Influence of quinoa adjunct on the sweet and hopped wort composition

Jean Carlo Vasconez, Zsuzsanna Kiss, Szilard Kun, Gabriella Kun-Farkas

Department of Bioengineering and Fermentation Technology, Hungarian University of Agriculture Life Sciences

HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES

Introduction

Recently, the development of new types of beer made of raw materials other than barley malt has been a common trend among brewers. Quinoa is a pseudocereal which can be used as adjunct in the brewing process to bring novel organoleptic properties to beer. Quinoa differs from barley malt in chemical composition, and beer is highly dependent on the composition of raw materials (Cadenas et al., 2021). Thus, an evaluation of the influence of quinoa in the obtention of wort should be assessed. Quinoa may influence the final beer product; especially the high content of protein in this pseudocereal.

Quinoa or Kinua in quechwa language, was considered by the people from the elder Inca Empire as the mother grain ("chisya mama") because of its unique properties (Piñuel et al., 2019). Quinoa seeds are rich in carbohydrates, proteins, lipids, polyphenols, fiber, and phytochemicals. According to the FAO, quinoa can provide food security during the next century (Lindeboom, 2005).

Chenopodium quinoa Willd.

Hordeum vulgare

Adjuncts play an important role in the brewing process, providing unique characteristics to the beer. They can be added as a whole cereal, as grist, as extruded grains, or in malted, torrified or syrup form. However, they may have poor enzymatic activities for degrading those materials. In consequence, malts rich in enzymes as pilsner malt, should be used when brewing is performed with adjuncts. Quinoa can be used in malted or unmalted form.

Wort obtention

Different grist mixtures made up of quinoa (10, 20, 30, 40%) and barley malt fractions were used in micro mashing tests. The pH, haze, extract and free α-amino nitrogen (FAN) contents were followed during the obtaining of wort, and they were evaluated in sweet and hopped wort (sweet wort after boiling and hop addition). The addition commercial brewing enzymes was considered to enhance the natural enzyme degradation properties of raw materials. The pH during the wort obtention is crucial for the well function of the enzymes. Treatments with an initial pH adjustment between 5.4–5.6 (normal brewing pH) and no adjustment were considered.

1. Recipe, grist preparation

Nº	Unmalted quinoa (%)	Unmalted quinoa (g)	Malted barley (%)	Malted barley (g)
1	10	7.5	90	67.5
2	20	15	80	60
3	30	22.5	70	52.5
4	40	30	60	45

$$\frac{\text{Water}}{\text{Grist}} = \frac{4}{1} = \frac{300\ \text{mL}}{75\ \text{g}}$$

Initial pH: no adjustment (5.4–5.6)

Enzymes: Ondea Pro, Neutrase

2. Milling

Quinoa → 0.2 mm

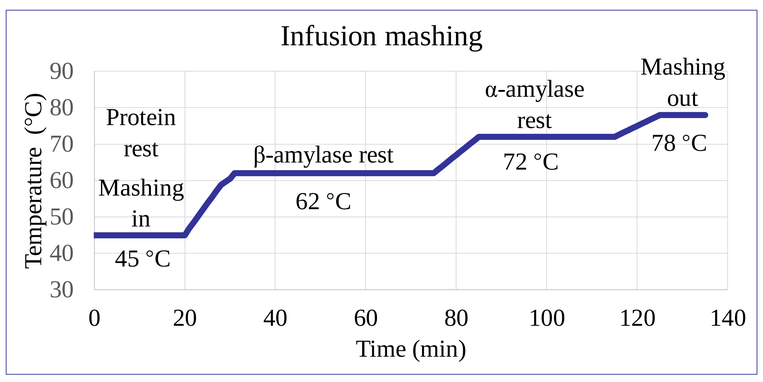
Malt → 1.2 mm

3. Mashing

1 – CUBE mashing bath

200 rpm – 100 mL water/mashing out

Mashing procedure	Temperature (°C)	Duration (min)
Mashing in	45	0
Protein rest	45	20
β-amylase rest	62	45
α-amylase rest	72	30
Mashing out	78	10



4. Filtration

→ filter paper MN 612

5. Boiling

→ Hop addition → 20 IBU → 40 min

Measuring methods

6. Wort analysis

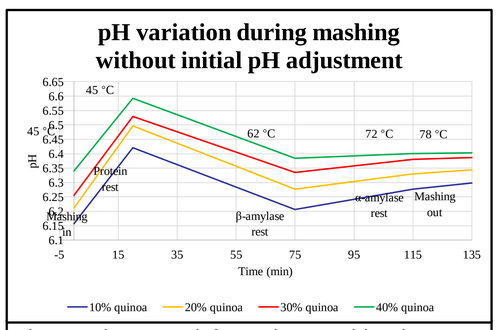
Extract, density	Anton Paar, Alcolyzer Plus
Haziness	HANNA, HI-847492-02
Free α-amino nitrogen	Ninhydrin method
pH	Mettler-Toledo FiveEasy™

