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Research Article

Effects of Variation in Brewing Steps; Mashing and Wort Boiling on Final Product

Nishant Kumar*, Manju Nehra and Suresh Kumar Gahlawat

Chaudhary Devi Lal University, Sirsa, Haryana (India)

*Corresponding Author E-mail: ngrover11@gmail.com

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ABSTRACT

The quality and the composition and of the beer is not only depend on the qualities of the raw materials used, but also on the technology used to make it. Each and every brewing step plays an important role in quality of final product. The aim of our study was to investigate the effect of changes in profiles of mashing and wort boiling on the final beer. It was observed that change in mashing steps greatly influences the extract content and prolonged boiling lead to increase in color and bitterness of final beer.

Keywords: *Beer, Brewing, Wort, Mashing, Wort Boiling.*

INTRODUCTION

Brewing a beer is a complex process having various steps. It starts with an important step that is mashing that greatly influence the quality of the brewed beer, in which milled malt (ratio of fine and coarse milling of grains depends on the type of equipment used for brewing) is mixed with water and heated through a time temperature profile, allowing various enzymes to complete the breakdown of complex sugars to simple sugars and lead to formation of a wort having fermentable sugars, yeast nutrients and other flavor compounds. Followed by second step lautering, which is the separation of barley juice (wort) from grains to produce sweet wort. Composition of the final wort depends on the temperature–time profile used during brewing procress which lead to the changes in the quality of the finished beer.

An another important step wort boiling, that lead to inactivation of enzymes, evaporation of water, color development, sterilization of the wort, removal of undesirable flavor components, formation of aromatic compounds, acidification of wort, isomerization of hop acids that provide bitterness to beer and precipitate haze-forming protein.

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Then followed by fermentation, in which the conversion of wort sugars into alcohol and flavor components by yeast; then maturation, in which yeast settles and removed along with other undesirable components; followed by filtration and packaging of final product.

MATERIALS AND METHODS

Materials for brewing

Pilsner malts (Weyermann, Germany), Saaz pellet Hops (Hopsteiner) and Saflager S-189 lager yeast (Fermentis) were procured from local distributors and used for brewing.

Wort production

Pilsner malt was milled and mashed using water grist ratio of 1:3. Mashing was done by using different time temperature combinations as:

1. Mash in was at 45°C and held for 20mins, then temperature was raised with the rate of 1°C/min to 52°C and held for 30mins then raised to 63°C and held for 30mins then finally raised to 72°C and held for 20mins followed by at 76°C for 2mins for mash out.
2. In second method, mash in was done at 65°C and held for one hour and followed by 76 °C for 2mins and mash out.
3. In Third, Mash in was done at 62°C and held for 45mins followed by 72°C and held for 20 mins and mash out at 76°C. An iodine test was carried out before mash out temperature to con firm conversion. After completion of mashing, wort was filtered using Whatman filter paper and subjected to boiling.

Wort Boiling

Then boiling was done and three different time intervals of 60, 90 and 120 min were used by boiling at 100.0 ± 1°C. After boiling, the wort was held for 30mins for turb removal and for further wort analysis; it was cooled to 4°C.

Table 1: Wort Samples

W1	Wort from Mashing Method 1 before boiling
W2	Wort from Mashing Method 2 before boiling
W3	Wort from Mashing Method 3 before boiling
Ab1	Wort from Mashing Method 1 After 60min boiling
Ab2	Wort from Mashing Method 1 After 90min boiling
Ab3	Wort from Mashing Method 1 After 120min boiling
Ab4	Wort from Mashing Method 2 After 60min boiling
Ab5	Wort from Mashing Method 2 After 90min boiling
Ab6	Wort from Mashing Method 2 After 120min boiling
Ab7	Wort from Mashing Method 3 After 60min boiling
Ab8	Wort from Mashing Method 3 After 90min boiling
Ab9	Wort from Mashing Method 3 After 120min boiling

Hop Addition

Hops addition was done in two stages and observed bitterness of final product. First hops addition (1g hop pellets for 100g malt) was done after 15mins of start of boiling and second hops addition (1g hop pellets) was done at last 30mins of wort boiling of every batch.

Fermentation

Pre-rehydrated dry yeast pitched into the wort prepared from the above different methods and fermentation was carried out at 10°C for 6 days and chill back at 4°C for 2 days followed by maturation at 1°C for 7 days.

