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The effect of steeping conditions on Arapiles malting

The effect of various steeping conditions (time, temperature and aeration) on the quality of Arapiles malt for brewing (in terms of diastatic power, free amino nitrogen and hot water extract) was investigated. Steeping time and temperature had a highly significant effect on malt quality. In general, malt quality increased with steeping time (from 16 – 31 hrs). Malt diastatic power increased with steeping temperature (up to 25 °C) and free amino nitrogen and extract content peaked at a steeping temperature of 20 °C. Aeration during steeping appeared to enhance the extract and free amino nitrogen content of the finished malt. It was found that malt quality was directly related to the steep-out moisture of the grain.

(Descriptors: steeping, malting, barley malt)

1 Introduction

Barley malt is widely to provide an important raw material in brewing. The primary objective of malting is to promote the development of hydrolytic enzymes that are not present in barley. The malting process can be divided into three physically distinct operations, i.e. steeping, germination and drying. Steeping (the soaking of grain in water) is widely acknowledged as the most critical stage of the malting process. This is a consequence of the importance of initiating germination such that modification of the endosperm structure will progress at a rate producing malt of the desired quality. Factors that are important for the successful initiation of germination are adequate moisture, temperature and the presence of oxygen. These factors can affect the extract yield, diastatic activity and other important malt quality characteristics. So much emphasis has been placed on the effects of various germination conditions on the quality of Arapiles malt in order to improve malt quality and its yield in the paper.

2 Experimental

Materials: Australia barley variety Arapiles that has no water sensitivity was used. All the samples were from the total sample that was homogenized before use.

Steeping: micro-malting plant imported from Seeger Germany. A pump connected to an air supply was used to aerate the steeping water (air-blast (AB)). The air-rest (AR) method of aeration was achieved by allowing the grain to rest for a predetermined period in the air before refilling the vessel with fresh temperature-controlled water. Non-aerated (NA) steeping conditions were achieved by steeping the grain for the full steeping period in non-aerated water.

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Tables and figures see Appendix

3 Methods

Steeping: Samples of grain (650 g), tap water. Sample at each of the pre-determined temperatures was steeped for one of three different times (16, 24 or 31 hrs), under one of three conditions of aeration (AR, AB or NA conditions).

Germination: All the samples were germinated at the same conditions (16 – 17 °C, fresh air 10 %, recycled air 90 %) in Seeger germinating cabinets and watered after germinating 20 hrs (100ml) and 48 hrs(60 ml) respectively.

Drying: After 6 days from the beginning of steeping, germination was arrested by drying the malt for 24 hrs in a forced draft kilning cabinet at 30 °C 1 hr, 50 °C 14 hrs, 70 °C 6hrs, 83 °C 3 hrs.

Analyses: Steep-out moisture on a wet weight basis, Malting loss on a drying weight basis, Diastatic Power (DP), Extraction content and Free amino nitrogen (FAN) were determined according to the EBC analytical methods.

3 Results and discussion

3.1 Effect of steeping conditions on malt quality

Malt quality for beer brewing is defined primarily in terms of DP and FAN. DP is a measure of the joint alpha-and beta-amylase activity. DP is especially important in the case of high proportion of cereal adjunct in beer brewing. FAN, the proteolytic breakdown products of endosperm proteins, composed of amino acids and small peptides, is particularly important in brewing since it is the source of nitrogen for yeast during fermentation. In conventional clear lager beer brewing, the most important malt quality criterion is extract. Extract is a measure of how much malt will dissolve during the brewing process. This is a less important measure of malt quality as malt makes up only approximately 30 % of the cereal grist. Results of the study indicate that malt DP increased significantly with increasing steeping time (Table 1). In addition to DP, other malt quality parameters important for brewing, FAN and extract content, were improved significantly by increasing the steeping time (Tables 2 and 3, respectively). The present study indicates clearly that the steeping times of 16 hrs or less are not satisfactory. It is important to note, however, if the oxygen requirements of the grain were not enough, long steeping times may lead to anoxic condition that may be compounded by microbial proliferation. Analysis of variance indicated that steeping temperature also had a significant effect on the malt quality

(Tables 1, 2 and 3). Malt DP was enhanced not only by an increase in the steeping time but also by an increase in the temperature of the steeping water. The maximum DP of 412 WK was obtained in grains steeped for 31 hrs under AR, 25 °C conditions (Table 1). With respect to malt FAN and extract content, it was apparent that 20 °C was optimum (Tables 2 and 3). The highest values for malt FAN and extract (220 mg/100 g and 79.9 % respectively), were obtained from sample that had been steeped at 20 °C for 31 hrs under AR conditions for the former and for 24 hrs under aerated conditions for the latter. Steeping temperature has also been shown to be important. These results show clearly the need for temperature control during steeping. It has been stated that adequate oxygen is necessary for the formation of alpha-amylase and peptidase because analysis of variance suggested that aeration during steeping did affect the DP of the malt (Table 1). Aeration and steeping temperature and the combined effect of time and aeration were found to have a significant effect on malting losses (Table 4). The higher the steeping temperature the higher the malting losses accrued. These results are not unexpected as malting losses are an outcome of respiratory metabolism and, therefore, any condition that affects respiration and consequently malt quality will also affect the losses accrued.

