Research Article

Effects of Flour Particle Size on Farinographic Properties of Wheat Dough

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Abstract | Effects of flour particle size on the rheology of whole wheat flour were investigated by using farinograph. Two types of wheat (*Triticum aestivum* L.) on the basis of hardness, hard and soft wheat, were analysed in this study. Each type of flour was fractionated separately into coarse (1000 to 1500µm), medium (500 to <1000 µm) and fine (<500 µm) fractions on the basis of particle size. All the farinographic parameters (except dough development time) were influenced by particle size of wheat flour. Water absorption was negatively related with flour particle size. Dough stability was positively related to flour particle size whereas the degree of softening was negatively related with flour particle size. However, there was insignificant and non-consistent effects were found on dough development time. The information generated from this study would be useful in the preparation of whole wheat flour products including traditional flat bread and fiber enriched items.

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Introduction

The rheological characteristics of the dough play a very important role in behavorial assessment of dough processing and quality of the end product. (Hruskova *et al.*, 2006). Dough properties, especially rheological characteristics of the dough, are useful to understand machinablity of the dough (Amjid *et al.*, 2013). Gluten is the key component that regulates the rheology of dough (Mikhaylenko *et al.*, 2000). In general, the wheat hardness, wheat genotype and environment conditions of crop may lead to vary the rheological properties of dough (Denčić *et al.*, 2011). There is a long history of predicting baking behavior in the bakery using measurements of rheological properties of dough prior to baking. Various rheological instruments, such as farinograph, extensigraph and alveograph have been used to derive parameters that have been related to baking performance.

Farinograph is the most commonly used instrument for dough testing throughout the world. In farinograph, mixing of flour and water is possible by using energy (a combination of shear and extensional deformations) for the formation of dough (Campos *et al.*, 1996, 1997; Schluentz *et al.*, 2000). The resistance to mixing, resulted from the dough mixing at constant speed, is recorded and produces farinogram. The farinogram (recorded curves) provides the information about changes in rheological properties during mixing. Farinograms typically consist of a rising part, reflecting an increase in resistance with mixing time, and a more or less identifiable peak

followed by a decrease in resistance.

Factors that influence the farinogram can be placed into three categories: Flour constituents, baking ingredients, and physical factors. It is well documented that the starch granules and gluten proteins play important roles in the rheology of dough (Cappelli *et al*., 2020). Many workers have described that the rheological behavior of doughs is affected by the mixing process including type of mixing apparatus, energy input, mixing time, and mixing speed (Jansen *et al*., 1996a, b). However, few studies had been focused on the effects of physical attributes of flour on the rheological characteristics of the dough. The present study has therefore been undertaken to analyze the effects of particle size of wheat flour on the physical characteristics of dough using Brabender farinograph.

Materials and Methods

Two types of wheat samples with distinct quality of hard and soft wheat were used in this study. The wheat grain samples were mixed thoroughly by precision electronic divider (Seedburo equipment company, model no. SB106) and thereafter cleaned manually. All the analysis was carried out at Grain Quality Testing Laboratory, PARC, and Karachi.

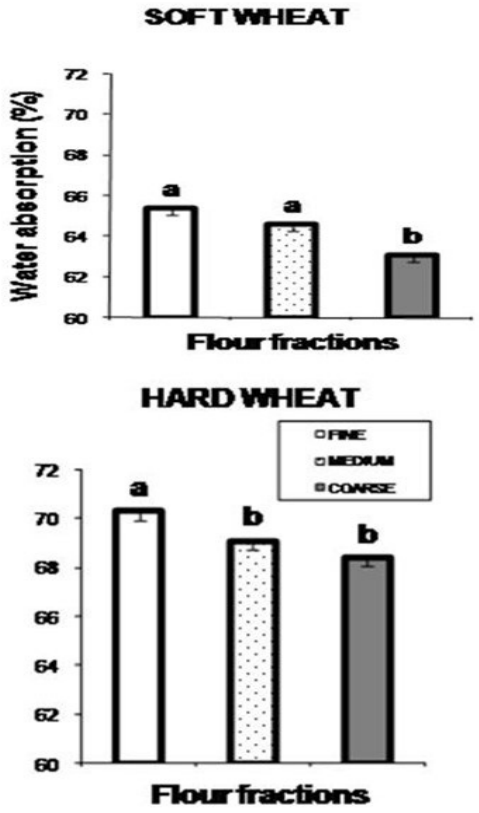

Figure 1: *Effect of flour particle size on water absorption of wheat flours.*

The cleaned wheat samples were milled into flour through a Brabender Quadrant Junior Mill according to the procedure AACC 26-50 (AACC, 2000). Both flours were sieved separately into 1000 to 1500µm; 500 to <1000µm and <500µm particles and these fractions were designated as coarse, medium and fine flours respectively.

