The Effect of Reducing Agent on Quality Characteristics of Flour and Cake (Glutathione)

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Abstract: ***The effect of adding whey protein concentration from natural sources (glutathione extracted) on the rheological and organoleptic properties of the flour used for making cakes was investigated. Four samples of cakes manufacturing which used hard wheat to study the effect of the sulfur bonds that form in the flour, which whey protein concentration (glutathione concentration extraction) was used of 1%, 2% and 3% and the sample without the addition. Proximate analysis of wheat flour values are 12.04%, 7.75%, 0.55%, 0.53%, 67.5% for protein and moisture content, ash, oil content, and Carbohydrates respectively. Rheological properties showed that in Farinograph readings the highest score for water absorption (66.2%) in the sample 2% WPC recorded, and highest volume found in the sample 1% WPC. Also the lowest devolving time (1.8 min) was obtained in samples 3% WPC and control sample. Moreover the dough stability ranged between 14.2 to 18.9 min, and the highest record by the control sample. The highest score degree of softness was obtained (51FU) by the control samples, while the lowest record (26FU) in sample containing 1% WPC. Extensopram reading showed that difference in the degree of samples. The highest resistance in time period (45min) showed (312cm) by the sample containing 1% WPC, while the time period (90min) and (135min) recorded (498cm) and (566cm) by the control sample respectively. The highest extensibility in time period (45min) showed (166min) in both sample containing 1% and 3% WPC, while the time period (90min) and (135min) recorded (151min) and (141min) by the sample containing 2% WPC respectively. Specific volume showed that significant differences (p<0.05) in the cakes making with glutathione. The highest specific volume obtained (1.807) in control sample, followed found (1.712) by sample containing 2%WPC showed the best, while other sample ranked in an intermediate position. Organoleptic quality of cake sample showed significant different (p<0.05) in (aroma, taste, color of crust, the color of crumb, crumb cells uniformity and general acceptability) found that the control and the sample containing 3% WPC was record the highest score, while the other samples ranked in an intermediate position.***

Keywords: Wheat flour, Whey Protein Concentration, Glutathione, Rheological, Organoleptic properties

1. Introduction

Wheat is one of the most important cereal crops grown worldwide and it ranks first among cultivated plants of the world and provides more nourishment to the people than any other food source. It contributes substantially to the feeding of domestic animals (Elshewaya, 2003). In the Sudan wheat is the second most important cereal, after sorghum, in terms of consumption. The Sudan has been cultivating wheat in the north for thousands of years. With urbanization, in the past 50 years, food traditions have changed, and wheat consumption has soared to about 1 million tons per year. Wheat is grown in the Sudan in the winter months only. Wheat planting takes place from the last week in October to the 2ndweek in December (FAO, 2001).

The chemical composition of whole wheat flour is: moisture (9.38–10.43%), ash (1.32–1.85%), crude protein (10.13–14.74%), crude fat (1.96–2.52%), crude fiber (2.31–2.99%), nitrogen free extract (78.71–85.37%), wet gluten (23.53–38.71%), and dry gluten (7.51–13.52%) among different wheat varieties (Kamaljit *et al*., 2010).

Cake flour with a high starch-to-gluten ratio is made from fine-textured, soft, low-protein wheat. It is strongly bleached, and compared to all-purpose flour, cake flour tends to result in cakes with a lighter, less dense texture. Therefore, it is frequently specified or preferred in cakes meant to be soft, light, and/or bright white.

Cake flour is finely milled white flour made from soft wheat. It has very low protein content, between 8% and 10%, making it suitable for soft-textured cakes and cookies. The higher protein content of other flours would make the cakes tough. Highly sifted cake flours may require different volume amounts in recipes than all-purpose flour. In bread manufacturing, the most important attributes are to make softer, smoother, better flavor, better color, more nutritious, and longer shelf life bread. Longer shelf life bread can be achieved by preventing or reducing staling reactions and microbial growth (Fernandez et al., 2006).

Glutathione whey protein is a mixture of globular proteins isolated from whey, the liquid material created as a by-product of cheese production. Although whey proteins are responsible for some milk allergies, the major allergens in milk are the caseins (Marshall, 2004). It is a 5% solution of lactose in water, with some minerals and lactalbumin. The fat is removed and then processed for human foods (Foegeding *et al*., 2002).

