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Rating of malt grist fineness with respect to the used grinding equipment

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Abstract

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Grain size distribution of grist is dependent on the type of grinding mill. The most widely used crushers used for malt grinding are roll grinding machines and dispersants are the disc mills. For rating of grist fineness grists made in the two-roller mill KVM 130/150 and dispersant the disk mill Skiold SK 2500 was used. The selected types of barley malt were processed: light malt, Munich malt, caramel malt and colouring malt. Rating of malt grist fineness was made with a help of sieve analysis using a "Pfungstadt sifter". Conclusions from the measurements are as follows: by using the two-roller mill the coarsest grist is got from caramel malt and the finest malt from the light malt. The dispersant was processing grist at a speed of 1,500 rpm and 2,800 rpm. For each speed, the coarsest grist was obtained from caramel malt and the finest grist was obtained by crushing colouring malt.

Keywords: milling of malt; two-roller mill; dispersant; sieve analysis; grinding fineness

The first phase of beer production is the production of so-called wort. However, in order to produce wort, it is necessary to grind appropriate (usually barley) malt to get the desired fineness first. Grinding is followed by further processing steps, which include in particular: mashing of malt grist into the water, mashing, wort drawing-off, wort boiling and wort cooling (Basařová 2010; Chládek 2007).

The notion of grinding is the most frequently associated with the issue of compound feed, or processing of especially hard feed raw materials. In beer production, as mentioned above, malt grinding stands at the beginning of the technology, if previous issues of malt production are left aside. Malt grinding might seem to be a relatively simple process based on the fundamental principles of mechanics; however, it fundamentally affects the processes of mashing and drawing-off and the brewing yield.

For the necessary disclosure of so-called extractive substances, contained in the malt grain and accelerating their dissolution, it is necessary to crush the grain. Two basic components, each of which comprises malted grain, are the husks and endosperm. Husks have a major impact to speed and quality of drawing-off. The endosperm is composed mainly of starch, carbohydrates and proteins. Suitably grinded grain and thus disclosed endosperm enables the desired enzymatic and physical-chemical reactions in the production of the wort (Dendy, Dobraszczyk 2001; Karaoglu 2011).

Drawing-off is also quite crucial technological step in the production of beer, because it leads to separating of the wort (extract solution) from the malt residue (solid, so-called saccharified mash). Traditional brewing technologies use for drawing-off so called filtration vat. An alternative to the fil-

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Table 1. Parameters of Pfungstadt sifter (Basařová 2010)

Sieve	Mesh size sieve (mm)	No. of mesh (1/cm^2)	Wire strength (mm)	Fraction name	Coarse grist (%)	Fine grist (%)
1	1.270	39.7	0.31	husks	20–30	8–13
2	1.010	62.4	0.26	coarse semolina	5–10	2–6
3	0.547	207.4	0.15	fine semolina 1	28–42	14–18
4	0.253	961.0	0.07	fine semolina 2	12–18	38–48
5	0.152	2,714.0	0.04	flour	4–8	8–12
6 (bottom)	–	–	–	powder	8–15	14–19

tration vat is so called mash filter, but this device can be found in breweries in much lesser extent than filtration vat. In the Czech Republic, which is known for production of high quality and in the worldwide market desired beers, use of filtration vat prevails in brewing technology. To fulfil the function of filtration vat properly it is necessary to have the least damaged grist and most thoroughly grinded husks. Other key requirements for malt grist are high proportion of fine semolina (fine grist) and conversely a small proportion of coarse semolina (coarse grist) (Kosař 2000).

To the production of malt grist for filtration vat with desired composition malt mills (roller mills) are usually used which contain two, four or six milling rollers. Conversely, for mash filter hammer mill or a dispersant is usually preferred, as grist should have, on the contrary, well-milled husk for this filter (Smejtková, Chládek 2012; Vaculík 2013).

Checking of the grist composition is performed on a vibrating “Pfungstadt sifter” which is a set of five sieves with a defined mesh size sieve.

Table 1 lists the parameters of a sifter and name of fraction on each sieve with percentage for coarse and fine grist.

MATERIAL AND METHODS

In the context of assessing the impact of grinding equipment on the grist fineness of selected different malts, grinding of four kinds of barley malt were made. Two different devices using different principles of crushing were used for the experiments.

