THE EFFECT OF GRAIN SIZE ON THE COLOUR CHARACTERISTICS OF DURUM SEMOLINAS

Zsuzsa H.Horváth, Sándor Csató
University of Szeged Faculty of Engineering
email:horvatzs@mk.u-szeged.hu

ABSTRACT

Pastas made of durum flour are becoming more prevalent also in our country, no eggs are needed for their preparation. The colour of the pasta produced this way is determined essentially by the colour of the durum semolina. Also in industrial practices instrumental colour analysis is applied for the colour qualification of durum semolina.

In our work we examined how the grain size influences the colour characteristics and ash content of durum wheat grindings. The correspondence between the ash content and the colour characteristics was also analysed.

Durum semolina from 12 different production units were used for our measurements. The semolina were produced from the yields of 2007 and 2008. The grindings were separated into different grain-size fractions by screening. The L*, a* , b* colour coordinates defined in the CIELab colour space were applied for the colour characterization. The measurements were carried out using a Hunter Miniscan colour analyser. The data was analysed applying variance analysis and regression analysis.
On the basis of the obtained results we can establish that the grain size significantly influences ($p<0.05$) the L* lightness the a* redness and the b* yellowness coordinate as well as the variation of the YI yellowness index. When the grain size increases, the L* lightness coordinate decreases. The difference is the biggest between the means of the 0-160 μm and the 160 μm -250 μm fractions though even in the other cases the difference is at least 1 unit. Hence the bigger grains are darker. The a* redness coordinate, the b* yellowness coordinate and the YI yellowness index increases when the grain size increases. On the average the a* coordinate increases by 0.4 unit, the b*coordinate by 3-4 units while the YI yellowness index by 5 units. Thus the colour of bigger grains is slightly redder and significantly yellower.

The ash content decreases with the increase of the grain size. The mean ash content varied between 0.7-1.1%. The ash content of the whole grinding is equal to that of the 315 μm -500 μm fraction. The difference between the ash content of the subsequent grain size fractions is 0.1% on the average.

Also the results have shown that there's a significant linear correlation between the ash content and each colour characteristic. ($p<0.01$).

KEYWORDS: durum grist, colour coordinates, grain size

1. INTRODUCTION

Wheat grindings are one of the most important and most frequently used raw materials. As for every alimentary product, also for the wheat grindings the colour is an important parameter, which gives a primary image of it. Especially for the durum wheat pasta, since they do not contain eggs. This explains the fact that instrumental colour measurements are applied on durum semolina also in industrial practice. In the literature various research results report on colour measurements of wheat grindings.

Oliver et al. (1993) already in 1993 showed during the qualification, that the ash-content influences the colour of the flours. Further research on this topic Horváth et al. (2004) proved that flours prepared from harder grain have lower L* coordinate and higher a* coordinate thus they are darker and have browner tone, besides the L* lightness coordinate shows good correspondence with the whiteness index of the flours.
Halászné et al.(1995) proposed a qualification system based on the colour measurements of durum semolina.
D'egido and Pagani (1997) compared the colour characteristics of pasta made of durum flours obtained by different grinding procedures.
During the product manufacturing the colour characteristics were mainly used to determine the appropriate roastedness (Hotti et al., 2000)
Humphries et al. (2004) found a correlation between CIE b* and lutein concentration of wheat. Konopka et al. (2004) established a relation between the colour characteristics of the flours and their lipid and colorant content. Gökmen and Senyuva (2006) investigated the effect of heating on the colour parameters of wheat flour. László et. al. (2008) examined effects of ozone, UV and combined ozone/UV treatment on the colour of wheat flour. Lamsal and Faubion (2009) studied effect of an enzyme preparation on wheat flour and dough colour and depicted, that enzyme preparation did not improve lightness (L*) and yellowness (b*) of flour system, but benzoyl peroxide sharply reduced b*.
In our work we examined how the grain size affects the durum semolina's instrumentally measured colour characteristics. The correspondence between the colour characteristics and ash content of the durum semolina was also investigated.

2. MATERIALS AND METHODS

2.1. Examined materials

Durum semolina from 12 different production units were used for our measurements. From these 5 were form yield of 2007 and 7 form the yield of 2008. The grindings were separated into different grain-size fractions by screening.
The samples which were of 0-700 μm grain size were divided into the following fractions:

- 0-160 μm
- 160 μm – 250 μm
- 250 μm -315 μm
- 315 μm – 500 μm
- above 500 μm

500 grams of each sample were separated into the above mentioned grain size fractions using a screening machine. Consequently colour measurements were performed on each fraction of the semolina and the whole grinding also.