The farinograph equipped with 50g mixing bowl was used for the evaluation of water absorption (%), dough development time (min), dough stability (min) and degree of softening (BU) by following the method number AACC 54-24 (AACC, 2000).

Each sub-sample was analyzed in triplicate for farinographic properties. Duncan's test (at $P<0.05$) was used to separate flour fractions according to their farinographic properties using SPSS software (SPSS version 17, Inc., USA).

Results and Discussion

Water absorption (WA) percentage demonstrates the amount of water required to make dough of flour to the desired consistency. The effects of flour particle size on water absorption were determined in this study. Hard and soft flours were used in order to cover the range of flour quality. It was found that hard flours had greater water absorptions than soft flours. It may be due to the fact that hard flours contained higher levels of proteins, damaged starch and strong gluten. Water absorption of wheat flour is known to influence by protein content, starch damage, pentosans and gluten strength (Zaidul *et al*., 2004; Lee *et al*., 2001). It is apparent from Figure 1 that three fractions of both hard and soft wheat flour showed different percent water absorptions. Fine flours of hard and soft wheats showed higher WA than medium and coarse flours. Hard and soft wheat possess differences in structures of endosperms that leads to cause differences in their milling properties. During the milling of soft textured wheat, wheat cracks across the dehydrated endosperm, while in hard type wheat cleavage occurs along the lines of cell walls of endosperms. Furthermore, medium flours exhibited greater WA than coarse flours. The higher absorption indicates that more water is required to reach a desired consistency in a commercial process (Aydoğan *et al*., 2015). It is evident that the WA negatively related with the flour particle size as shown in Figure 2. The increase in WA was found to be

almost linear with the decrease in flour particle size as interpreted from greater R^2 values. Figure 3 showed that the magnitude of increase in WA is presented in terms of differences in WA values of flour fractions. The highest differences were observed in between fine and coarse flour fractions of both hard (1.9%) and soft (2.3%) wheat flours.

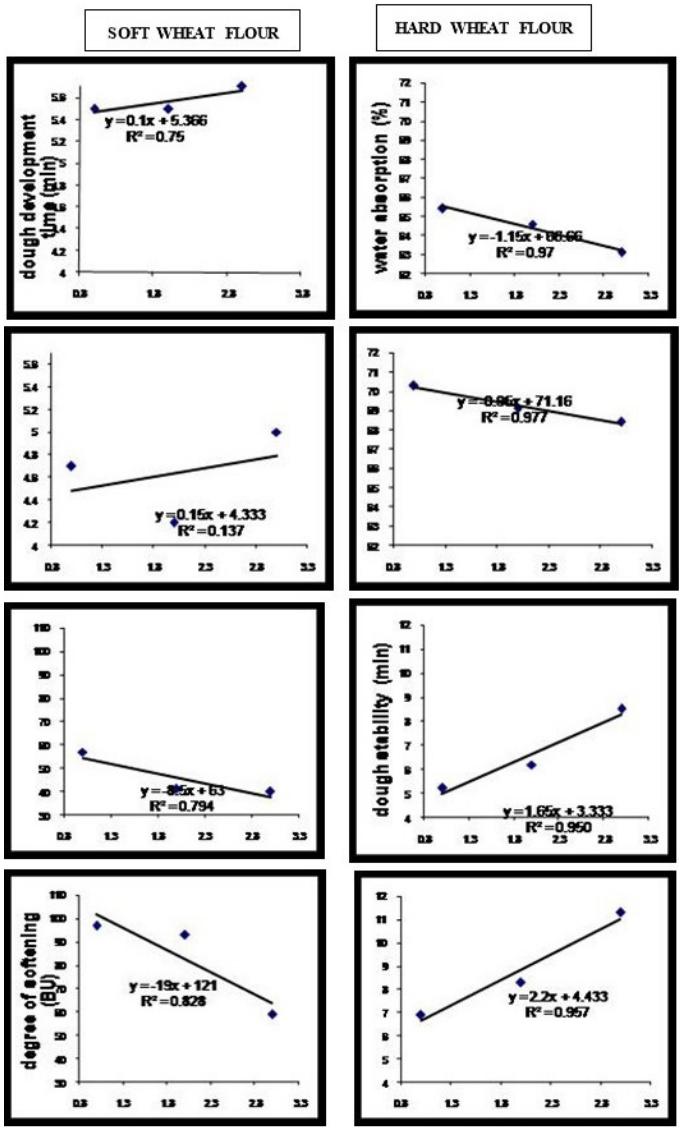

Figure 2: *Effect of flour particle size on dough properties of hard and soft wheat flours.*

