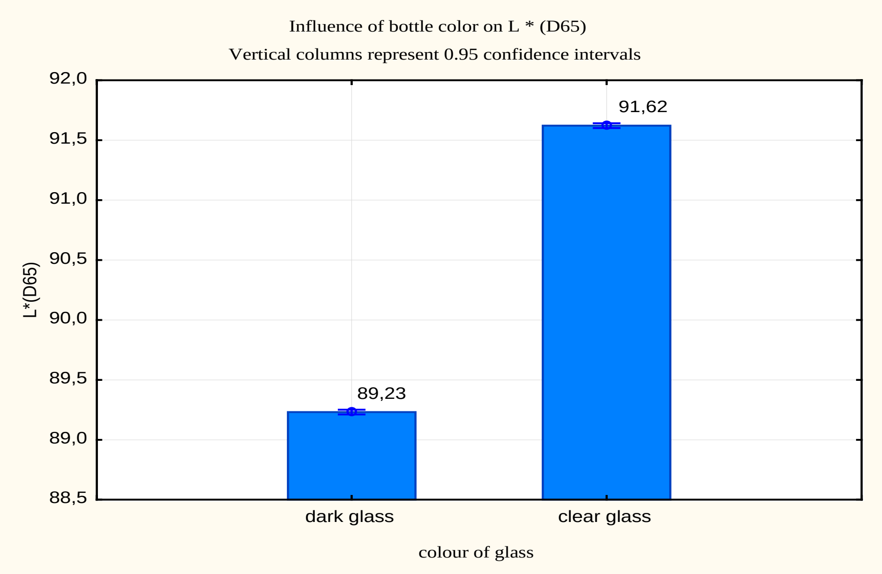
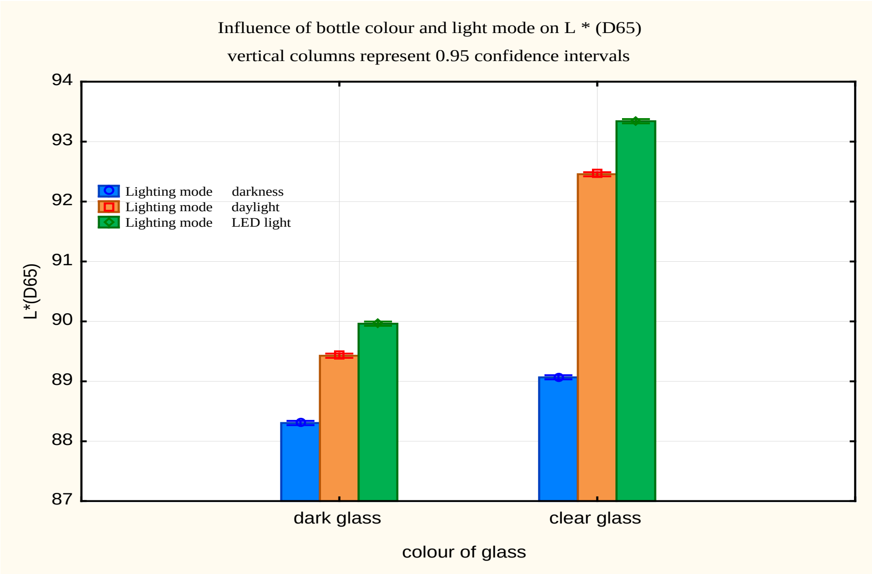


Figure 4 The effects of the colour of the bottle and the lighting mode on the value of L(D65)*



The effects of the date of sampling (length of storage)

In Figure 5, we can see that the demonstrably ($p < 0.05$) greatest differences in the measurement of the value of L*(D65) were ascertained during the first measurements (in the first third of the minimum shelf life), where it increased from a value of L*(D65) = 83.32 to a value of L*(D65) = 89.02. Thus, a significant lightening of the product occurred right at the beginning of storage. The following samples and measurements did not show such significant differences.

In Figure 6 we can see that the breakdown of colour over time (the length of storage) is significantly influenced by the storage temperature. The high temperature had a negative effect on the speed of the colour change.

