*Pak. J. Bot.*, 49(SI): 383-387, 2017.

# IMPACT OF DISTINCT COMPOSITIONAL VARIATIONS IN FLOURS OF VARIOUS MILLED STREAMS ON DOUGH BEHAVIOR AND END QUALITY OF BAKED PRODUCTS

**RAHIL AHMED[1,2*], RASHIDA ALI[1,2,3], SYED ASAD SAEED[1], SYED MUHAMMED GHUFRAN SAEED[1] AND LUBNA MOBIN[1]**

*[1]Department of Food Science and Technology, University of Karachi, Karachi, Pakistan*
*[2]English Biscuit Manufacturers (Pvt.) Limited, Karachi, Pakistan*
*[3]Department of Food Science and Technology, Jinnah Women University, Karachi, Pakistan*
*Corresponding authors e-mail: rahilahmed_fst@hotmail.com*

## Abstract

Each flour mill produces number of break and reduction streams with distinct differences in physicochemical characteristics of flours which at the end of processing are blended to produce “composite flours” that is dispatched to various baking units making breads, cakes, pasta, biscuits, burgers, rolls, pizza etc. Milling streams vary in physical, nutritional, sensorial and textural properties of the bakery products as indicated by variations in properties such as the particle size, color and composition. The influential chemical parameters include endosperm and bran proteins, starch and damage starch, non-starch polysaccharides and ash, while physical parameters include particle size, water absorption and bulk density etc. Type of mills used in processing (dry/wet, ball, stone, roller and hammer mills) also show impact on particle morphology, its size distribution, crystalline structure and pasting properties etc. Flour particle size, damage starch, protein, ash content determine the rheological properties of dough as the water absorption, dough development time and dough stability that are interlinked to shape, size, weight and volume of the end product. Type of grain, tempering/conditioning of grain, inducing enzyme treatment drastically affect the end quality. The oxidative cross-linking potential of various streams depends on the processing and blending the steams. It significantly shows that blending requires selection of suitable specific streams that will produce the desired composite flour ideal for bakers. The present study is based on exploring the physicochemical properties of 6 break streams and 14 reduction streams, its influence on dough behavior and finally the impact of dough rheological characteristics on the end quality of biscuit. It shows that flour functionality suitable for biscuit production may be achieved by altering milling and blending techniques. Conclusively we may say that a strong professional link between millers and processors is missing and highly skilled manpower is strongly needed at both the ends to supervise the processing of wheat for bakery products in Pakistan.

**Keywords:** Milling streams, Farinograph, SRC, physicochemical parameters, rheological behavior, end quality

## Introduction:

It is not well accepted yet at the biscuit manufacturer level that an ideal flour for a specific recipe may not be suitable for another type of cookie’s recipe. The wide compositional variation in the recipe, such as in the quantities of fat, sugar and additives leave no option for biscuit processors but to select ideal flour according to the recipe with the help of millers. The ideal flour will produce optimal dough by adjusting the quantity of water added (Fustier *et al.*, 2009). Flour functionality not only depends upon proportion of hydrophilic components present but also on the amount of available water in presence of sugar and additives in the recipe. The technological difficulties encountered such as dimensional, weight, surface Island (top grain), color etc. faced by the processors may be reduced by proper blending the flour streams at the millers end (Rogers *et al.*, 1993). Biscuit making quality of mill streams depends partly on the protein contents that is why early break and early reduction streams are preferred for biscuit making as the protein contents increases both in break and reduction streams with the flow toward tail streams (Madhugiri *et al.*, 2008). Hard flour consisting more protein requires excess water and reduces the biscuit spread (Miller *et al.*, 1997). Higher protein contents, substitution of legume proteins or proteins other than wheat, produced biscuit of hard texture and of lower spread ratio which also showed lower cutting strength due to the decrease in hardness of dough (Dipika *et al.*, 2014). Granulation and particle size are the important factors to produce quality flour. Large mean particle size are produced more in hard wheat as compared to the soft wheat. The (1st and 2nd roller) streams either from the break or reduction have better distribution of small, medium and large particle size of flour. Flour particle size is linearly related to the contents of damaged starch and like the protein content both increase with the number of streams. Streams at the end will have more damaged starch that will absorb more water and will spreads less (Barak *et al.*, 2012).