Dough stability generally indicates the tolerance of flour during mixing (Sarker *et al.*, 2008). It was found that hard flours showed greater dough stabilities than soft flours Figure 1. Dough stabilities of three fractions of flours (of both types) were found to be different from that of each other. Within a same flour type, the higher dough stabilities were shown by the flour fractions that contained flour particles <1500µm. This relationship was found consistent and the flour fraction consisted of <1000µm particles exhibited greater dough stability than <500µm flour. Thus, the stability of dough was positively related to the flour particle size.

Degree of softening (DS) generally gives the rate of breakdown and strength of flour. Higher value of DS interprets the weaker strength of flour. Degree of softening was also affected by the particle size of flour as all flour fractions showed different degree of softening. The relationship of degree of softening was negative with flour particle size. The lower sized particles containing samples exhibited higher degree of softening.

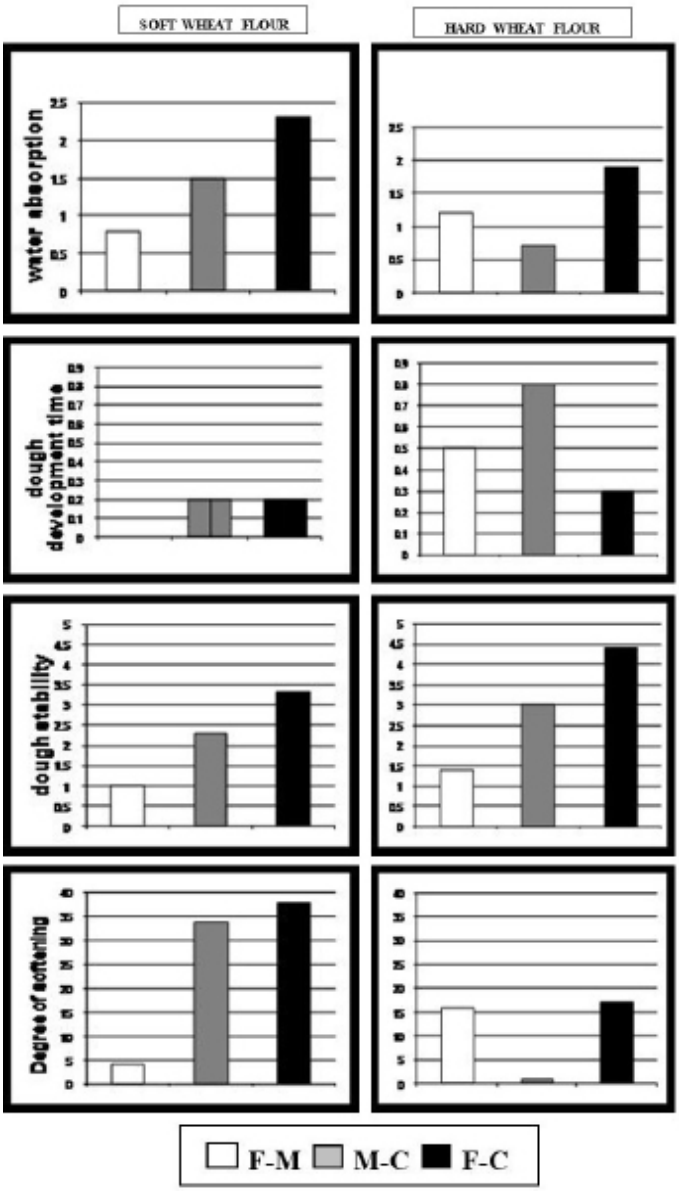

Figure 3: *The difference between dough properties of fine, medium and coarse flours. F-M: difference between fine and medium flours; M-C: difference between medium and coarse flours; F-C: difference between fine and coarse flours.*

Figure 3 showed that no significant difference was observed in dough development times of flour fractions in soft wheat flours. In hard wheat flours,

there was no consistency in dough development time with flour particle size. Thus, the significant relationship among the flour particle size and dough development time cannot be established on the basis of these results.

Conclusions and Recommendations

The effects of flour particle size on physical properties of dough were studied. For this, two types of wheat flours (hard and soft) were fractionated into three portions on the basis of particle sizes. All the dough properties (except dough development time) were affected by flour particle size. The larger particle size of wheat flour absorbs less water for producing optimum dough and yield more stable dough than smaller particle size of wheat flour and vice versa.