3.2 Effect of steeping-out moisture content on malt quality

The steeping-out moisture content of the grain was significantly affected by steeping time and temperature. There was a general increase in steep-out moisture with increasing steeping time (16 – 31 hrs) and temperature (15 – 25 °C) (Table 5). Analysis of variance indicated that aeration did not significantly affect the steep-out moisture of the grain. It has been reported that the moisture content of barley at the end of steeping (as long as air-

rests are employed) is an effective way of selecting the steeping regime giving the highest hot water extract. In this study, a significant correlation was obtained between the steep-out moisture and malt DP (Fig. 1a). Significant correlations were also found between steep-out moisture and FAN, and extract content (Fig. 1b). It would appear, therefore, that steep-out moisture could similarly provide the maltster with a rough tool with which to select the steeping procedure that will maximize the malting quality of the grain together with germination properties, though the steep-out moisture may vary depending upon the grain size and barley variety.

4 Conclusions

The findings of this study clearly indicate that malt quality, for barley Arapiles, is significantly affected by steeping time and temperature. Malt quality within the range of parameters studied, increases with steeping time (16 – 31 hrs) and the optimum steeping temperature is around 20 °C. Aeration during steeping was also shown to be necessary to maximize malt quality. It was found that the quality of malt was directly related to the steep-out moisture of the barley.

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Appendix

Table 1 The effect of steeping conditions on diastatic power (WK)

Steeping time (h)	Temperature								
	15°C			20°C			25°C		
	Aeration condition								
	AR	AB	NA	AR	AB	NA	AR	AB	NA
16	291	240	259	273	329	330	351	313	328
24	320	302	284	305	287	359	376	356	387
31	357	358	313	360	339	367	412	400	391

Table 2 The effect of steeping conditions on FAN (mg/Kg)

Steeping time (h)	Temperature								
	15°C			20°C			25°C		
	Aeration condition								
	AR	AB	NA	AR	AB	NA	AR	AB	NA
16	136	138	133	178	184	164	163	174	150
24	144	134	138	196	194	186	168	174	168
31	190	190	180	220	214	190	214	202	194

Table 3 The effect of steeping conditions on extract (%)

Steeping time (h)	Temperature								
	15°C			20°C			25°C		
	Aeration condition								
	AR	AB	NA	AR	AB	NA	AR	AB	NA
16	78.0	78.3	77.8	78.8	78.9	78.1	78.4	78.9	77.8
24	79.1	78.6	78.3	79.3	79.5	78.5	78.4	79.4	78.0
31	79.5	79.6	79.2	79.9	79.9	79.4	78.0	79.2	78.9

Table 4 The effect of steeping conditions on malting losses (%)

Steeping time (h)	Temperature								
	15°C			20°C			25°C		
	Aeration condition								
	AR	AB	NA	AR	AB	NA	AR	AB	NA
16	16.2	16.5	16.1	17.7	17.3	17.2	18.0	17.5	16.3
24	16.2	16.4	16.1	17.5	18.2	17.4	17.4	17.5	16.3
31	16.5	16.6	15.8	17.1	17.4	15.5	18.3	17.5	17.4

Table 5 The effect of steeping conditions on steeping-out moisture (%)

Steeping time (h)	Temperature								
	15°C			20°C			25°C		
	Aeration condition								
	AR	AB	NA	AR	AB	NA	AR	AB	NA
16	38.0	38.3	38.1	38.9	39.8	39.6	41.3	42.0	43.1
24	40.1	39.3	40.1	41.5	42.4	42.0	42.6	42.3	43.7
31	43.5	42.9	42.4	44.2	44.4	43.5	44.9	45.2	44.3