Wheat flour quality may be evaluated on the basis of damaged starch which varies widely among the streams and indicate the importance of careful blending process for getting the desired flour (Ali *et al.*, 2014). The pentosan contents vary in different streams that are present in the highest amount in starch tailing that increases consistency and the density of the dough that makes biscuit heavy weight, harder and of reduced diameter. The dough rheology is directly related to its chemical composition that is also affected by even water stress during growth of the crop. It has been noticed in the drought area that kernel weight, protein, its amino acid composition including the lysine content vary significantly (Noorka *et al.*, 2009 and Ahmad *et al.* 1999). Insects attach is also responsible for variety of compositional changes, Khapra beetle larvae reduced 20% grain weight during the storage (Ahmedani *et al.*, 2009 & 2011). The nutritional losses were also visible after larvae infestation.

The true assessment of the baking performance of wheat flour is commonly achieved through two predictive tests as the sugar snap cookies and Japanese sponge cake. The tests when applied to evidence the functional variation between straight grade flour (SGF) with 75% ER and patent (P) with 60% ER showed that stream blending is a greater source of compositional differences than the selection of different grains. Biscuits of larger diameter were produced from (P) flour which consisted less ash, water extractable arabinoxylans and protein than SGF. Apart from protein quantity, the quality also changed. More viscous dough was produced from P flour because of enhanced endogenous cross linking among protein molecules than in SGF (Ramseyer *et al.*, 2011). Biscuit length and stickiness is related to density elasticity and stickiness of the dough, arise in dough temperature > 35 $^{0}$C induces increase in viscoelasticity that causes biscuit shrinkage.

The extent of compositional changes are different in the two streams, it has been noticed that the amount of disulfide bridges produced are higher in break/reduction rollers streams than in bran flour which had more HMW glutenins (Iqbal *et al.*, 2015). The biochemical parameters that may be identified as the responsible constituents of the soft wheat flour functionality for biscuit making quality are gluten, water soluble and starch fractions isolated from three different flour grades i.e. patent, middle cut and clear flours. Further in view of the constituent interactions the dough rheological behavior, baking performance and end quality were significantly affected (Fustier *et al.*, 2008.). Wide compositional differences were observed in flour streams obtained from patent (middle of kernel), middle cut layer in between patent and clear or the layer just after bran, JAB) and clear flour grade (peripheral part) that consequently affected dough properties and end quality. Dough from patent flour moving towards clear flours increased in the hardness/consistency and become less sticky that alter the end quality. Biscuit from patent are larger, thinner than biscuits from clear flour that are heavy weight because of greater cohesion (tearing force) and more grains (Fustier *et al.*, 2009.). Impact of compositional and dimensional differences are also visible in flour streams made with native and reconstituted flours.

The milling steams vary in composition because of milling softness (less mechanical pressure) controlling protein content, damaged starch, pentosan and ash that in turn affects cookies diameter. A simple sucrose-SRC test has been developed to predict the diameter (Gains, C. S., 2004 and Kaur *et al.* 2014).

The present study 6 break and 14 reduction streams were separately studied to point out variations that will help in blending the streams for desired biscuit production.

## Material and Method

Commercially available soft wheat was milled by Garibsons Private Ltd. Karachi, 6 flour samples from break and 14 samples from reduction stages were collected. The entire chemicals used were of analytical grade and were purchased from the distributor of Sigma in Pakistan, Labline Pvt. Ltd.

**Physicochemical analysis:** Flour moisture content was determined using Brabender moisture analyzer (Duisburg, Germany) according to AACC approved method (44-19) by drying 9 - 11 gm of flour at 155 °C for 20 minutes. Ash and protein content were obtained using Brabender Kernelyzer (Omega Analyzer, Bruins Instruments, (Germany). Flour particle size was obtained by Fritsch vibratory sieve shaker (Oberstein, Germany) set at 2 mm amplitude for 10 minutes and the percentage of sizes <160, 160 to 100 and >100 were used. Results are given in Fig. 1.

**SRC profile:** SRC profile obtained is based on the International Method No. 56 - 11 (AACC 2000) with some modifications. Flour samples (1g) were suspended in either of 5% sodium carbonate, water, 50% sucrose solution or in 5% lactic acid solution to hydrate the flour for 20 min (each vortexed for 5 second at 5, 10, 15, and 20 minutes) and then centrifuged at 1,000 × g for 15 minutes. The supernatant in each case was decanted and the tube was drained at a 90° angle for 10 min on a paper towel. The precipitates obtained were weighed and the SRC value for each sample was calculated according to Haynes *et al.*, (2009) as described in International Method No. 56 - 11 (AACC, 2000).

