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RESEARCH ARTICLE

Effect of Adding Guava Powder on the Rheological Properties of Wheat Flour Dough

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Abstract

The objective of this study was to find the effect of adding guava fruit powder on the rheological properties of the wheat flour dough. The falling number, gluten, farinograph and extensograph were determined on wheat flour with different ratios (0, 3, 4 and 5%) of guava fruit powder. Wheat flour dough containing guava fruit powder exhibited slight differences in rheological properties compared with dough containing chemical ascorbic acid and control sample. The wet gluten of wheat flour containing guava fruit powder was significantly reduced as compared with the control sample and sample B (with vit. C). Wet gluten for samples C, D, E, A and B was 29.92%, 28.64%, 28.67%, 31.51% and 31.44% respectively. No significant differences were found in dry gluten content of the wheat flour samples containing guava fruit powder as compared with sample A and B. The content of the dry gluten ranged between 11.00%, and 11.75%. Addition of guava fruit powder to wheat flour exhibited significant increase in falling number values compared with flour containing chemical ascorbic acid and control flour without improver. The falling number values were 398.00, 398.00, 417.00, 300.00, and 313.00 sec for samples C, D, E, A and B respectively.

Keywords: Guava fruit powder, rheological properties, wheat flour, falling number, farinograph, extensograph

Introduction

Wheat (*Tritium aestivum*) is the most important grain since it provides more nourishment for more people throughout the world than any other food crop. Greater than one third of world's population utilizes wheat as the main dietary staple. Three requirements in making bread from wheat flour are formation of gluten network, aeration of the mixture by incorporation of gas and coagulation of the material by heating in the oven so that the structure of the material is stabilized (Kent, 1983). Although many mills rate their flours according to analytical quality data, these often supply too little information on the processing characteristics. It is the way the dough behaves during baking that shows what flour really worth. Special attention has to be given to rheological factors such as kneading tolerance, surface moisture and fermentation stability. Rheological properties of the wheat flour dough are measured with Farinograph and Extensograph, which characterize the gluten protein of the wheat protein. Farinograph measures the processing characteristics of the flours (development time, stability and dough softening) besides measuring water absorption of flours for evaluating the flour quality and the processing properties of the dough. The weak flour gives dough of low elasticity and stability, while the strong flour gives elastic dough with high stability. Pagenstedt (1965) reported that the dough development, stability, mixing tolerance and the softening of dough after 12 min dough kneading of soft and strong wheat flours was found to be 1 and 3 min, 0 and 4 min, 1 and 7 min and 150 and 40 Farinograph units respectively. Peterson *et al.* (1992) pointed out that slat-soluble flour proteins (albumins and globulins) were correlated positively with mixing tolerance index and negatively with dough development time, stability and loaf volume. He and Hoseney (1992) found that protein content was positively correlated with Farinograph mixing tolerance and water absorption. Guava is a good source of vitamin C, lycopene and fair source of calcium, phosphorus, vitamin A and pectin. In this study, the dried powder of guava is added to wheat flour as natural source of vitamin C to replace the commercial ascorbic acid in bread making to give bread better or similar characteristics. The rheological characteristics were used to evaluate the quality of the bread produced using different ratios of guava fruit powder.

Materials and methods

Collection of guava: Mature green fruits of white and pink fleshed guava fruits were obtained from Elkadaro village, Khartoum state. Fruits were selected for uniformity in size, color and free from blemish. About 10 kg of the selected guava fruit were washed, sliced to small pieces and chopped in blender, dried in vacuum oven and packed in polyethylene bags. Wheat flour (72% extraction) was obtained from local flour Mill, Khartoum North. The flour was free from flour improver. Other baking materials were obtained from local market.

Table 1. Gluten quantity and quality of wheat flour with ascorbic acid or guava fruit powder.

Sample	Dry gluten gram %	Wet gluten gram %	Gluten index
A	11.75± 1.06066[a]	31.5089± 1.33785[a]	90.93±2.68827[a]
B	11.22± 1.11335[a]	31.4398± 1.42617[a]	89±3.29983[a]
C	11.01± 0.55066[a]	29.9243± 2.15183[a]	83.5± 5.83571[b]
D	11.00± 1.05409[a]	28.64± 2.33723[b]	83.63± 6.1221[b]
E	11.00± 1.05409[a]	28.617± 1.72466[b]	79.00± 7.43864[b]
Mean	11.196± 0.99179	30.026± 2.1141	85.212± 6.72421

Mean values (±SD) having different superscript letters in each column differ significantly at 0.05 ($p \leq 0.05$). Where, Sample A (Control, wheat flour without ascorbic acid and guava powder), Sample B (Standard, wheat flour with ascorbic acid), Sample C (Wheat flour with 3% guava powder), Sample D (Wheat flour with 4% guava powder) and Sample E (Wheat flour with 5% guava powder).

