MBAA TQ doi:10.1094/TQ-46-2-0430-01

Use of Isomerized Hop Extract as a Replacement for Conventional Hop Extract and Its Influence on Beer Flavor

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ABSTRACT

The procurement of raw materials has become an increasingly important factor for brewers. Depending on the crop year, not only malt, but also hops could be available in limited supply. Brewers using conventional hop products have limited options for reacting to this situation by optimizing their hopping formulations. One option for working around possible hop shortages might be the use of isomerized hop products. IKE (isomerized kettle extract) is one of the products that could be used as a replacement for CO_2 hop extract. However, in addition to any financial benefits, it is essential to preserve the sensory characteristics of the beer. To obtain reliable data, extensive commercial-scale brewing trials were carried out. Analyses of hop products, wort, and beer samples were performed. Bitter compounds were quantified using specific (HPLC) and nonspecific (UV-spectro) methods. For hop aroma components, especially the compound linalool, which has a major impact on beer character, a method using GC-FID was applied for analyses of wort and beer samples. Samples were taken at different stages of wort boiling, which made it possible to obtain exact information about the solubilization of α- and iso-α-acids and the evaporation of hop aroma compounds during wort boiling. Beer samples were evaluated by a trained tasting panel. The trials demonstrated that IKE is a suitable kettle hop product that can be used to reduce hopping costs without affecting the sensory characteristics of a beer.

Keywords: beer flavor, hop extract, IKE, isomerized kettle hop extract

SÍNTESIS

La compra de materias primas es ahora un factor muy importante para las cerveceras. Dependiendo de la año de cosecha, no sólo la malta, pero también los lúpulo podía ser en cantidades limitadas disponible. Las cerveceras utilizando productos convencionales de lúpulo están limitados en cuanto a como reaccionar a esta situación mediante la optimización de sus formulaciones de lupulado. Una opción para trabajar alrededor de escaseces posibles del lúpulo pudo ser el uso de los productos isomerizados del lúpulo. IKE (extracto isomerizado para la paila) es un producto que puede ser utilizado en lugar de extracto CO_2 de lúpulo. Considerando que es imprescindible mantener las características sensoriales del producto (aparte de cualquier beneficio financiero), se realizaron extensas pruebas cerveceras a escala industrial, analizando tanto los productos de lúpulo utilizados como los mostos y la cerveza final. Las sustancias amargas fueron cuantificadas mediante métodos analíticos específicos (HPLC) como no específicos (espectro-UV). Para determinar componentes aromáticos del lúpulo (especialmente el linalol, tan importante para el carácter del aroma), se utilizó un método usando GC-FID para analizar las muestras de mosto y de cerveza. Se tomaron muestras de mosto a diferentes etapas de la cocción para poder obtener información exacta en cuanto a la solubilización de los ácidos alfa e iso-alfa, y para medir la evaporación de los aromáticos del lúpulo durante el décorrer de la cocción. Se demostró que IKE es un producto de lúpulo adecuado para la adición en la paila con el fin de reducir los costos del lupulado sin afectar las características de la cerveza.

Palabras claves: extracto de lúpulo, extracto isomerizado de lúpulo para paila, IKE, sabor y aroma de cerveza

Introduction

The procurement of raw materials has become an increasingly important factor for brewers. Brewers using conventional hop products have only limited options for reacting to substandard crop yields by optimizing their hopping formulations. One option for working around a hop shortage is the use of pre-isomerized hop products. Isomerized kettle extract (IKE) is one of the products that could be used as a replacement for CO_2 extract. In addition to any financial benefits, however, it is essential to preserve the sensory characteristics of the beer.

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Material and Methods

To obtain reliable data, numerous commercial-scale brewing trials focusing on changes in hop bitter and aroma compounds during wort boiling were carried out, and the resulting beers were compared. The bitter compounds found in the hop products, wort, and beer samples were analyzed using specific (HPLC, EBC 7.8) and nonspecific (UV-spectro, EBC 8.8 and 9.8) methods (1).