Table 2: Beer Samples

B1	Beer brewed with Mashing Method 1 and 60min boiling
B2	Beer brewed with Mashing Method 1 and 90min boiling
B3	Beer brewed with Mashing Method 1 and 120min boiling
B4	Beer brewed with Mashing Method 2 and 60min boiling
B5	Beer brewed with Mashing Method 2 and 90min boiling
B6	Beer brewed with Mashing Method 2 and 120min boiling
B7	Beer brewed with Mashing Method 3 and 60min boiling
B8	Beer brewed with Mashing Method 3 and 90min boiling
B9	Beer brewed with Mashing Method 3 and 120min boiling

Wort and Beer Analysis

All samples of wort produced by using different methods were analyzed for following parameters. All analysis were performed in triple samples, therefore the reported data are the mean of three values.

pH

The pH was measured by using a pH-meter. Wort pH was determined directly while the beers were degassed before analysis.

Total polyphenols

Total polyphenols (TP) content was determined according to the Singleton method (1999).

Total soluble nitrogen

The soluble nitrogen content of wort and beer was determined using the Kjeldahl method.

RESULTS AND DISCUSSION

The effect of variation in mashing and boiling profile on wort and beer properties was compared. Three different mashing profiles were used having same raw material and their effects were evaluated on the worts and beers by determining the pH, the total soluble nitrogen and total polyphenols.

Wort pH is one of main characteristic of the recipe and is uniform from brew to brew within a beer brand. Any variations in recipe and process affect fermentation, beer flavour and flavour stability. The amount of toal nitrogen in wort plays an important role during beer fermentation, and greatly effects beer flavour. Wort nitrogen comprises protein content and the free amino nitrogen which is fundamental for yeast nutrition (Meillegard & Peppard, 1986). The nitrogenous compounds present in beers vary greatly in their chemical configuration and that effects beer odour, flavour, character etc. The amino compounds present in final beer are almost exclusively nitrogenous compounds that are not utilized by yeast (Montanari et al., 2005).

Table 3 reports the pH value, total polyphenols and total nitrogen of wort samples produced by using different mashing profiles. Our results confirmed literature data.

Table 3: the pH value, total polyphenols and total nitrogen of wort samples

	pH	Total polyphenols (mg/L)	Total Nitrogen (mg/L)
W1	5.37^{a}	536.6^{a}	1170^{c}
W2	5.53^{c}	540.8^{a}	1128^{a}
W3	5.46^{b}	542.1^{a}	1146^{b}

The phenolic compounds present in beer also responsible for the total antioxidant capacity of plasma (TRAP). They contribute to astringency and colour, serve as browning substrates, participate in chill haze formation and are responsible for overall beer stability. The pH, total nitrogen and Total polyphenols were compared statistically.

Table 4: Specific gravity (SG), Evaporation and total nitrogen of wort samples

	Specific gravity (SG)	Evaporation (%)	Total Nitrogen (mg/L)
Ab1	1.044	6.77	876
Ab2	1.048	7.89	853
Ab3	1.050	8.15	824
Ab4	1.046	6.48	801
Ab5	1.048	7.23	787
Ab6	1.050	7.84	761
Ab7	1.048	7.01	849
Ab8	1.050	7.68	821
Ab9	1.052	8.12	806

It was observed that evaporation rate increase with increase in boiling time. This is due to increase in water evaporation upon prolonged boiling and that leads to increase in Specific gravity of wort.

It was observed that there is decrease in total nitrogen with the increase in boiling time. Also, similar results were observed by Mishra & Speers (2020), they observed a 6-7% decrease in nitrogen fraction by an increase from 30 min to 120 min in boiling time.

Table 5: Color, total nitrogen and bitterness of beer samples

	Color (EBC)	Total nitrogen (mg/L)	Bitterness (BU)
B1	7.5	496	21.17
B2	8.5	448	24.66
B3	9	421	26.02
B4	8	473	21.01
B5	8.5	429	24.35
B6	9	403	25.98
B7	7.5	479	21.32
B8	8.5	434	24.49
B9	9	419	26.18

Generally, Mashing method 2 processes are used for less modified malt and if adjuncts having starch with a high gelatinization temperature are used, their precooking should be done in a separate vessel before being added in with the malt mash. In some previous studies, it was also observed that two similar commercial lager style beer of same brand have difference in their foam stability, despite using same raw materials and production processes (except wort boiling). It was believed that prolonged boiling lead to decrease in foam stability (Van Nierop et al., 2004).

CONCLUSIONS

Results indicated that not just recipes but also variation in brewing profile lead to changes in final product. The addition of the proteolytic step (52°C) in mashing profile had an effect on the total nitrogen of wort and beer. Also, increase in boiling time led to increase in color of beer as well.

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