References

- Lindeboom, N. (2005). *Studies on the characterization, biosynthesis and isolation of starch and protein from quinoa (Chenopodium quinua Willd.). August, 170.*
- *Piñuel, L., Boeri, P., Zubillaga, F., Barrio, D. A., Torreta, J., Cruz, A., Vásquez, G., Pinto, A., & Carrillo, W. (2019). Production of white, red and black quinoa (Chenopodium quinoa willd var. real) protein isolates and its hydrolysates in germinated and non-germinated quinoa samples and antioxidant activity evaluation. Plants, 8(8), 1–18. https://doi.org/10.3390/plants8080257*
- *Cadenas, R., Caballero, I., Nimubona, D., & Blanco, C. A. (2021). Brewing with starchy adjuncts: Its influence on the sensory and nutritional properties of beer. Foods, 10(8). https://doi.org/10.3390/foods10081726*

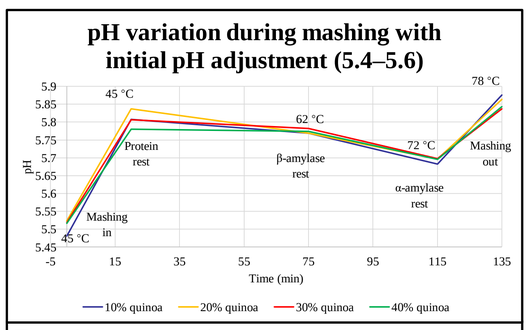
Results and discussion

Production of wort samples containing quinoa adjunct



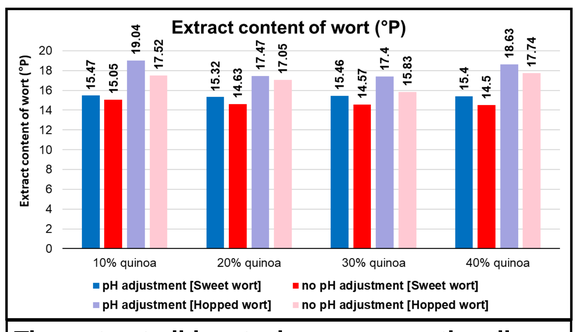
The pH increased from the mashing-in up to the end of protein rest and then decreased until β-amylase rest end was reached, and then slightly increased until mashing out.

The pH of the samples increased as more quinoa was added to the grist.

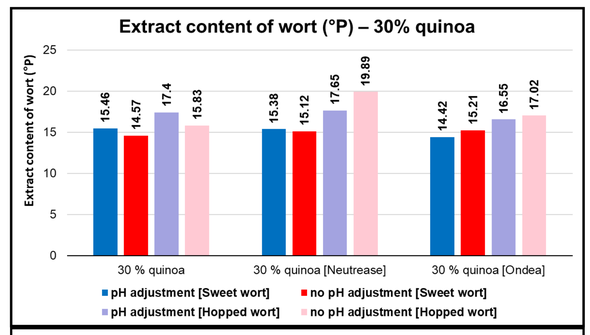


The pH increased from the mashing in up to the end of protein rest and then decreased until α-amylase rest end was reached, and then increased until mashing out

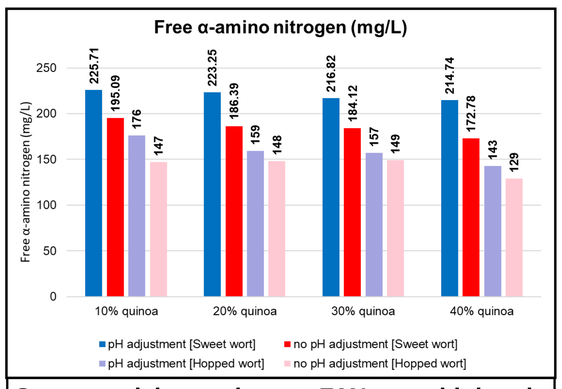
The final pH of the samples containing less quinoa fractions was higher.