Glutathione exists in both reduced (GSH) and oxidized (GSSG) states. In the reduced state, the thiol group of cysteine is able to donate a reducing equivalent (H^{+}+ e^{-}) to other unstable molecules, such as reactive oxygen species. In donating an electron, glutathione itself becomes reactive, but readily reacts with another reactive glutathione to form glutathione disulfide (GSSG). Such a reaction is probable due to the relatively high concentration of glutathione in cells (up to 5 m in the liver)(Banerjee, R.2011).

The objectives of this study was to investigate the comparative effect of glutathione at three different concentrations on gluten of wheat and to evaluate the effect of adding different ratios of Glutathione on cake nutritional quality also study the Rheological properties of supplementing soft wheat flour with Glutathione on dough and cake quality and to study the effect of Glutathione on the quality of cake produced

2. Materials and Methods

2.1 Materials

Wheat flour was obtained from Sega flour milling company (Khartoum) whey protein concentrate produced using the heat precipitation. Whey was obtained from the Khartoum university (dairy production section) .Other Food materials (sugar, salt, egg, oil, baking powder and vanilla) were purchased from the local market (Bahri). All chemicals and reagents were of analytical grade.

2.2 Methods

Whey concentrate were prepared by

I Bring the liquid whey protein and extract it by used heat precipitations(boiling) in lab lottery of milk technology and after extracted putting wet why protein on room temperature overnight to dry and after that collect the dry why protein .

Blends of concentrate why protein and Wheat Flour

The blends between flour and whey protein concentrate was partially substituted with (W.P.C) at level of 1%, 2%and 3%by weight.

Preparation of cake Samples

Cake preparation by using control cakes was prepared without adding (W. P.C) flour samples were prepared by substitution of (W.P.C) in ratios of 1%, 2% and 3% .and mixed with dry ingredients (sugar, baking powder and vanilla). The liquid ingredients prepared by add 2egg with 180 ml oil mixed together in blender and after that add the dry ingredients on the blender to make dough and putting baked box and baking oven at121c, for 10 min.

2.3 Analytical Methods

Proximate Composition

The proximate composition of samples like moisture content, ash content, crude protein, crude fat, and crude fiber were analyzed on dry weight basis according to American Association of Cereal Chemists, (2000). Carbohydrates were determined by difference. Carbohydrates= 100 – (Ash % + moisture % + CP% + oil % + fiber

Examination of rheological properties

The water absorption and the other farinograph parameters of flour were determined by Brabender Farinograph (Brabender GmbH & Co. KG, Duisburg, Germany) according to ISO/WD 5530-1standard. To determine the extensigraph properties of dough I used a Brabender Extensigraph (Brabender GmbH & Co.KG, Duisburg, Germany) according to AACC Standard No. 54-10 (AACC International 2000) afterthe45, 90, and135min rest period. The studied extensigraph parameters were: extensibility (mm), standard resistance to extension (the resistance at a constant extension of 5 cm) (BU), maximum resistance to extension (BU), and area under the curve(cm2).

Physical characteristics of cake

The weight of the loaf cake was taken in gram. The loaf volume was determined by the seed displacement method according to (Pyler, 1973). The specific volume of the loaf was calculated according to the AACC method (2000) by dividing volume (CC) by weight (g).

Organoleptic quality

Ten panelists were chosen to judge the quality of cake term of appearance , aroma, taste and crust colour, crumb texture, crumb color ,crumb cells uniformity, general acceptability, the sensory evaluation of bread was evaluated by ranking procedure , described by Ihekoronye and Ngoddy (1985).

2.4 Statistical analysis

Analysis of variance was carried out according to the SAS (1997).

3. Results and Discussion

Chemical Composition of Wheat Flour

The chemical composition of wheat flour, were shown in table (1) the results of protein , moisture , ash, oil and carbohydrate were 12.04% ,7.5% , 5.23% , 0.55% and 67.5% respectively The moisture content of wheat was found 7.5 %. They were also reported by (Achi andOkereka,1999). The crude protein of the samples was (12.04%) This result was agrees with (Belderok.,2000). Found (11-14%) protein. The fat content was showed (0.5 3%) the results was agree with (Belderok *et al.*, 2000). Who found that the fat content of wheat flour from 0.9 to 1.5% respectively. The ash content was found (0.55%) which agree with (Belderok *etal.*, 2000) obtained in rang (0.5-1%) the carbohydrates content recalled (67.5%) The observation is in agreement with the report of (Belderok*et al* 2000). The total carbohydrates are (60-75%).