Table 2. Falling number values of wheat flour, with ascorbic acid or with guava powder.

Sample	Falling number value (Sec)
A	300±44.92215[a]
B	313±65.66751[a]
C	388±51.22716[b]
D	398±44.2292[b]
E	417±43.84822[b]
Mean	363.2±68.19061

Determination of ascorbic acid in guava: Vitamin C was determined in guava powder using the indophenols method as described by Eromosele *et al*. (1991).

Rheological properties

Falling number determination: Falling number apparatus (FN 1400, Norlandsgation 16 and Stockholm, Sweden) was used to measure the activity of α-amylase in wheat flour and composite flour (Perten, 1964).

Determination of gluten in wheat flour: Wet gluten in wheat flour, a plastic elastic substance, consisting of gliadin and glutenin was determined by the method specified in the International Association of Cereal Science and Technology (ICC) (1994).

Farinograph methods: The farinograph measures and records the resistance of dough to mixing. It is used to evaluate water absorption of the flour and to determine stability and other characteristics of dough during mixing. The rheological properties of wheat flour and (flour + improver) were determined using Brabender Farinograph with 300 g of sample in mixing bowl, according to AACC (1983) method. The farinograph characterized the quality and mixing behavior of the tested flour sample. The values derived from farinogram include the following: Water absorption, dough development time (or peak time), stability and tolerance index (B.U).

Extensograph measurements: Extensograph records a load extension curve for a test piece of dough stretched until it breaks. Characteristics of load extension curve on extensograph are used to assess the general quality of flour and to response to improving agent. The rheological characteristics of dough from different wheat flours were determined using extensograph (Duisburg, Germany) procedure (method 54-10) as described by AACC (1983).

Statistical analysis: Data was analyzed statistically by SPSS (Khwaja, 2002).

Results and discussion

Gluten quantity and quality: Table 1 shows the different readings of the wheat flour gluten accomplished by glutomatic system. The wheat flour (sample A) exhibited high wet and dry gluten than the flour which contained ascorbic acid improver (sample B) and wheat flour with added guava (samples C, D and E) as 31.55 and 11.75, 31.43 and 11.22, 29.92 and 11.01, 28.64 and 11, 28.61 and 11% for wet and dry gluten respectively. The decrease in case of wheat flour with added guava is due to the fact that guava has no gluten and consequently more decrease is seen with the increase of guava powder. The wet and dry gluten content for all samples were in good agreement with Hamada *et al*. (1982) who reported that for hard red spring wheat, the wet gluten content and dry gluten content ranged between 31.0% and 41.9% and between 11.7% and 15.3% respectively. The high content of wheat flour gluten is a desirable characteristic in dough for bread making. For gluten index, the same trend as gluten content is followed i.e. higher content for flour alone followed by flour with ascorbic acid and then flour with added guava (samples C, D and E), i.e. 90.93, 89.00, 83.50, 83.63 and 79.00 respectively. This result falls in the optimum range for bread making (between 60 and 90) as proposed by Perten (1990).

Falling number (α-amylase activity): The activity of α-amylase or the falling number values of wheat flour alone (sample A) and flour with ascorbic acid (sample B) and flour with guava powder (samples C, D and E) was 300, 313, 388, 398 and 417 sec respectively as shown in Table 2. The increase in the falling number of samples C, D and compared to samples A and B is due to the low content of α-amylase in guava powder.

Table 3. Effect of vitamin c and guava powder on the farinogram readings.