All sodium carbonate SRC analyses were at least performed in triplicate and the coefficient of variation of the SRC values was less than 2.0%. The results are reported in Fig 2.

**Farinograph parameters:** The rheological properties of dough were determined using Brabender Farinograph-E (Duisburg, Germany) according to AACC method 54-21. A flour sample of 300 grams (14 % moisture basis) was placed into the Farinograph mixing bowl. Water from a burette was added to the flour to reach the center of the curve on the 500- Farinograph unit (FU) line. Water absorption (WA), dough development time (DDT), DoS, Farinograph quality number (FQN), consistency and dough stability (DS) were recorded. Results are given in Fig 3.

**Biscuit preparation:** Biscuits were produced according to the recipe consisting flour (500g), sugar (150g), invert syrup (8g), vegetable fat (120g), skimmed milk powder (8g), ammonia (5g), baking powder (1g), salt (3g), lecithin (0.5g) and water (62ml). The dough was prepared by mixing the ingredients for 2 minutes and 30 seconds.

**Dimensional analysis:** Diameter (mm) and weight (g) of cookie were determined by the standard method taking mean of 6 biscuits and the results are given in Table 1.

**Table 1. Sensory analysis of end product**

| Sample Name | Water Absorption | Diameter | Thickness | Cookie Factor |
|---|---|---|---|---|
| BR - 1 | 50 | 49.5 | 6.1 | 8.11 |
| RR - 7 | 67.9 | 47.1 | 6.3 | 7.48 |
| RR - 11 | 59.5 | 48.3 | 6.2 | 7.79 |

**Statistical Analysis**

Data were analyzed using bar graph of MS Excel 2013. All values are a mean of minimum three readings.

**Result and Discussion**

**Physicochemical variations in break and reduction streams:** The physicochemical parameters including moisture, protein and particle size are compared in Fig 1. The mean moisture contents of break streams are higher than moisture present in reduction streams because with flow in milling process resulting in size reduction and increase in surface area, moisture evaporates steadily. Another factor in moisture reduction is the rise in temperature of the flour due to higher input of mechanical energy as the time for processing increases. Protein percentage in both the streams remain similar. However, significant variation was observed in particle size as sifting through 125 um sieve produced 42.25% of larger particles as compared to 13.22% of particles <125 um, while as expected in the bottom streams larger particles ere 57.23% and fine particles represented 86.52%.

**SRC analysis:** The results of flour SRC analytical tests are compared in Fig 2. The sodium carbonate absorption capacity was less in break streams 86.23% than in reduction streams 103.86%. Sodium carbonate SRC swelling capacity represents presence of damage starch which is produced more during reduction. The difference in sucrose solution absorption is not visible which represents the presence of pentosan and gliadins, however lactic acid absorption that is related to gluteneins content is less in break streams as compared to reduction streams. It is in agreement with the results as mentioned earlier (Liu, *et al*, 2015) the possibility of cross linking of gluten proteins during milling producing more HMW glutenins is increased as shown by lactic acid absorption and water absorption.

**Farinograph parameters:** The Fig. 3 shows the comparative statement of Farinograph parameters for the average of two mill streams (break and reduction). Farinograph quality no FQN which is related to consistency did not change much showing the stability. However WA capacity of reduction stream is higher 64.86% as compared to break streams (56.25%) that consequently increased dough development time. DDT in case of reduction stream flour also indicated the increase in SRC – Lactic acid value for reduction streams (more HMW gluteneins). Presence of higher amount of glutenins results in increase of WA, mixing time and the higher values for DDT. Increase WA, DDT and lactic acid – SRC make dough more stable as shown by dough stability DS higher in case of reduction streams (4.5 min) as compare to break stream 4.25 min. Dough degree of softening (DoS) as a result of decreased in reduction stream 68.93BU compared to break streams 89.00.

**End quality evaluation:** Various physicochemical properties of the flours from the two streams were evaluated which were found to be correlated to dough behavior and the end quality of biscuits (Charun, *et al*, 2000). The relationship of water absorption capacities of the flours from break and reduction streams with respect to the cookies factors (diameter/thickness) are shown in the Table 1. The WA of flours from reduction roll (RR) 7 and 11 is higher than flour from break roll (BR), that caused decrease in diameter and increase in thickness resulting in reduced cookies factors in case of biscuits made from RR flour.