Analyses of hop aroma components in wort and beer samples were performed using GC-FID (4). Special attention was paid to the compound linalool, which has a major impact on beer character (2,3). Samples were taken at different stages of wort boiling. To achieve the same bitterness in the final product, the addition of IKE was reduced by 25% (based on HPLC) compared

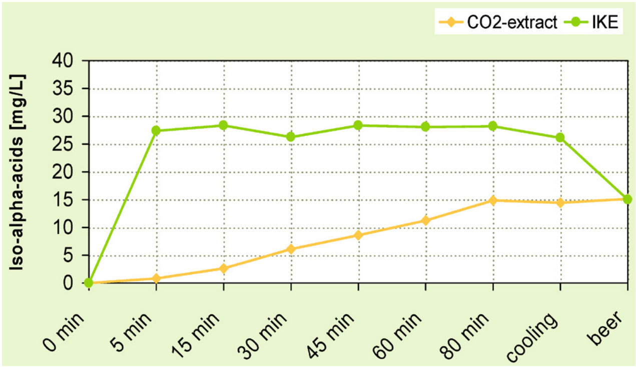

Figure 1. Analysis of changes in iso-α-acids from wort boiling to final concentration in bottled beer. IKE = isomerized kettle extract.

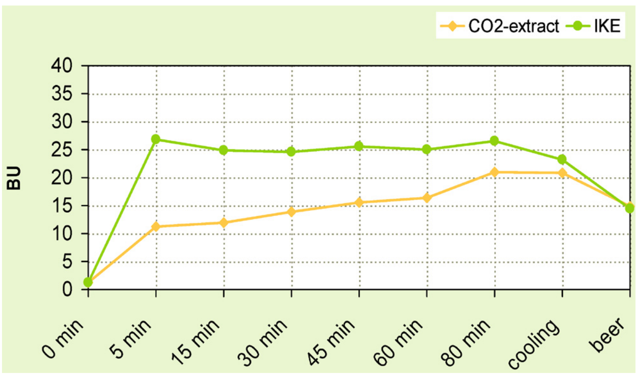

Figure 2. Analysis of bitterness (BU) from wort boiling to bottled beer. IKE = isomerized kettle extract.

with the regular dose of CO_2 extract. Both products were added at the beginning of the boiling process. A trained tasting panel assessed the bottled beer produced from the brews.

Results and Discussion

The brewing trials focused on the following parameters: iso-α-acids yield, resulting bitterness, and hop aroma. Figure 1 compares changes in the iso-α-acids analyzed from wort boiling to the final concentration in bottled beer. The figure shows the average for all brews tested. All analyses were performed in duplicate.

The hop product IKE dissolved very quickly in wort. While the iso-α-acids concentration in wort with IKE reached its maximum level after only 5 min, the isomerization process for wort with CO_2 extract increased continuously over a period of 80 min. This is in line with previous tests in which delayed dissolution was also noted in the case of pure resin extracts (4).

Brews with IKE showed no significant change in iso-α-acids concentration (mg/L) during the later stages of wort boiling. Consequently, the use of IKE would allow brewers to reduce wort boiling time significantly. Shorter boiling times result in better flavor stability and can be implemented without incurring iso-α-acid losses. Energy costs can also be reduced. Care must be taken to assure that all other flavor-influencing compounds are considered when reducing boil time.

As shown in Figure 1, IKE brews experienced a high loss of iso-α-acids during fermentation. (This phenomenon will be subject to further investigation.) The corresponding plots of the resulting bitterness (BU) are shown in Figure 2. The curve of the IKE brews was quite similar to the curve displayed in Figure 1. The resulting bitterness in the wort with CO_2 extract was significantly higher compared with the specific iso-α-acids measured by HPLC (Fig. 1). This was due to the use of the nonspecific BU method that measures not only the iso-α-acids, but also the majority of nonisomerized α-acids. It is well known that when adding conventional hop products, bitter acids are first dissolved in wort and isomerized during the later stages of boiling. IKE and CO_2 extract produced the same analytical bitterness (BU and HPLC) in the final beer. The reduced dosage of IKE was enhanced by its improved utilization compared with CO_2 extract. Further brewing trials confirmed this improved utilization (based on HPLC; Fig. 3), which varied depending on brewing technology and equipment.