Sample	Water absorption (%)	Dough stability (min)	Dough development time (min)	Degree of softening ice 12 min after mix
A	59 ± 1.78076^{a}	10.904 ± 0.891^{a}	2.711 ± 0.293^{a}	46 ± 6.359^{a}
B	59.101 ± 2.028^{a}	9.905 ± 0.928^{b}	2.230 ± 0.305^{b}	47 ± 6.20036^{a}
C	58.811 ± 1.978^{a}	9.927 ± 0.954^{b}	2.223 ± 0.437^{b}	51 ± 9.28559^{a}
D	58.8 ± 2.394^{a}	10.405 ± 1.139^{ab}	2.232 ± 0.255^{b}	57.000 ± 8.472^{b}
E	59.001 ± 2.464^{a}	9.120 ± 0.737^{c}	2.031 ± 0.330^{b}	66.000 ± 7.512^{b}
Mean	58.943±2.0591	10.052±1.0810	2.285±0.3902	53.4±10.4705

The falling number is one of the most important quality factors for bread making flour. It has been observed that wheat flour with high falling number value is not desirable in bread baking. Due to high seasonal temperature and low moisture, the falling number of Sudanese wheat cultivars is high (Badi *et al*., 1978). However, variations in falling number values may be due to the seasonality and storage conditions of the wheat grains (moisture and temperature). Wheat flour with low falling number (i.e. high α-amylase activity is also undesirable for bread making. The optimum of falling number is said to be in the range of 250 to 350 sec.

Farinograph characteristics: Water absorption is one of the most important constituents of dough and plays a major role in dough characteristics (Bushuk and Wrigley, 1971). Table 3 and Figs. 1, 2, 3, 4 and 5 shows the results of farinograph of the wheat flour dough with vitamin C or guava fruit powder. The water absorption of the control sample A, sample B with added ascorbic acid, samples C, D and E with different ratios of guava powder was 59.000, 59.101, 59.810, 58.800 and 59.001% respectively. These results showed that the addition of vitamin C improver and different levels of guava powder gave a slight increase of water absorption but not significant differences. Dough stability was found to be ranging between 9.11 and 10.90 min (Table 3). The control sample A without improver gave the highest value (10.90), while sample E with 5% guava powder gave the lowest value (9.1), showing no consistent direction in the results. From these results, it is clear that the dough stability decreased with the addition of vitamin C, as well as the addition of guava powder. Addition of vitamin C and three levels of guava powder improver showed a significant decrease in dough development time when compared with control sample A i.e. 2.71 for control sample A and 2.23, 2.22, 2.23 and 2.03 for samples B, C, D and E respectively. The degree of softening showed an increase by the addition of vitamin C and three levels of guava powder when compared with control sample A as shown in Table 3. However, the increase is significant in sample D and E.

Fig. 1. Farinogram of dough prepared from 100% bread wheat flour (Control sample).

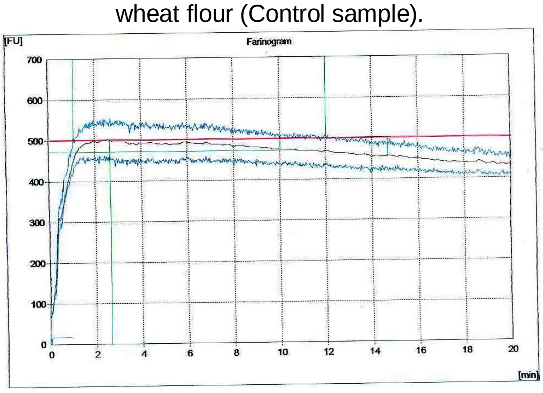


Fig. 2. Farinogram of dough prepared from blend of bread wheat flour and ascorbic acid (standard sample).

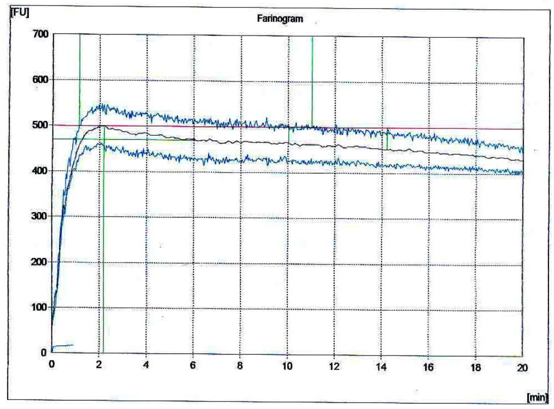


Fig. 3. Farinogram of dough prepared from blend of 97% bread wheat flour and 3% guava powder.