2.2. Analysis Methods

The colour measurement was carried out using a Hunter Miniscan spectrum based colour-analyzer.

For the colour characterization we applied the CIELab colour-system that is described in figure 1 For the colour description the L* lightness-, the a* redness-, the b* yellowness coordinates and the YI yellowness index were applied (Hunter, 1987).

Figure 1. The CIELab colour-space

The determination of the ash content was carried out following the MSZ 6369/3-87 standard (Flour analysis methods, Ash- and Sand-Content Determination).
The data was evaluated by regression analysis and variance analysis. The calculations were performed with the help of the STATISTICA 7.0 software.

3. RESULTS AND DISCUSSION

3.1. Influence of the grain size on the colour characteristics

To establish weather the grain size influences the colour-characteristics one-way analysis of variance (ANOVA) was performed. The result of the Bartlett and Cochran-probe confirmed the homogeneity of the variances, the Shapiro-Wilk test was applied to control the normality.
Table 1 shows the results of the variance analysis.
The significance-level values in the table suggest that the grain size has significant effect on the value of the L*, a*, b* colour coordinates and that of the YI yellowness index.

Table 1. Results of the variance analysis performed to determine the colour characteristics of the different grain-size fractions

Colour Characteristic	F -value	Significance level
L*	88.25	0.0001
a*	264.5	0.0001
b*	160.6	0.0001
YI	173.2	0.0001

In figure 2 and 3 mean values of the colour-characteristics measured on the different grain-size fractions with the confidence interval of 95% reliability are shown.

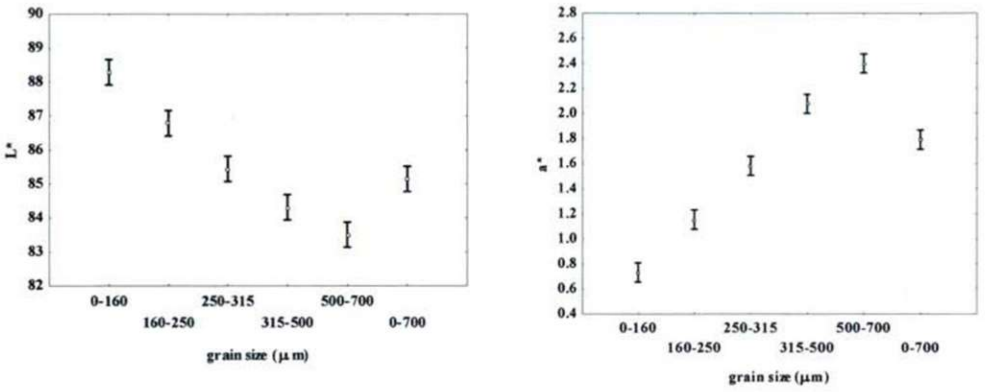

Figure 2. Effect of grain size on the L and a* colour coordinates (mean values with the confidence interval of 95% reliability)*

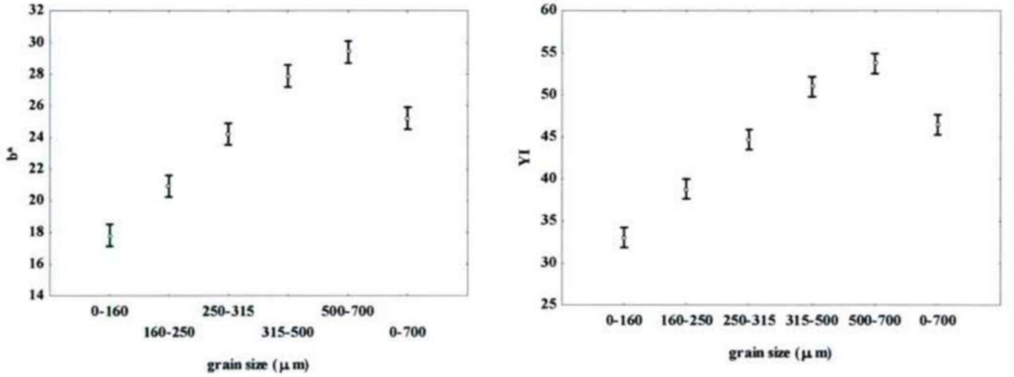

Figure 3. Effect of grain size on the b colour coordinate and the YI colour index (mean values with the confidence interval of 95% reliability)*

In figure 2 it can be observed that the L* lightness coordinate decreases with the increase of the grain size. The difference is the most significant between the mean of the 0-160μm and that of the 160 μm -250 μm fractions, although the difference is at least 1 unit also in the other cases. Thus the bigger grains are darker.

