STUDY ON SOLUTIONS FOR STABILIZING FRUITY FLAVOUR MIXED BEER DURING FILTRATION AND PACKAGING

Le Viet Cong1,2,*, Pham Anh Tuan1, Ho Phu Ha2

1Hanoi Beer Alcohol and Beverage JSC, 183 Hoang Hoa Tham street, Ha Noi, Viet Nam
2Hanoi University of Science and Technology, 1 Dai Co Viet street, Ha Noi, Viet Nam

*Email: conglv@habeco.com.vn

Received: 15 August 2017; Accepted for publication: 12 October 2017

ABSTRACT

Nowadays, fruity flavours mixed beers are very popular and widely accepted in the world. However, there aren’t brewers producing this brand of beer in Vietnam; hence it is mostly imported products. New beer types can be produced based on lager beer, then mixed with natural flavours, sugar and citric acid. Mixed beer have low alcohol content ranged from 2.5 to 3.0 % v/v. Due to the blending process of lager beer with other ingredients mixed beer may have different stability from the base lager beer. The aim of this study is to improve beer stability up to six months shelf-life. Experiments were conducted on 500 liters pilot scale. The base lager beer was filtered using Silicagel at dosing rate from 10 to 50 g/hl, polyvinyl polypyrrolidone (PVPP) at dosing rate from 10 to 30 g/hl, and sodium metabisulfite at dosing rate from 1 to 5 g/hl were used during beer filtration and blending. Mixed beer was bottled at volume of 450 ml, and then was pasteurized with pasteurization units (PU) from 8 to 18. Final beer was assessed with physicochemical, sensorial and microbiological properties. The results showed that, to achieve six months of beer stability, PVPP dose at 20 g/hl, sodium metabisulfite at 3 g/hl and 16-18 pasteurization units was required.

Keywords: fruity flavour mixed beer, beer stability, pasteurization.

1. INTRODUCTION

Beer haze is formed by hydrogen link between sensitive protein and polyphenol in beer. In order to improve beer stability, it is important to reduce protein- polyphenol complex and/or to prevent the formation of this linkage by removal of protein and/or polyphenol content. The efficiency of this mean can be assessed by measuring protein and polyphenol content in beer after treatment. Another method is forcing test to predict shelf life of beer based on forcing haze formation under hot and cold conditions [1, 2, 3].

Fruity flavour mixed beers are products that based on conventional lager beer mixed with deaerated water, sugar and fruity flavour to have desirable products. The based beer is produced from malt, rice, and hop, which contain significant amount of protein and polyphenol, both of them can react together to form beer haze during beer storage. PVPP, an additive, absorbs
polyphenol specifically in beer [2, 4, 5]; while silicagel absorbs protein [6]. During beer production, in particular in filtering and blending process, oxygen is easy to pick up, leading to beer stale during storage. It is reported that SO₂ as an antioxidant, can remain beer stability in storage with fresh aroma and taste [2, 7, 8]. Fruity flavor mixed beer production includes mixing a number of materials/ingredients; therefore, it is important to ensure clean production condition, as well as suitable pasteurization condition. It is also to keep in remark the compromise between effect of microbiological treatment using pasteurization and sensorial characteristics of pasteurized product during storage (fresh aroma and taste) [2, 8]. In production of conventional beer, beer treatments during filtration were used to stabilize final beer product up to six months. In this study, the mix of other ingredient in final stage such as sugar, flavouring agents, organic acid may lead to instability of final beer in term of physicochemical, sensory, as well as microbiological characteristics. Our goal is to select appropriate methods to remove haze components out of mixed beer, and suitable preservatives concentration in order to insure beer shelf life up to six months.

2. MATERIALS AND METHODS

2.1. Materials

In this study, the materials included two rows barley malt (provided by Joe White maltings- Australia), maltose syrup (Minh Duong food JSC, Vietnam), citric acid monohydrous 1:1 type F6000-JBL, lemon flavor (Döhler- Germany), silicagel (Stabifix- Germany), polyvinyl polypyrrolidone, PVPP (ISP- USA), sodium metabisulfite (AB Vickers- United Kingdom), brewing yeast (yeast collections of Technical institute of brewing - Hanoi beer alcohol and beverage JSC).

2.2. Methods

2.2.1. Technological methods and experimental design

Beer was produced on pilot scale (500 liters per brew) in Hanoi beer alcohol and beverage JSC (Habeco). Base lager beer was made following the existing procedure for Hanoi 450 ml bottle beer brand of Habeco. Fermented beer was filtered and blended with deaerated water, dosed with syrup, citric acid, flavour and additives. Beer was filled in brown glass bottles at volume of 450 ml, then was pasteurized using tunnel pasteurizer with different sets of pasteurization units. Pasteurization unit was determined by formula $PU = t \times 1.393 \times (T - 60)$, where $T$ is pasteurizing temperature ($°C$), $t$ is the time of beer passing pasteurization zone (minute). After pasteurization, beer quality was evaluated by Habeco’s expert sensory panel. Chemical and microbiological analysis, as well as haze formation was investigated to estimate shelf life of beer using forcing test method.