Results have shown that streams blending process should be carefully carried out after thorough study of the physicochemical characteristics of flours from various streams.

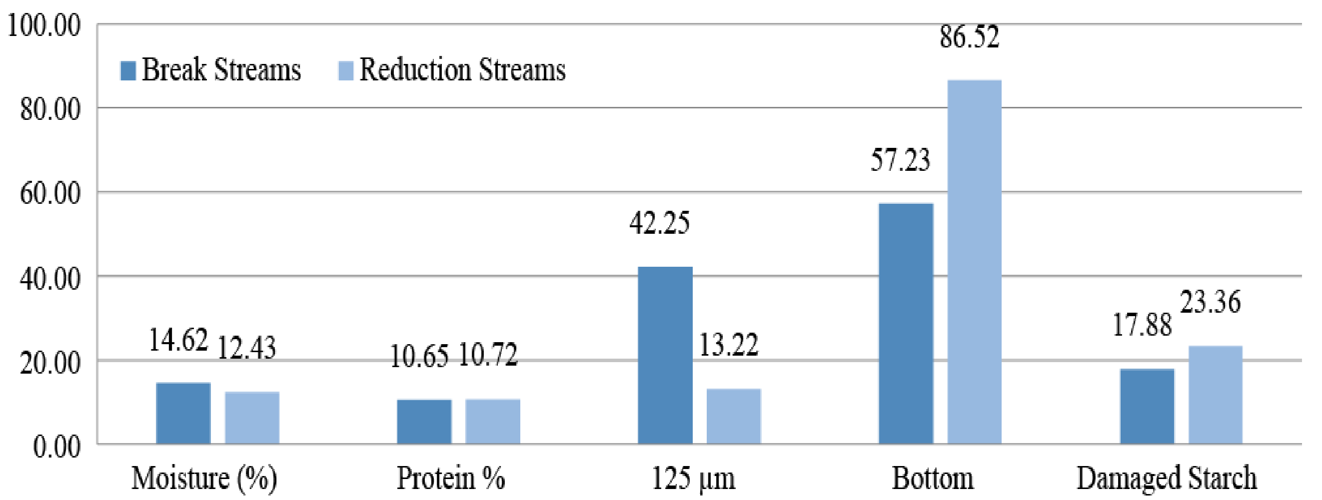


Fig. 1. Milling streams Vs. Physicochemical Parameters

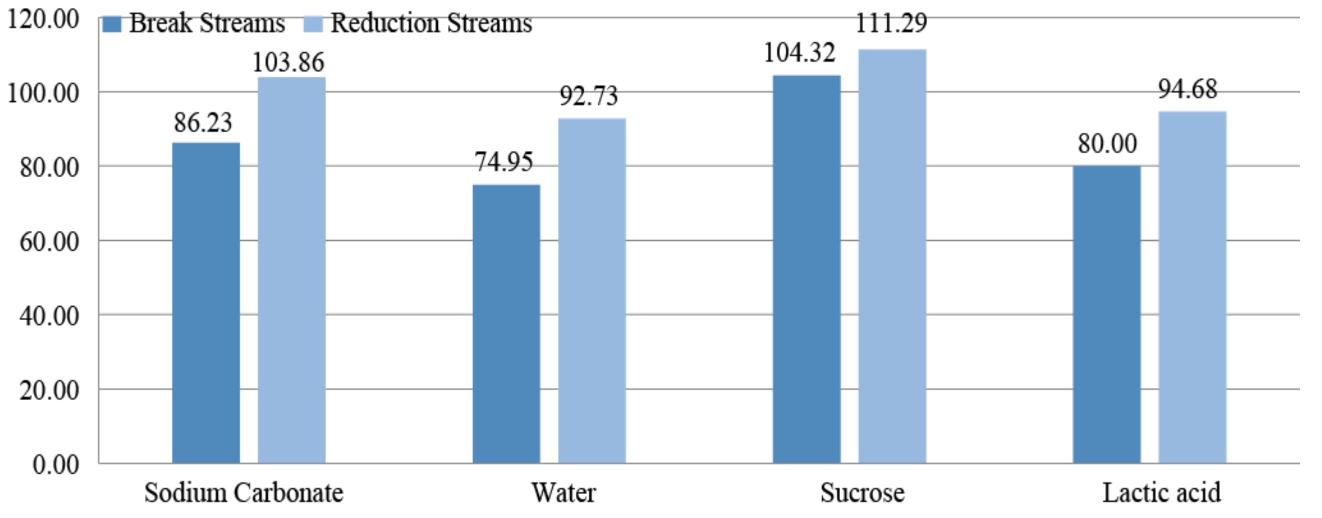


Fig. 2. Milling streams Vs. SRC

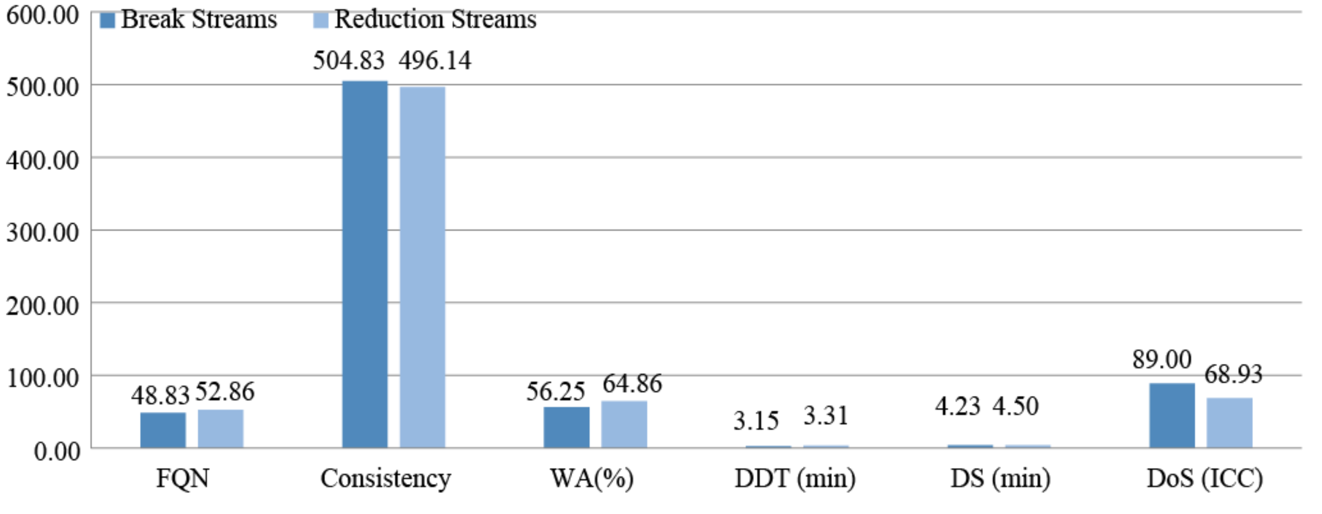


Fig. 3. Milling streams on Farinograph Parameters

## Conclusion

The study has elaborated that dimensional qualities of biscuit are dependent on the milling process producing variety of flours from BR and RR that differ widely in their chemical composition. Moreover the blending of the streams is equally an important technical process that needs qualified staff who is able to understand the constant compositional changes taking place in streams with the flow of milling proceeds. The end quality of biscuit depends on the chemical constituents present in composite flour that is produced after selection of certain streams based on their chemical composition and the blending the collected streams in the appropriate proportions.

Similar studies during the last few decades have clearly demonstrated that a strong coordination and collaboration are required between growers, millers and processors to grow the desired variety of kernel, to produce the identified streams of specific chemical composition and then to blend them to produce the required specific composite flour. It is the baker's responsibility to identify the chemical and physical characteristic of the desired flour suitable for their bakery products.


## Acknowledgment

The authors are grateful to DR. Zeelaf Munir and Ms. Saadia Naveed for supporting the research activities and for the financial support. The cooperation from the technical staff is greatly appreciated


## Reference


Ahmad, M. and M.A. Arain. 1999. Effect of dough simulation on grain weight, protein and lysine content of bread wheat. *Pak. J. Bot*., 31(1):109-114.

Ahmedani, M.S., M.I. Haque, S.N. Afzal, M. Afzal, M. Aslam and S. Naz. 2009. Varietal changes in nutritional composition of wheat kernel (*Triticum Aestivum* L.) by khapra beetle infestation. *Pak. J. Bot.*, 41(3): 1511-1519.