Figures 2 and 3 show that the a* redness and the b* yellowness coordinate and the YI yellowness index increases with the increasing grain size. On the average the a* coordinate increases by 0.5 unit, the b* coordinate by 3-4 units and the YI yellowness index by 5 units. That is to say that the colour of the bigger grains is slightly redder and yellower.

3.2. Variation of the ash content of different grain sized semolinas

The influence of the grain size on the ash content was valued using a one-way variance analysis. Table 2 contains the results of the evaluation. The significance value of the table shows that the grain size significantly influences the ash content. For a detailed analysis we can see the mean ash content values of each fraction of the different samples, with the confidence interval of 95% reliability.

Table 2. Results of the variance analysis performed to evaluate the ash content of the different grain size fractions

	F –value	Significance level
Ash content	35.73	0.0001

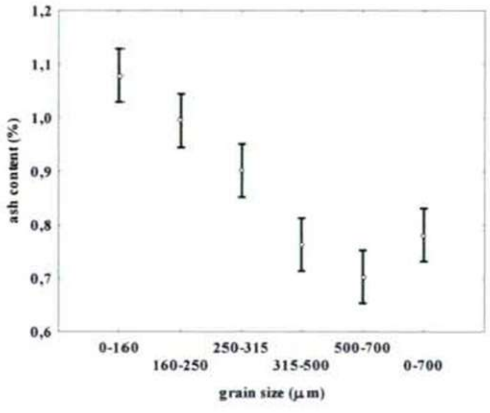

Figure 4. Effect of grain size on the ash content (mean values with the confidence interval of 95% reliability)

Figure 4. shows that the ash content decreases when the grain size increases. The mean ash content varied from 0.7% to 1.1%. The ash content of the whole grinding is equal to that of the 315μm-500μm fraction. The difference between the ash content of the subsequent grain size fractions is of 0.1%.

3.3. The relationship between the colour characteristics and the ash content

We examined weather there is a connexion between the ash content of the semolinas and the single colour characteristics.

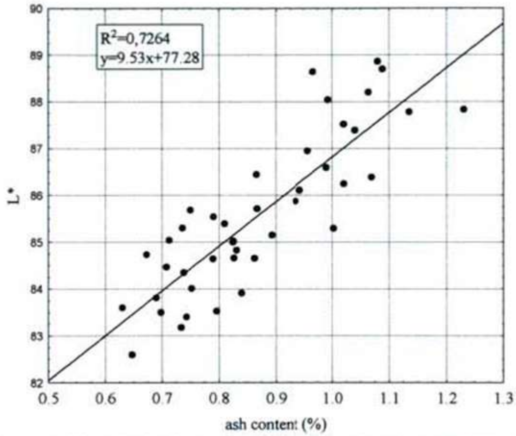

Figure 5. The L* lightness coordinate in function of the ash content

In figure 5 we can see the L* lightness coordinate measured in function of the ash content. In the figure the equation of the regression line and the determination coefficient is presented.

We can establish that there is a significant linear correlation between the ash content and the L* lightness coordinate ($p<0.01$). The L* lightness coordinate increases when the ash content increases, so the semolina with higher ash content are lighter.

In figure 6. we can observe the a* redness coordinate measured on the different samples in function of the ash content. In the figure the equation of the regression line and the determination coefficient is presented.

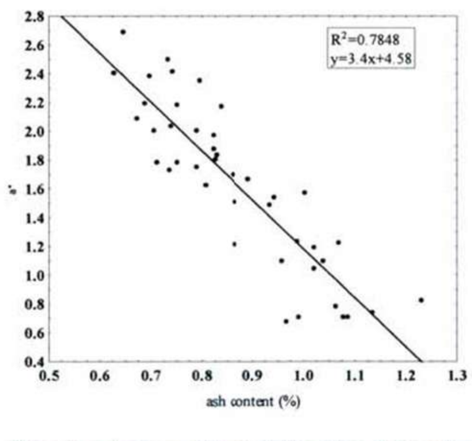

Figure 6. The a* redness coordinate in function of the ash-content

We can establish that there is a significant linear correlation between the ash content and the a* redness coordinate ($p<0.01$). When the ash content increases the a* redness coordinate decreases thus the semolina with higher ash content are less red toned. In figure 7. we can observe the b* coordinates measured on the different samples in function of the ash content. In the figure the equation of the regression line and the determination coefficient is presented. We can establish that there is a significant linear correlation between the ash content and the b* yellowness coordinate ($p<0.01$). The b* yellowness coordinate decreases with the increase of the ash content, consequently the semolina with higher ash content are less yellow.