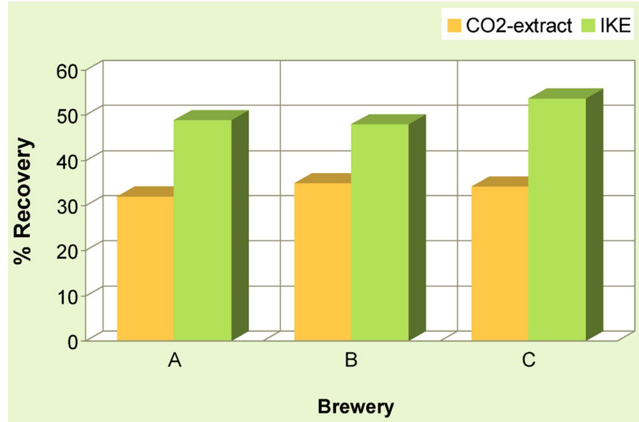

Figure 3. Utilization of hop bitter acids in final beer. IKE = isomerized kettle extract.

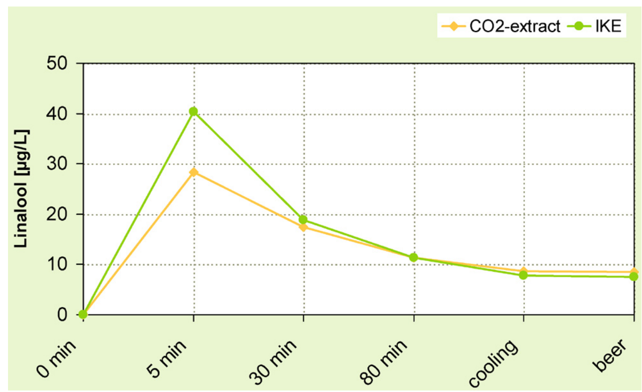

Figure 4. Changes in Linalool concentration during wort boiling. IKE = isomerized kettle extract.

In the breweries shown in Figure 3, the utilization improvement factor ranged between 1.37 and 1.57. The main differences in the results for the three breweries were observed after wort boiling. The pH appeared to be very influential, but other parameters, such as yeast strain, number of yeast cells, fermentation conditions, etc., clearly also contributed to utilization of hop bitter acids.

Figure 4 shows the changes in linalool concentration during wort boiling. The higher solubility of IKE resulted in a higher linalool concentration at the beginning of boiling. However, due to continuous evaporation, this difference was compensated for

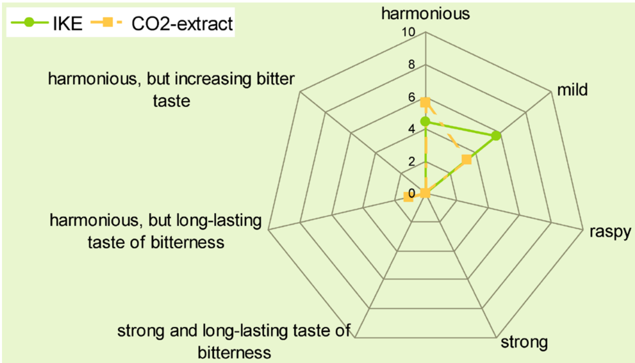

Figure 5. Bitter profiles of beers brewed with either isomerized kettle extract (IKE) or CO_2 extract.

within a maximum of 30 min. Thereafter, the concentration remained constant in each brew through to the finished product. In both beers, the linalool concentration was below its threshold. If a hoppy aroma is desired, it could be achieved by adding IKE later during boiling without any loss of bitterness (Figs. 1 and 2).

Tasting Results

As expected, our tasters detected no hop aroma. Therefore, we continued the investigation by evaluating and discussing only beer bitterness. Figure 5 shows the bitter profiles of a beer produced with IKE compared with a beer produced with CO_2 extract. While the IKE beer seemed to be a bit milder, the CO_2-extract beer was slightly more harmonious. According to the results of the individual tasters, the differences were not significant. Neither product gave any negative sensory impressions.

Summary

The brewing trials demonstrated that IKE is a suitable kettle hop product that reduced hopping costs without affecting the sensory characteristics of a beer. Based on the results of the brewing trials, the following benefits are evident:

- The same quantity of beer can be produced using at least 25% less hop in the form of IKE compared with CO_2 extract.
- There are no significant flavor differences between beers produced using IKE or CO_2 extract, making a product change straightforward.
- Using IKE, hop aroma can easily be achieved by late hopping, with no loss of iso-α-acids.

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