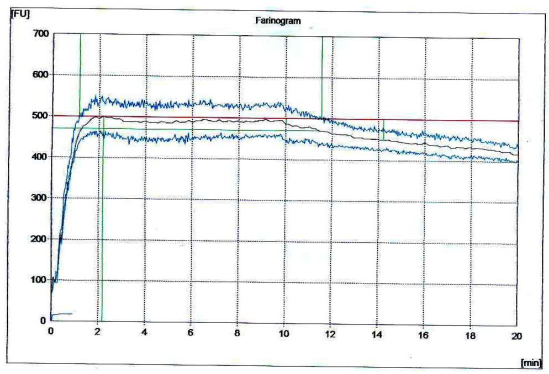


Table 4. Extensogram reading of wheat flour with ascorbic acid or guava powder at different levels.

Sample	Energy (cm^2)	Restore extension (R/E)	Extensibility (min)	Maximum resistance (BU)	Ratio number
A	63±8.83176^a	226.0±180.765^a	149±9.4868^a	326.0±3.2659^a	1.50±0.40825^a
B	106.00±10.509^b	602.0±41.3118^b	117.3±2.40601^b	702.0±17.9629^b	5.23±0.37727^b
C	106.0±11.3627^b	445.10±192.88^c	140.0±12.018^c	601.0±33.4763^c	3.70±0.57155^c
D	98.0±12.534^b	546.0±77.774^c	120.0±11.5470^b	646.0±6.3421^c	4.50±0.40825^c
E	97.0±10.7496^b	587.0 ±57.358^b	116.0±11.737^b	652.0±1.6329^c	5.41±0.49542^d
Mean	94±19.19396	481.22±185.85	128.46±16.700	585.4±135.96	4.068±1.499

Fig. 4. Farinogram of dough prepared from blend of 96% bread wheat flour and 4% Guava powder.

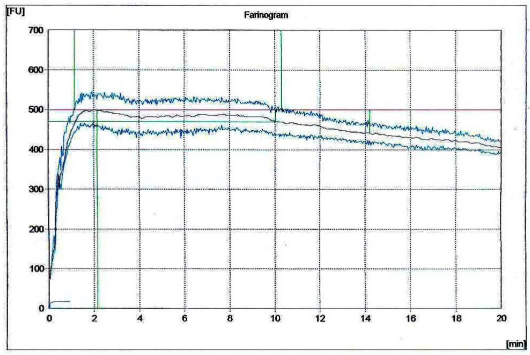
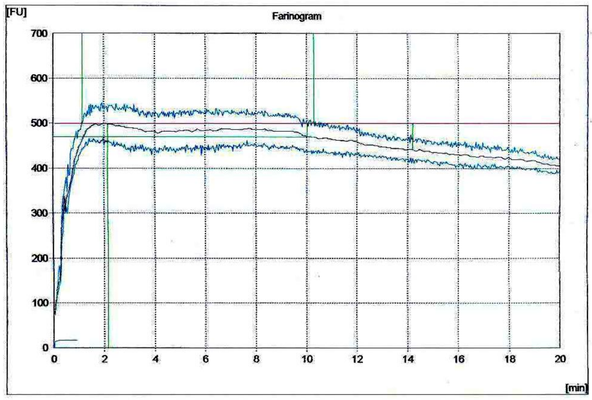


Fig. 5. Farinogram of dough prepared from blend of 96% bread wheat flour and 5% Guava powder.



Extensograph results: Extensogram of the five samples (A, B, C, D, and E) are shown in Table 4 and Figs. 6, 7, 8, 9 and 10. The extensogram measures the energy (cm^2), the resistance to extension (R/E), the extensibility (E), maximum resistance (BU) and ratio number of the dough's from wheat flour and wheat flour with commercial ascorbic acid improver or different levels of guava fruit powder. The stretching properties of the dough in particular the resistance to stretching and extensibility characterize the flour quality and consequently the baking and processing properties of corresponding dough. The control sample A has shown the lowest value of energy (63 cm^2) compared to other samples as shown in Table 4, while the highest value of energy is shown by sample B (106.000 cm^2).

Fig. 6. Extensogram of dough prepared from 100% bread wheat flour (control sample).

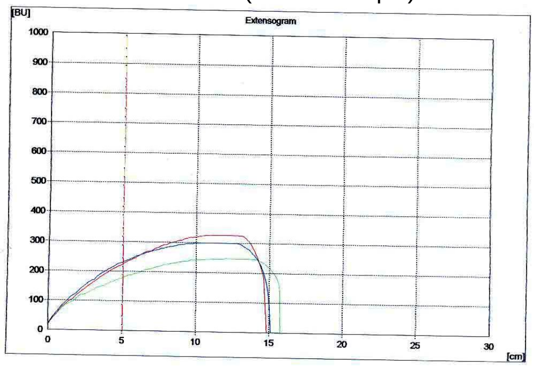


Fig. 7. Extensogram of dough prepared from a blend of bread wheat flour and ascorbic acid.