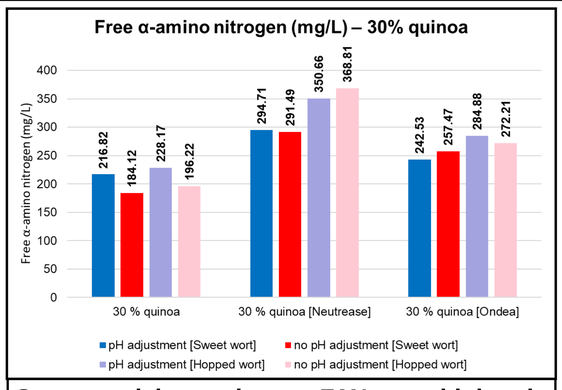
The extract did not change proportionally as more quinoa was added to the grist, except when the initial pH was not adjusted in the case of sweet wort (extract decreased).



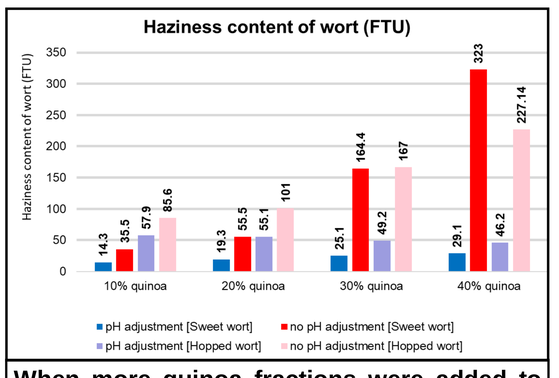
The highest sweet wort extract was obtained when no enzyme was used. The highest hopped wort extract was obtained when Neutrease enzyme was used.



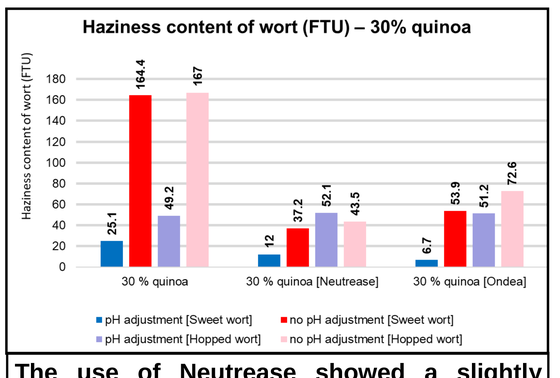
Sweet and hopped wort FAN was higher in samples where initial pH was adjusted and it decreased meanwhile more quinoa was added to mash.



Sweet and hopped wort FAN was higher in samples where initial pH was adjusted and it decreased meanwhile more quinoa was added to mash.



When more quinoa fractions were added to grist, sweet wort haze increased, but hopped wort haze decreased. Haze was lower in samples where initial pH was adjusted.



The use of Neutrease showed a slightly higher haziness when pH was adjusted and less haze when there was no adjustment compared to the use of Ondea Pro enzyme.

When pH was adjusted between 5.4–5.6 (in order to favour degrading enzymes), the haziness reduced, and the extract and FAN content increased compared with results when no pH adjustment was performed in sweet and hopped wort samples, as well. On the other hand, when the quinoa fraction was increased in the grist. The haziness reduced, extract fluctuated, and FAN content increased in sweet wort samples. Furthermore, the haziness reduced, extract fluctuated, and FAN content decreased in hopped wort samples.

The best treatment resulted using 30% of quinoa and initial pH adjustment. Mash was also treated using proteolytic and brewing commercial enzymes. The proteolytic enzyme increased FAN content in both sweet and hopped wort samples, and increased extract in hopped wort. The brewing enzyme decreased haze in sweet wort samples. When no enzyme was used, pH adjustment increased the extract content of sweet wort, and reduced haze in hopped wort.

In conclusion, the application of quinoa in brewing can open new possibilities for the development of new types of beers. The use of 30 % of quinoa in the grist with an initial pH between 5.4–5.6 showed acceptable values of pH (5.83), extract (17.40 °P), haze (49.2 FTU) and FAN (228.17 mg/L) in the hopped wort. Thus, it can be used without enzyme addition with agreeable results, since the enzymes from malt can compensate for the lack of degrading enzymes to obtain suitable wort needed in the fermentation process.

Wort obtained using a barley-quinoa grist at 30% can be used in further steps to perform a fermenting process and obtain a new type of beer with a reduced content of gluten.
Further investigations should be performed regarding other factors which are important for the wort production, quinoa has shown potential applicability in the brewing process and it can be used for a new kind of product development.

Acknowledgement

Authors would like to thank the support of Department of Bioengineering and Fermentation Technology, Hungarian University of Agriculture Life Sciences, Budapest, Hungary.