Figure 5 The effects of the date of sampling on the value of L(D65)*

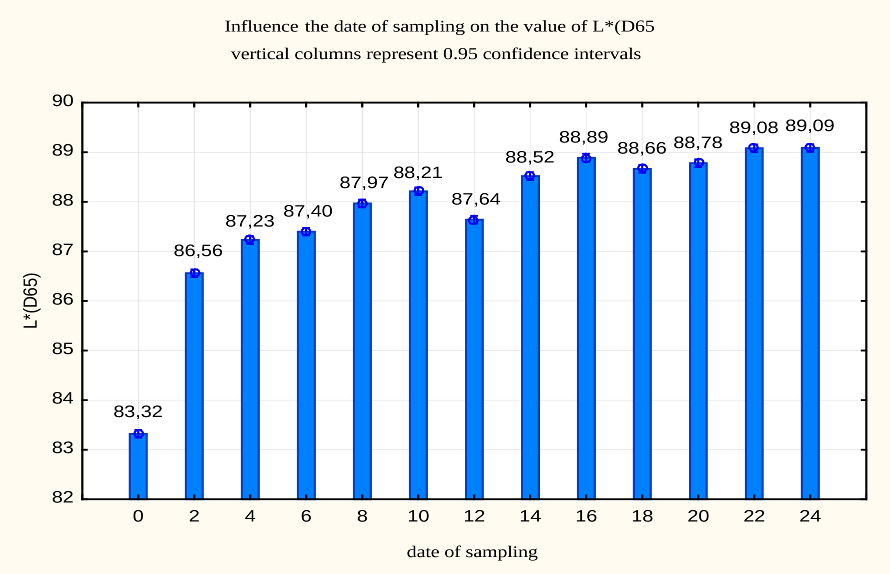
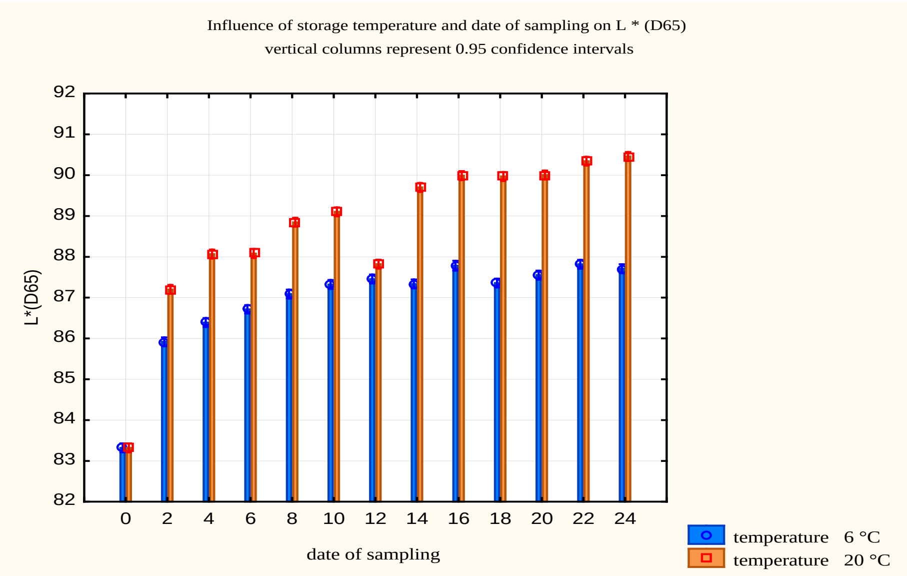


Figure 6 The effects of storage temperatures and the date of sampling



If we focus on the dynamics of change of the experiment´s individual variants, the most important changes occurred in variant no. 5, which is in the sample stored at a temperature of 20 °C under a LED bulb. On the other hand, the smallest colour changes were recorded when storing in dark bottles, without the presence of light and at a low temperature (6 °C) in variant no. 8.

CONCLUSION

Storage is an essential step in preserving all of the required characteristics. The present work shows that suitable storage conditions are essential for maintaining the appropriate product quality. The results show that the most important changes in colour occur when storing in a clear glass bottle under a LED bulb at room temperature. In contrast, when storing without the presence of light in dark bottles and at low temperatures, the changes are more gradual. Due to the fact that most manufacturers package their spirits into clear bottles in order to make their products more attractive for their customers, and considering that storage often occurs at room temperature, it is essential to at least list the basic storage conditions on the labels, or to use additional (secondary) packaging to prevent light from penetrating the product in order to ensure higher stability of its colour as well as its overall appearance.

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