In order to prevent haze formation during beer storage, only silicagel was used for beer filtration. Silicagel powder was mixed with deaerated water, then was dosed into green beer line before KG filter at dosing rates of 10 g, 20 g, 30 g, 40 g, 50 g silicagel/hl, namely TN11, TN12, TN13, TN14, and TN15, respectively. Sample without silicagel (DC1) was used as control.

PVPP was used to absorb polyphenol. Five experiments were performed: TN21 (10 g PVPP/hl), TN22 (15 g PVPP/hl), TN23 (20 g PVPP/hl), TN24 (25 g PVPP/hl), TN25 (30 g PVPP/hl). Blank sample without PVPP was used as control (DC2). In these experiments no
silicagel was added. After filtration, beer was bottled in glass bottles. Forcing test was performed as follow (EBC9.30): beer bottles were incubated in cycles (60 °C for 24 hours, then at 0 °C for 24 hour). After each cycle chill haze was measured by haze meter. If beer turbidity was less than 2EBC, next cycle would be conducted. This procedure would terminate when beer turbidity was greater than 2EBC. The number of forcing cycles is recorded and is considered equal to the shelf life in months that beer would not form haze.

Sodium metabisulfite was mixed with deaerated water; then was dosed to beer after filtration at dosing rates ranged from 1 to 5 g/ml (TN31: 1 g/ml, TN32: 2 g/ml, TN33: 3 g/ml, TN34: 4 g/ml, TN35: 5 g/ml). Blank sample without sodium metabisulfite was used as control (DC3). Samples were subjected to sensory tests once per month.

After filtration, beer was bottled in brown glass bottles, and then went into tunnel pasteurizer that could set pasteurization unit. Six experiments with six different PU (8, 10, 12, 14, 16 and 18PU) were performed. Beers after pasteurization were analyzed for microbiological aspects.

2.2.2. Methods of analysis

Forcing test method to predict haze formation time during beer storage was by EBC 9.30 method as described above [9]. Chill haze was measured using Haze meter supplied by Haffman- Netherland. Pasteurization unit of beer during beer pasteurization was determined using PU meter (Haffman - Netherland). Wort and beer colour was determined by EBC 8.5 and EBC 9.6 [9]. Beer pH was measured on WTW -INOLAB pH meter by EBC 8.17 and EBC 9.35 [9]. Determination of alcohol, original extract and real extract was conducted using EBC method on the autolyser beer (Antonpaar - Austria). Determination of CO₂ content in beer was by EBC 9.28.1 [9]. Determination of diacetyl as VDK in beer was by EBC 9.24.1 [9]. Foam beer stability was determined using Nebem foam tester (Haffman- Netherland). Total count of aerobics microorganisms was determined followed TCVN 4884:2005 (ISO 4833:2003) [10]. Determination of Escherichia coli was by TCVN 6846:2007 (ISO 7251:2005) [11]. Determination of Clostridium perfringens was by TCVN 4991:2005 (ISO 7937:2004) [12]. Determination of Coliforms followed TCVN 6848:2007 (ISO 4832:2006) [13]. Determination of Streptococcus faecalis followed TCVN 6189:2-1996 (ISO 7899-2: 1984) [14]. Total molds and yeasts were determined by TCVN 8275-1:2009 (ISO21527-1:2008) [15]. Sensory tests were conducted by Habeco’s expert sensory panel following TCVN 6063: 1995 [16].

3. RESULTS AND DISCUSSION

3.1. Studies to improve beer stability after filtration

3.1.1. Effect of Silicagel on shelf life of beer

Effect of silicagel to shelf life of beer was assessed using forcing test. The result is shown in Figure 1.

The results from Figure 1 showed that when silicagel content increased, time to form beer haze increased. Due to the aim of beer shelf life was six months, sixth forcing cycles were tested. From Figure 1, in the exception of DC1 and TN11, which did not achieve six months of shelf life, TN12, TN13, TN14 and TN15 samples could meet the requirement of six months shelf life.
This can be explained that silicagel absorbed sensitive protein leading to reduce protein content in beer that could react with polyphenol to form beer haze [4].