Thus obtained barley malt grist was subsequently categorized on the Pfungstadt sifter. Measurements were repeated and the average values are presented in the results.

Both processing devices, on which the measurement was made, are part of the laboratories of selected food technologies that fall under the Department of Technological Equipment of Buildings of Faculty of Engineering at the Czech University of Life Sciences Prague, Prague, Czech Republic.

The first disintegrating device was two-roller mill KVM 130/150 (KVM Uničov, Uničov, Czech Republic) (Fig. 1):
- performance – max. 250 kg/h
- drive – two electric motors, each with input 2.05 kW,
- grinding gap width – 0.4 mm.

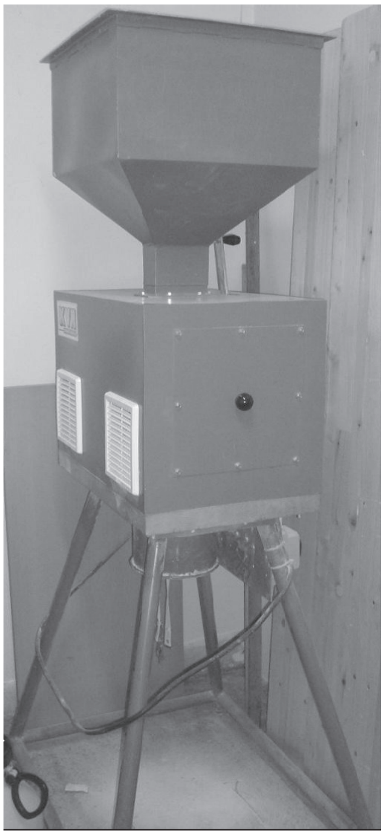

Fig. 1. Two-roller mill KVM 130/150

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Fig. 2. Disc mill Skiold SK 2500 + dynamometer DS 546-4/V

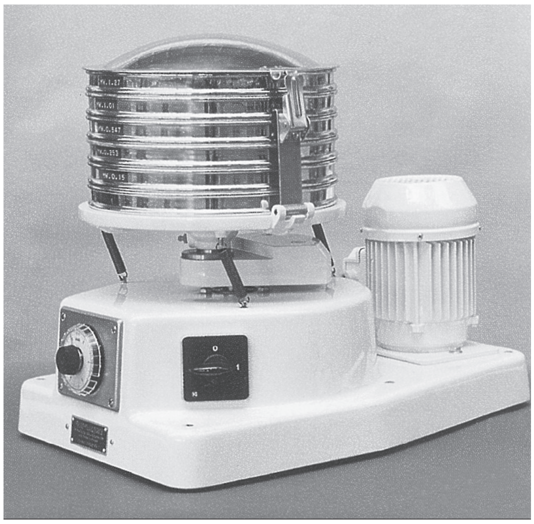

Fig. 3. Pfungstadt sifter (Kosař 2000)

The second device was dispersant – disc mill Skiold SK 2500 (Skiold, Sæby, Denmark) (Fig. 2):

- drive of disc mill – dynamometer type DS 546-4 /V (Mezservis, Vsetín, Czech Republic),
- dynamometer performance – adjustable (max. 26 kW)
- gap width between the grinding discs – 0.4 mm.

Dispersant was used with 1,500 rpm and 2,800 rpm. Dry grinding of barley malt was made on both devices and four kinds of malt were processed:

- light barley malt (pilsner type) (Soufflet, Hodonice, Czech Republic),
- barley malt called Munich (Heinz Weyermann, Bamberg, Germany),
- barley malt called caramel (Heinz Weyermann, Bamberg, Germany),
- barley malt called colouring (Heinz Weyermann, Bamberg, Germany).

Sieve analysis of grist from single grinding malts was performed using a Pfungstadt sifter PLPK (Bühler, Uzwil, Switzerland) (Fig. 3).

From each of the grinding malt a sample weighing 100 g was taken, it was placed on the top sieve and then sieved. Sieving of each sample took 5 min, frequency 300 period·min^{-1} was set on the sifter.

After sieving, the weight of grist on each sieve was determined. Weighing the individual balances on the sieves was realized with the aid of digital scales Kern PEJ (Kern & Sohn GmbH, Balingen, Germany) which was calibrated to the value of 0.1 g. Fineness of grinding was determined by summing the weight of the sample from the bottom and two sieves above the bottom.