Ahmedani, M.S., M.I. Haque, S.N. Afzal, M. Naeem, T. Hussain and S. Naz. 2011. Quantitative losses and physical damage caused to wheat kernel (*Triticum Aestivum* L.) by khapra beetle infestation. *Pak. J. Bot*., 43(1): 659-668.

Ali, R., M.S. Khan, S.A. Sayeed, R. Ahmed, S.M.G. Saeed and L. Mobin. 2014. Relationship of damaged starch with some physicochemical parameters in assessment of wheat flour quality. *Pak. J. Bot*., 46(6): 2217-2225.

Barak, S., D. Mudgil, B.S. Khatkar. 2012. Effect of flour particle size and damaged starch on the quality of cookies. *J. Food Sci. Technol*., DOI 10.1007/s13197-012-0627-x

Charun, E., J. Abecassis, A.S. Contamine, T.M. Roulland, B. Vergnes, M.H. Morel. 2000. Effect of temperature and mechanical input on semisweet biscuit (cookie) quality and dough characteristics. *Cereal Chem*., 77(3): 265-271

Dipika, A.M, P. Gulati, N. Kotwaliwale and C. Gupta. 2014. Evaluation of nutritional, textural and particle size characteristcs of dough and biscuits made from composite flours containing sprouted and malted ingredients. *J. Food Sci. Technol*., DOI 10.1007/s13197-014-1597-y

Fustier, P., F. Castaigne. S.L. Turgeon and C.G. Biliaderis. 2008. Semisweet biscuit making potential of soft wheat flour patent, middle-cut and clear mill streams made with native and reconstituted flours. *J. Cereal Sci*., 46: 119-131.

Fustier, P., F. Castaigne. S.L. Turgeon and C.G. Biliaderis. 2009. Impact of commercial soft wheat flour streams on dough rheology and quality attributes of cookies. *J. Food Eng.,* 90: 228-237.

Gaines, C.S. 2004. Prediction of Sugar snap cookie diameter using sucrose solvent retention capacity, milling softness, and flour protein content. *Cereal Chem*., 81(4): 549-552.

Haynes, L.C., A.D. Bettge and L. Slade. 2009. Soft wheat and flour products methods review: solvent retention capacity equation correction. *Cereal Foods World*, 54(4): 174-175.

Iqbal, Z., I. Pasha, M. Abrar, M.S. Hanif and S.M. Arif. 2015. Protein concentrate, composition and distribution in wheat flour mill streams. Annals. *Food Sci and Tech.,* 16 (1).

Kaur, A., Singh, N., Kaur and K. Seeratpeet. 2014. Relationship of flour solvent retention capacity, secondary structure and rheological properties with the cookie making characteristics of wheat cultivars. *Food Chem*., 158: 48-55.

Liu, C., L. Liu, L. Li and X. Wang. 2015. Effects of different milling process on whole wheat flour quality and performance in steamed bread making. *Lebensmittel-wissenchaf und-technologie,* 62(1): 310-318.

Madhugiri, L. Sudha, R. Krishan and Leeavathi., 2008. Relationship between the protein content and cookie making quality of different mill streams. *Adv. Food Sci*. 30(2): 70-77.

Miller, R.A. and R.C. Hoseney. 1997. Factors in hard wheat flour responsible for reduced cookie spread. Cereal chem. 74: 330-336.

Noorka, I. R., S.U. Rehman, J.R. Haidry, I. Khaliq, S. Tabassum and G.M.U. Din. 2009. Effect of water stress on physico-chmeical properties of wheat (*Triticum Aestivum* L.). *Pak. J. Bot.*, 41(6): 2917-2924.

Ramseyer, D.D., A.D. Bettge and C.F. Morris. 2011. Flour mill stream blending affects sugar snap cookie and Japanese sponge cake quality and oxidative cross-linking potential of soft white wheat. *J. Food Sci*., 76(9): 1300-1306.

Rogers. D.E., R.C. Hoseney, G.L. Lookhart, S.P. Curran, W.D.A. Lin and R.G. Sears. 1993. Milling and cookie baking quality of near isogenic lines of wheat differing in kernel hardness. *Cereal Chem.,* 70: 183-187.

(Received for publication 15 January 2016)