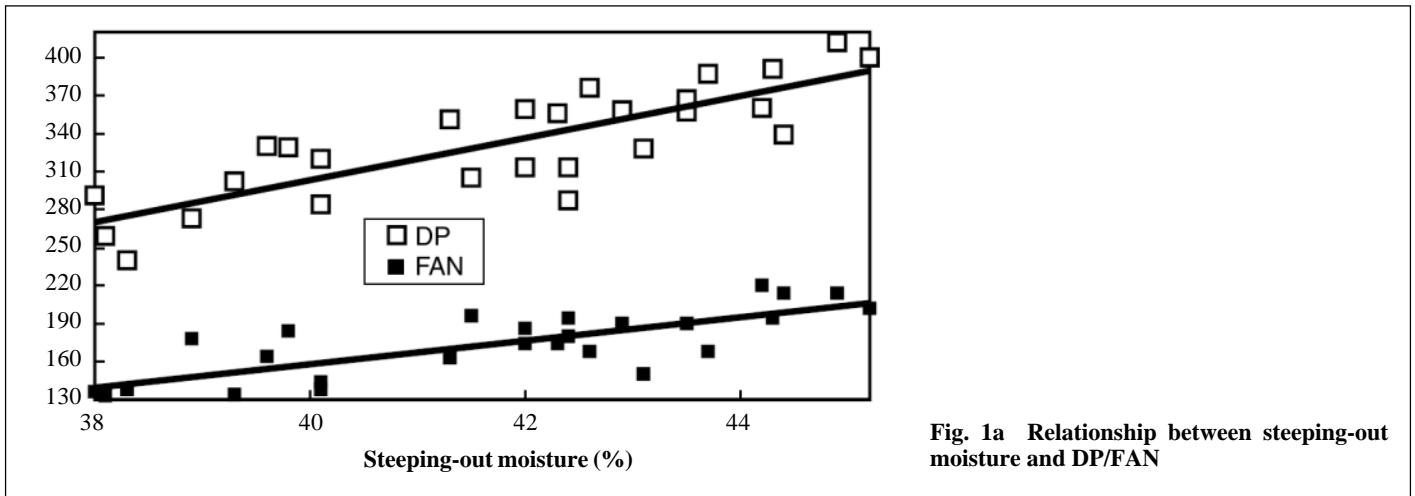


Fig. 1a Relationship between steeping-out moisture and DP/FAN

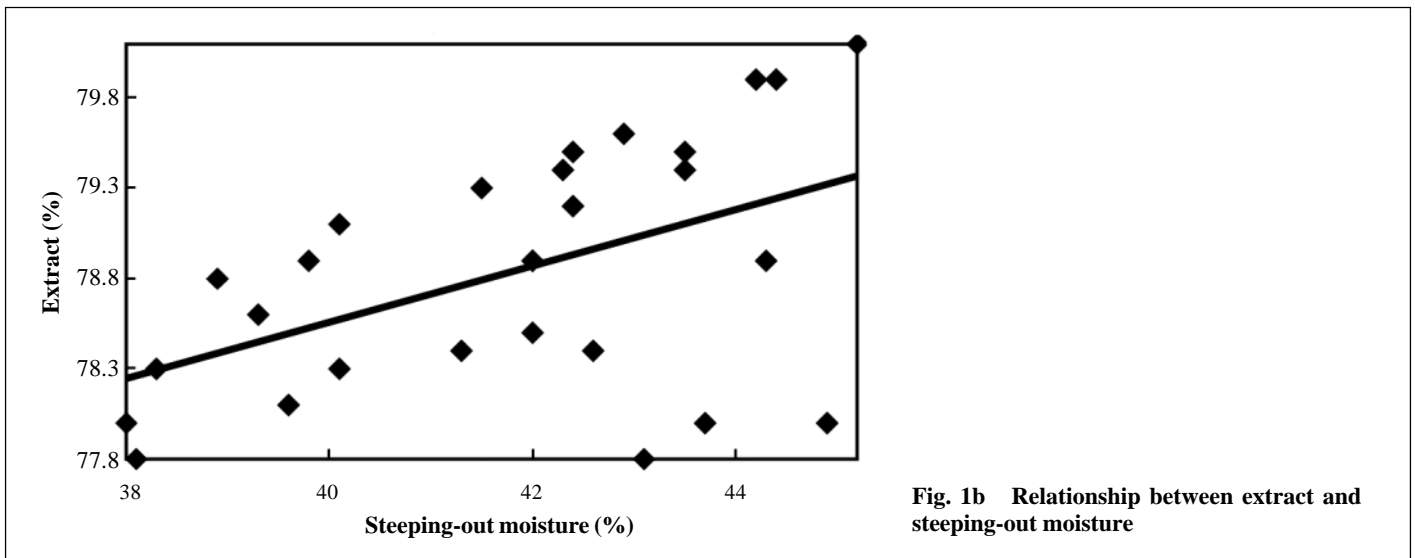


Fig. 1b Relationship between extract and steeping-out moisture