RESULTS AND DISCUSSION

Fig. 4 shows the results obtained by sieve analysis for the roller mill. Previously mentioned four types of malt were processed.

The sieve analysis of grist from the two-roller mill shows that the largest proportion of particles was caught on the sieves 1–3. This means that the grist thus obtained contains mainly coarser particles.

Fig. 5 shows the results obtained by sieve analysis for dispersant with 1,500 rpm. Previously mentioned four types of malt were processed.

The sieve analysis of grist from the dispersant (1,500 rpm) shows that the largest proportion of particles was caught on the sieve 3. This means that the grist thus obtained contains mainly medium size particles. Fine semolina is obtained.

Fig. 6 shows the results obtained by sieve analysis for dispersant with 2,800 rpm. Previously mentioned four types of malt were processed.

The sieve analysis of grist from the dispersant with 2,800 rpm shows that the largest proportion of particles was caught on the sieves 3–4. This means that the grist thus obtained contains mainly medium size and fine particles. Finer semolina is obtained than when using the dispersant with 1,500 rpm.

In Table 2 fineness of grinding is listed for individual mill devices and used kinds of malt. Since the sample taken weighs 100 g, the sum of the weights on sieves corresponds to percentage in which the fineness of grinding is expressed.

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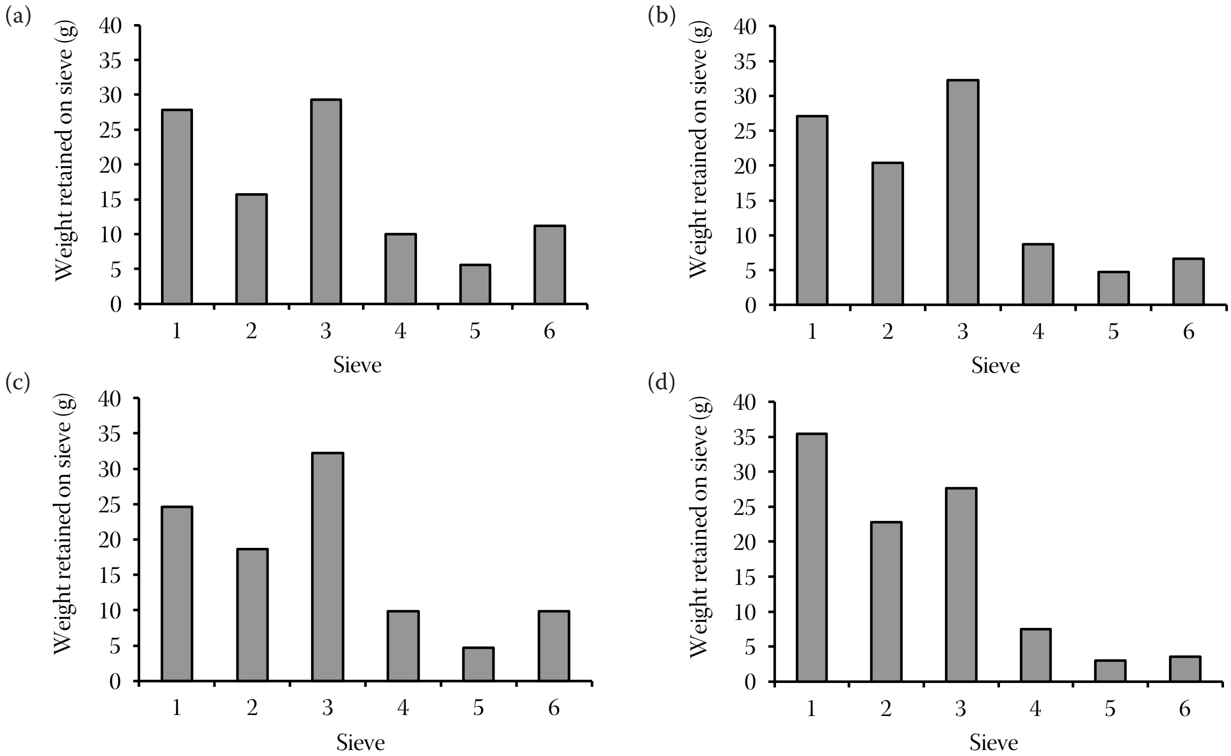