Because silicagel lead to reduce protein content in beer, which may affect the beer foam stability, experiments on foam stability was conducted. Results are shown in Figure 2:

From the results showed in Figure 2, using silicagel reduced foam stability when compared with the control. The higher silicagel content was used, the lower foam stability was obtained. Beer foam stability is very important aspect, therefore it is not recommended to use silicagel for fruity flavour mixed beer. In order to improve shelf life of beer while guaranteeing foam stability, PVPP was used to remove a part of polyphenol from beer.

3.1.2. Effect of polyvinyl polypyrrolidone (PVPP) on beer quality

Beside protein, polyphenol is the second component to form beer haze during storage. PVPP was added as described in section 2.2.1 to remove a part of polyphenol. Results are shown in Figure 3.
Results in Figure 3 showed that control (DC2), TN21 and TN22 samples could not be stored within six months, while TN23, TN24 and TN25 were stable for at least six months of storage. Higher PVPP content lead to better performance of beer during storage as reported earlier [6, 8]. In order to keep fruity flavor mixed beer in six months of storage, turbidity of beer is less than 2 EBC for six cycles; PVPP content should be at least 20 g/hl.

Effects of PVPP on physicochemical properties of beer were shown in Table 1.

<table>
<thead>
<tr>
<th>No</th>
<th>Analytical parameter</th>
<th>Unit</th>
<th>DC2</th>
<th>TN21</th>
<th>TN22</th>
<th>TN23</th>
<th>TN24</th>
<th>TN25</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Real extract</td>
<td>%m</td>
<td>5.42</td>
<td>5.43</td>
<td>5.43</td>
<td>5.43</td>
<td>5.42</td>
<td>5.43</td>
</tr>
<tr>
<td>2</td>
<td>Alcohol</td>
<td>%V</td>
<td>2.51</td>
<td>2.52</td>
<td>2.51</td>
<td>2.51</td>
<td>2.51</td>
<td>2.51</td>
</tr>
<tr>
<td>3</td>
<td>Bitterness</td>
<td>⁰BU</td>
<td>10.0</td>
<td>9.8</td>
<td>9.7</td>
<td>10.0</td>
<td>9.7</td>
<td>9.9</td>
</tr>
<tr>
<td>4</td>
<td>pH</td>
<td></td>
<td>3.66</td>
<td>3.65</td>
<td>3.66</td>
<td>3.64</td>
<td>3.66</td>
<td>3.63</td>
</tr>
<tr>
<td>5</td>
<td>Polyphenol</td>
<td>mg/l</td>
<td>86.7</td>
<td>75.2</td>
<td>66.4</td>
<td>56.3</td>
<td>46.2</td>
<td>35.5</td>
</tr>
<tr>
<td>6</td>
<td>CO₂</td>
<td>g/l</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>7</td>
<td>Colour</td>
<td>⁰EBC</td>
<td>5.99</td>
<td>5.89</td>
<td>5.88</td>
<td>5.85</td>
<td>5.83</td>
<td>5.78</td>
</tr>
<tr>
<td>8</td>
<td>Diacetyl</td>
<td>mg/l</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>9</td>
<td>Acidity(ml NaOH 1N/ 100ml of beer)</td>
<td>ml</td>
<td>1.97</td>
<td>1.97</td>
<td>1.97</td>
<td>1.97</td>
<td>1.97</td>
<td>1.97</td>
</tr>
</tbody>
</table>

From results showed in table 1 it was found that in exception of polyphenol content change in all experimental samples (lower than that of the control, DC2), no other chemical or physical properties were effected by PVPP.

3.2. Effect of bottling process on beer quality

3.2.1. Effect of antioxidant agent on beer quality

It was found that when the dissolved oxygen content in beer increased, the sensory quality of the beer decreased very fast along with time of storage [7]. To minimize effects of oxygen
pick up on beer quality during filtration and packaging, sodium metabisulfite was used as antioxidant. It was dosed into beer during filtration. Dissolved oxygen content in the control sample (DC3) and experimental samples were 0.09 mg/1. Sensory evaluation was performed once per month with score range of 10, scores of a samples was averaged from all sensory panels, it can be concluded that the averaged scores of six samples were different at the 5% level of significance. Results are shown in Figure 4.

![Figure 4. Effect of antioxidant concentration on beer quality.](image)

Results on Figure 4 showed that beer quality decreased along with storage time in both cases of with or without antioxidant. Higher content in the range 1 to 4 g/hl of sodium metabisulfite lead to higher beer sensory quality. When sodium metabisulfite content reached 3 g/hl, no significant change in beer sensory score was obtained. When antioxidant concentration increased to 5 g/hl sensory score seemed to decrease. This could be explained that at high concentration of antioxidant, SO$_2$ content would be over threshold, thus reduced sensory scores. It was recommended to use sodium metabisulfite at 3 g/hl. Beer quality retained stable for at least six months.