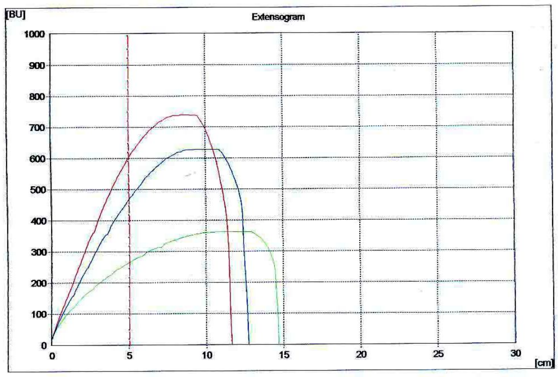


Fig. 8. Extensogram of dough prepared from a blend of 97% bread wheat flour and 3% guava powder.

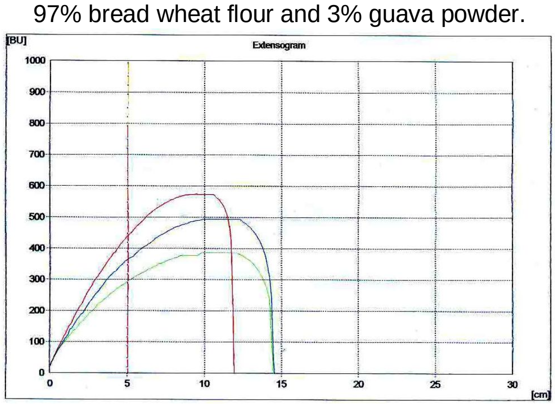
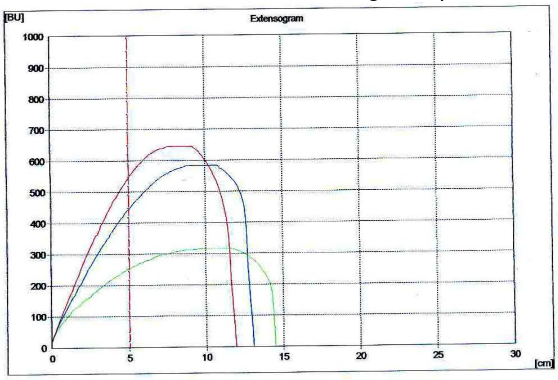


Fig. 9. Extensogram of dough prepared from a blend of 96% bread wheat flour and 4% guava powder.

Fig. 10. Extensogram of dough prepared from a blend of 95% bread wheat flour and 5% guava powder.



There is slight decrease in energy value with the increase of addition of guava powder 106.00, 98.00 and 97.00 cm^2 for samples C, D and E respectively. It is noticed that samples B and C have the same energy value. Vitamin C and guava powder added samples showed a significant increase in energy value when compared with control sample A as shown in Table 4. Control sample A without improver exhibited a significantly (P≤0.05) lower resistance to extension value (226.000) as compared to treated flour. Sample B with commercial ascorbic acid showed the highest value (602.00) of resistance to extension followed by samples E, D and C, 587.00, 546.00 and 445.00 R\E respectively. Control sample A exhibited significantly (P≤0.05) higher extensibility as compared to treated samples. Among the guava added flour, sample C showed highest value (140.0), followed by D (120.0) and E (116.0). Sample B with added commercial ascorbic acid had shown the maximum resistance value (702.00 BU) as compared to other samples. The control sample A has the lowest value among all the samples (326.00 BU). Increase of guava powder in the dough increased the maximum resistance value, 601.00, 646.00 and 652.00 BU for samples C, D and E with 3% 4% and 5%. Samples C, D, B and E guava ratio number was 1.5, 3.7, 4.5, 5.2 and 5.4 respectively. Generally the addition of ascorbic acid as chemical improver as well as guava powder as natural improver, improved the flour quality with regard to baking and processing properties of the dough.

The reason may be related to the oxidizing action present in chemical or natural ascorbic acid improver which caused more S-S groups in the dough resulting in high resistance to extension.

Conclusion

The flour which contained guava powder has slightly lower wet and dry gluten as well as α-amylase activity. Flour dough containing guava powder showed decrease in stability and increase in dough resistance to extension but gave maximum decrease in extensibility.

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