Novelty Statement

Research study comprise of originality and novelty. The research carried out revealed the impacts of particle size of wheat flour on the rheological parameter of farinographic properties.

Author's Contribution

Qurrat ul Ain Akbar: Designed the study, analysed the results and wrote the manuscript.
Saqib Arif: Designed the study, analysed the results.
Shahid Yousaf and Salman Khurshid: Analysed the samples and data.
Najmus Sahar: Analysed the data.

Conflict of interest

The authors have declared no conflict of interest.

References

American Association of Cereal Chemists, 2000. Approved methods No. 38 – 12, 56 – 81 B, 54-24, Minnesota.

Amjid, M.R., A. Shehzad, S. Hussain, M.A. Shabbir, M.R. Khan, M. Shoaib. 2013. A comprehensive review on wheat flour dough rheology Pakistan. J. Food Sci., 23(2): 105-123.

Aydoğan, S., M. Şahin, A.G. Akçacik, S. Hamzaoğlu and S. Taner. 2015. Relationships between farinograph parameters and bread volume, physicochemical traits in bread wheat flours. J. Bahri Dagdas Crop Res., 3(1): 14-18. www.arastirma.tarim.gov.tr/bahridagdas

Campos, D.T., J.F. Steffe and P.K.W. Ng. 1996. Mixing wheat flour and ice to form undeveloped dough. Cereal Chem., 73: 105-107.

Campos, D.T., J.F. Steffe and P.K.W. Ng. 1997. Rheological behaviour of undeveloped and developed wheat dough. Cereal Chem., 74: 489-494. https://doi.org/10.1094/CCHEM.1997.74.4.489

Cappelli, A., N. Oliva and E. Cin. 2020. Review a systematic review of gluten-free dough and bread: Dough rheology, bread characteristics, and improvement strategies. Appl. Sci., 10: 6559. https://doi.org/10.3390/app10186559

Denčić, S., N. Mladenov and B. Kobiljski. 2011. Effects of genotype and environment on breadmaking quality in wheat. Int. J. Plant Prod., 5(1): 1735-6814.

Jansen, A.M., T.V. Vilent and J.M. Vereijken. 1996a. Rheological behaviour of wheat glutens at small and large deformations. Effect of gluten composition. J. Cereal Sci., 23: 33-42. https://doi.org/10.1006/jcrs.1996.0003

Jansen, A.M., T.V. Vilent and J.M. Vereijken. 1996b. Rheological behaviour of wheat glutens at small and large deformations. Comparison of two glutens differing in bread making potential. J. Cereal Sci., 23: 19-31. https://doi.org/10.1006/jcrs.1996.0002

Hruskova, M., I. Svec and O. Jirsa. 2006. Correlation between milling and baking parameters of wheat varieties. J. Food Eng., 77: 439-444. https://doi.org/10.1016/j.jfoodeng.2005.07.011

Lee, L., P.K.W. Ng, J.H. Whallon and J.F. Steffe. 2001. Relationship between rheological properties and microstructural characteristics of nondeveloped, partially developed, and developed doughs. Cereal Chem., 78(4): 447-452. https://doi.org/10.1094/CCHEM.2001.78.4.447

Mikhaylenko, G.G., Z. Czuchajowska, B.K. Baik and K.K. Kidwell. 2000. Environmental influences on flour composition, dough rheology and baking quality of spring wheat. Cereal Chem., 77: 507-511. https://doi.org/10.1094/CCHEM.2000.77.4.507

Sarker, M.Z.I., H. Yamau CHi, S.J. Kim, C. MatSuura-endo, S. Takigawa, N. HaSHimoto and T. Nnoda. 2008. A Farinograph study on dough characteristics of mixtures of wheat flour and potato starches from different cultivars.

Food Sci., Technol. Res., 14(2): 211–216. https://doi.org/10.3136/fstr.14.211

Schluentz, E.J., J.F. Steffe and P.K.W. Ng. 2000. Rheology and microstructure of wheat dough developed with controlled deformation. J. Texture Stud., 31: 41-54. https://doi.org/10.1111/j.1745-4603.2000.tb00283.x

Zaidul, I.S., M.A.A. Karim, D.M.A. Manan, A.A. Ariffin, N.A.N. Noruliani and A.K.M. Omar. 2004. A farinograph study on the viscoelastic properties of sago/wheat flour dough systems. J. Sci. Food Agric., 84: 616-622. https://doi.org/10.1002/jsfa.1713