### 3.2.2. Effect of pasteurization on beer quality

<table>
<thead>
<tr>
<th>No</th>
<th>Pasteurization unit</th>
<th>E.coli (CFU/ml)</th>
<th>Total aerobic bacteria (CFU/ml)</th>
<th>Yeasts, molds (CFU/ml)</th>
<th>Cl. perfringens (CFU/ml)</th>
<th>Coliforms (CFU/ml)</th>
<th>S. faecalis (CFU/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8 PU</td>
<td>0</td>
<td>40</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>10 PU</td>
<td>0</td>
<td>18</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>12 PU</td>
<td>0</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>14 PU</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>16 PU</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>18 PU</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Pasteurization is very important to beer quality. Due to pH of mixed beer was lower than that of base beer (3.66 versus 4.1, respectively), required pasteurization units for the mixed beer may differ from that of base beer. Therefore, different pasteurization conditions were inspected. Effect on microbiological quality is shown in Table 2.

Results showed that to ensure microbiological quality, pasteurization at 16-18 PU was needed. Beer sensory quality was assessed after six months of storage. Results showed that there was no significant change in sensory characteristics (unpublished data).

4. CONCLUSIONS

In order to obtain stable fruity flavor mixed beer during six months of storage it is recommended to use KGF filter and PVPP filter, including blending system, additive and fruity flavour dosing unit, with PVPP concentration of 20 g/hl, sodium metabisulphite concentration of 3 g/hl; while silicagel leads to decrease beer head retention significantly. In bottling process, it is suggested that oxygen pick up level to be ensured lower than 0.09 mg/l. 16-18 PU is required to obtained stable beer in microbiological quality.

REFERENCES

Study on solutions for stabilizing fruity flavour mixed beer during filtration and packaging


TÓM TÁT

NGHIỆN CỨU MỘT SÔ GIÁP PHÁP NHẤM ÔN ĐỊNH CHẤT LƯỢNG BIA PHÔI TRỌN HƯỚNG HOA QUẢ TRONG GIAI DOAN LỌC VÀ CHIẾT

Lê Việt Công¹,².*, Phạm Anh Tuân¹, Hồ Phú Hà²

¹Tổng công ty CP Bia Rượu Nước giải khát Hà Nội, 183 Hoàng Hoa Thát, Ba Đình, Hà Nội
²Trường Đại học Bách Khoa Hà Nội, 1 Đại Cồ Việt, Hai Bà Trưng, Hà Nội

*Email: conglv@habeco.com.vn

Hiện nay, bia phơi trở hương hoa quả là sản phẩm đang được ưa chuộng trên thế giới. Ở Việt Nam chưa có nhà sản xuất nào sản xuất chung loại sản phẩm này, nên các sản phẩm đều được nhập khẩu. Công nghệ sản xuất bia hương hoa quả được biết đến là sử dụng phơi bia nén, thông thường là loại bia lager với hương liệu thiên nhiên, có bổ sung đường tinh, axit citric với lượng hợp lý nhằm tạo vị đặc trưng cho sản phẩm. Sản phẩm có hàm lượng cồn thấp từ 2,5 - 3% v/v. Do có sự phơi trở và pha loãng sản phẩm nên tính chất và độ ổn định sản phẩm có thể thay đổi so với bia lager. Mục đích nghiên cứu là tìm được chế độ ổn định thích hợp nhằm bảo đảm chất lượng sản phẩm bia sau 6 tháng bảo quản. Các thực nghiệm được tiến hành trên quy mô pilot công suất 500 L / mẻ. Bia được lọc, phơi trở sử dụng hàm lượng silicagel từ 10 đến 50 g/ml, polyvinylpolypyrrolidone (PVPP) từ 10 đến 30 g/ml, natri metabisunfit từ 1 đến 5 g/ml. Bia sau khi đông chai 450 ml được thảnh trùng ở chế độ từ 8 đến 18 PU. Bia được đánh giá chất lượng về chỉ tiêu hòa lý, cảm quan và vi sinh. Kết quả thụ được là để đảm bảo bia có chất lượng tốt, thời gian bảo quản đến 6 tháng thì hàm lượng PVPP thích hợp là 20 g/ml, natri metabisunfit với hàm lượng 3 g/ml, thanh trùng ở chế độ 16 - 18 PU. Như vậy bia hương hoa quả hoàn toàn có thể đảm bảo chất lượng với điều kiện ổn định sản phẩm đã nghiên cứu và có thể đưa ra thí nghiệm.

Từ khóa: bia hướng hoa quả, ổn định bia, thanh trùng.