Fig. 4. Sieve analysis (two-roller mill) for (a) light malt, (b) Munich malt, (c) colouring malt, and (d) caramel malt

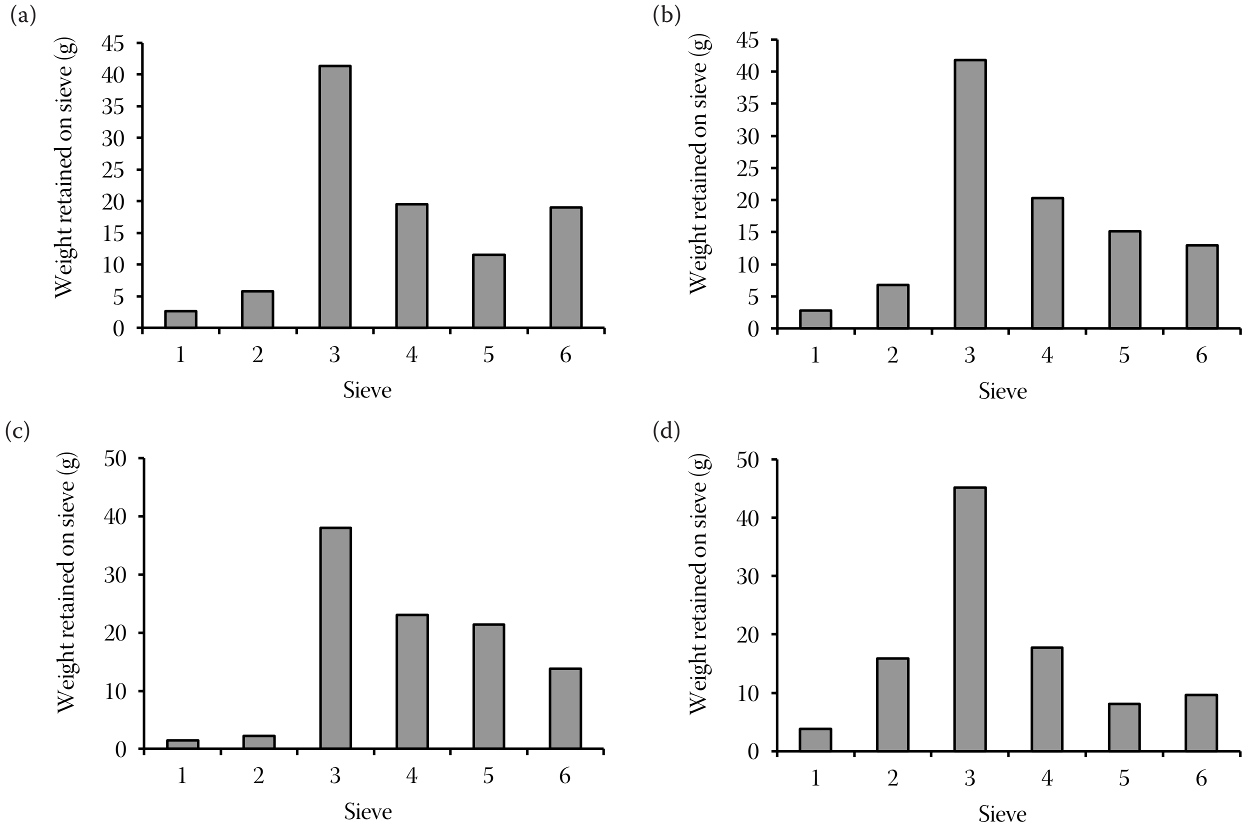

Fig. 5. Sieve analysis (dispersant 1,500 rpm) for (a) light malt, (b) Munich malt, (c) colouring malt, and (d) caramel malt