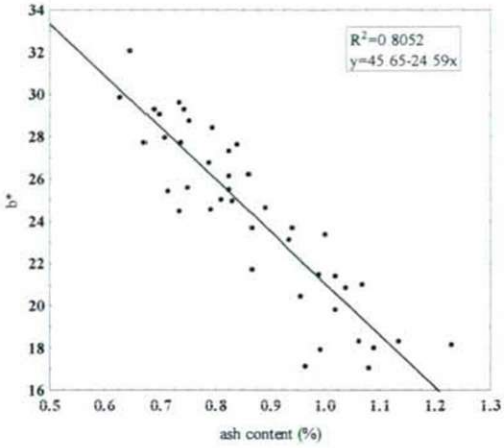

Figure 7. The b yellowness coordinate in function of the ash content*

In figure 8 we can observe the YI yellowness index measured on the different samples in function of the ash content. In the figure the equation of the regression line and the determination coefficient is presented.

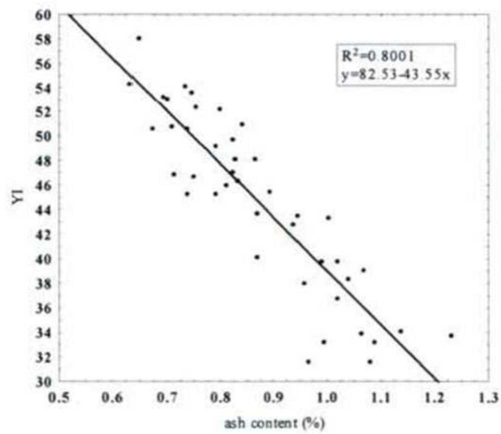

Figure 8. The YI yellowness index in function of the ash content

We can establish that there is a significant linear correlation between the ash content and the YI yellowness index similar to the one between the ash content and the yellowness coordinate ($p<0.01$). With the increase of the ash content the YI yellowness index decreases accordingly the semolina with higher ash content are less yellow.

4. CONCLUSIONS

In the pursuance of our investigations we analysed the instrumentally measured colour coordinates and ash content of the different grain size fractions of 12 durum semolina samples. On the basis of the statistical analysis we found the following.

- The grain size significantly influences the L* lightness the a* redness and the b* yellowness coordinate as well as the YI yellowness index.
- The ash content is lower when the grain size is smaller. The mean ash content varied between 0.7% and 1.1%. The ash content of the whole grinding is equal to that of the 315 μm -500 μm grain size fraction. The average difference between the ash content of the subsequent grain size fractions is of 0.1%.
- There's a significant correlation between the ash content and every single colour coordinate.

REFERENCES

1. Hunter R. (1987): The measurement of appearance.
2. Oliver, J., Blakeney A., Allen H.(1993): The colour of fluor strems related to ash and pigment contents. Journal of Cereal Science, 17(2), 169-182.
3. Halászné-Fekete, M., Záhonyiné-Racs, P., Keleti, Á.(1995): Colour measurement of durum grists for aim of qualification in paste industry. Book of the XXVth Colouristic Symposium, 41-48.
4. D'Egidio, M., Pagani, M.(1997): Effect of the different Stage of durum Wheat chain on pasta colour. Italian Food & Beverage Technology, 10, 17-20.
5. Hotti, A., S., Sidhu, J., Al- Sager, J.(2000): Utillty of CIE tristimulus system in measuring the objective crumb colour of high –fibre toast bread formulation. Journal of Food Quality, 23(1), 103-116.
6. Horváth, Zs., Fekete, M., Lakatos, A.(2004): Instrumental Colour Measuring for weathen grits. Cercetarea Stiintifica O Punte Spre Integrarea Europeana Simpozionului Cu Participare Internationala, Arad, Analele, 83-88., 2004.
7. Konopka, I., Kozirok, W., Rotkiewicz, D.(2004): Food Research International, 37(5), 429-438.
8. J. M. Humphries, R. D. Graham, D. J. Mares (2004): Application of reflectance colour measurement to the estimation of carotene and lutein content in wheat and triticale Journal of Cereal Science 40. 151-159.
9. Vural Gökmen, Hamide Z. Şenyuva (2006): Study of colour and acrylamide formation in coffee, wheat flour and potato chips during heating Food Chemistry 99. 238-243

Zs. László, Zs. Hovorka-Horváth, S. Beszédes, Sz. Kertész, E. Gyimes, C. Hodúr (2008): Comparison of the effects of ozone, UV and combined ozone/UV treatment on the colour and microbial counts of wheat flour Ozone Science & Engineering Journal, 30(6), p. 419-417

10. B.P. Lamsal, J.M. Faubion (2009): Effect of an enzyme preparation on wheat flour and dough color, mixing, and test baking Food Science and Technology 42, 1461-1467.