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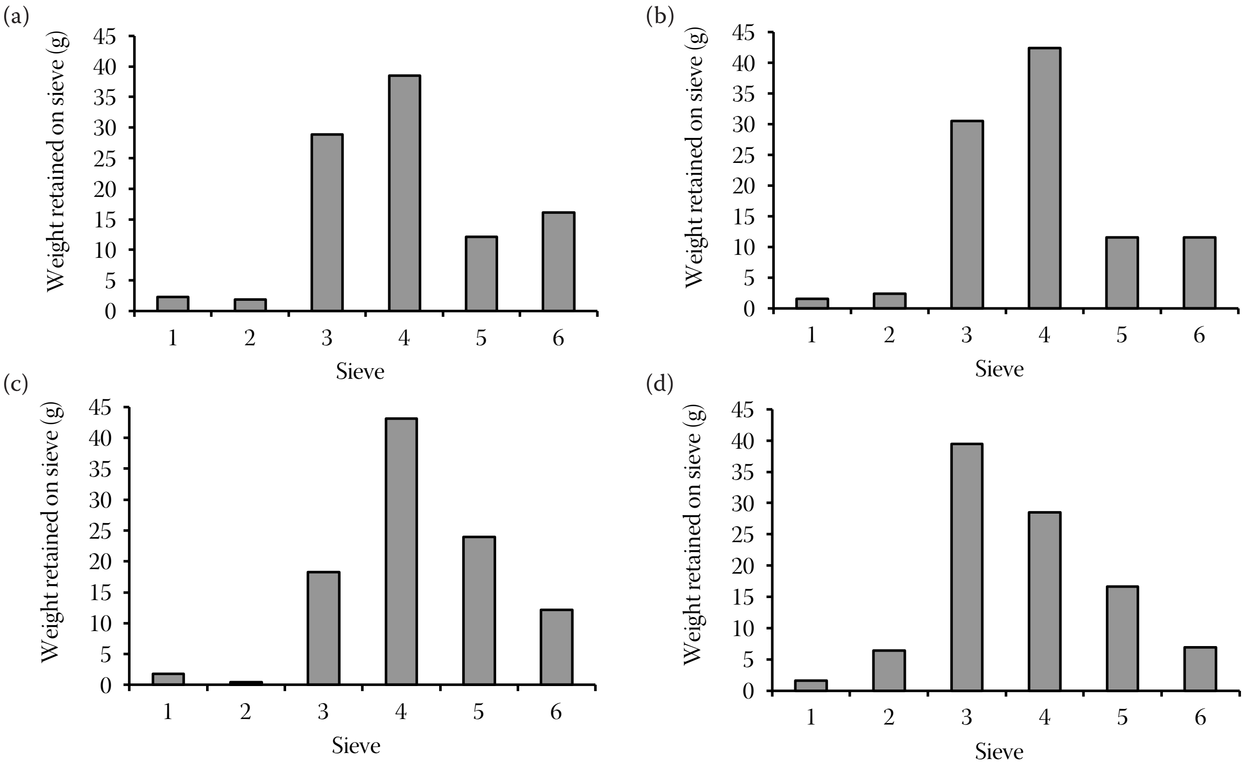

Fig. 6. Sieve analysis (dispersant 2,800 rpm) for (a) light malt, (b) Munich malt, (c) colouring malt, and (d) calamel malt

Table 2. Fineness of grinding

Kind of malt	Fineness of grinding (%)		
	two roller mill	disc mill 1,500 rpm	disc mill 2,800 rpm
Light	26.75	50.1	66.69
Munich	20.08	48.43	65.41
Colouring	24.42	58.12	79.21
Caramel	14.03	35.44	52.15

CONCLUSION

From the measured results shown in the Fig. 4 is evident that when using a two-roller mill the largest proportion of the sample of grist in all cases was collected on the first three screens. This means that it is coarser grist, which is also apparent from a comparison with Table 1. Among the four kinds of malt the coarsest grist comes from caramel malt and conversely the finest scarp from light malt.

Using a dispersant with 1,500 rpm and 2,800 rpm finer grist was obtained; smallest share of grist was caught in the first two screens (Figs 5 and 6). By comparing the grinding fineness it can be seen that the coarsest grist is again from caramel malt which corresponds to higher portions of the sample on coarser sieves compared to the remaining kinds of malt. On the contrary, the finest scrap was gained by crushing colouring malt. By comparing the samples obtained at different speeds, it is apparent, that at higher speed finer grist for all used kinds of malt is achieved.

The measurement result confirmed the theory that the roller mills give coarser grist and are therefore suitable for filtration vat. Dispersant gives finer grist in the same size of milling gap, but it depends on the rpm. A theoretical assumption that the higher rotation frequency the finer grist was also confirmed. Using dispersant is therefore suitable especially for the production of grist when mash filter is used for drawing-off.

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