Table 1: Proximate analysis (%) of wheat flour

Protein content	Moisture content	Ash content	Oil content	carbohydrates	fiber
12.04±0.01	7.75±0.25	0.55±0.05	0.53±0.25	67.50±2.50	0.55±0.05

Farinograph Results

Table (3) and Fig (1, 2,3and4) show farinograph values of dough prepared from wheat flour blends with WPC. The water absorption of control cake flour was 66.0%. Adding WPC to wheat flour in the ratios of 1, 2 and 3% was shown to decrease the water absorption of the blends gradually. The maximum value is 66.2% for the lowest substitution 2% and 65.4% at the highest substitution 3%.

Dough development time the highest value (2.5 min) obtained with 1%WPC,the lowest value recorded (1.8 min) obtained by 3%WPCand control sample., while the addition of 2% WPC ranked in an intermediate position (2.2 min).

The dough stability ranged between14.2 and 18.9 min .The highest value (18.9 min) obtained by control sample. The lowest value found (14.2 min) by sample 3%WPC, while the 1% and 2% WPC dough stability were 14.3 and16.4 min respectively.

The result showed similar with Gani et al.,(2015) who were studies the effect of whey and casein protein hydrolysates on rheological, textural and sensory properties of cookie and found the water absorption of wheat flour (control) was 58.4 %, however, it was in the range of 51.7–58.0 % for WPC, 49.8–58.1 % for WPH, 53.3–58.2 % for casein concentrate and 51.5–58.2 % for casein hydrolysis.

The relative lower percentage of water absorption in wheat flour blend with protein concentrates and hydrolysates may be attributed to lower water binding ability of milk proteins than wheat flour. Indrani et al. (2007) reported water absorption decreased as the amount of whey protein concentrate in the wheat flour blend increased. The result shown similar with Indrani et al.,(2007) who studies the Influence of whey protein concentrate on the rheological characteristics of dough, microstructure and quality of unleavened flat bread (parotta) and found the Farinograph data indicated that substitution of wheat flour with WPC decreased farinograph water absorption. An increase in dough stability was observed up to 10% level of WPC as against the control value. Beyond the level of 10% WPC there was decrease in dough stability.

The degree of softening values of the three blends with 1,2and 3% WPC were 26, 31 and 29 FU respectively compared with control, which had 51FU.cakes flour Ranged between (26 to 51FU) control sample gave the highest value ,whereas 1%WPC gave the lowest values, while the other samples 2%WPC and 3%WPC ranked in an intermediate position (29and 31FU). Bloksma found that estimated, on the basis of farinograph measurements, that -25-35% of sulfhydryl groups and 4-13% of the disulfidebonds were rheological effective. However, a small decreasing cross linking was sufficient to cause a considerable rheological effect because of disappearance of archeologically effective groups (Bloksma 1992).

Most current theories on the improver action of oxidants agree that sulphydryl groups are involved in the reaction mechanism. The bromate is assumed to oxidize low molecular Shpeptides (glutathione) and consequently hamper sulfhydryl disulfide interchange of gluten molecules (Bloksma 1992).

Table 2: Pharinogram reading of cake flour

Sample / Item	Water absorption (%)	Developing time (min)	Stability (min)	Degree of Softening (FU)
(A) WPC1%	66.0%	2.5	16.4	26
(B) WPC2%	66.2%	2.2	14.3	31
(C) WPC3%	65.4%	1.8	14.2	29
(D) CONTROL	66.0%	1.8	18.9	51

Were:-
Sample (D) 100% wheat flour
Sample (A) 99% wheat flour 1%WPC
Sample (B) 98% wheat flour 2%WPC
Sample (C) 97%wheat flour 3% WPC

Extensograph results

The extensograph results of the wheat dough with WPC substitution were presented in Table (4) and Fig (5.6.7.8). The results of the present study showed that energy, resistance and extensibility at 45min, 90 min and 135 min. of fermentation were reduced with the increase of WPC content compared with control wheat flour.

The present results, using WPC in ratios of 1% ,2% and 3%, showed lower values of energy at 45, 90 and 135 min compared with control cake flour .The energy values were in the range from(65 to 93), (117 to 107)and, (128 to 116 cm^2), respectively. The highest value obtained in (95min) by sample 1%WPC however The lowest value found in (65min) by control sample, while the other samples 2%WPC and 3%WPC ranked in an intermediate position (91and 93 min).

The energy at 135min ranged between (107 to 133cm^2) .sample 2 % WPC gave the highest value (133cm^2). The lowest value recorded (107cm^2) by sample1% WPC, while the other control samples and 3%WPC ranked in an intermediate position (116and 128cm^2).

The result also showed that as the fermentation time increased the resistance value of wheat flour blends and control increased .the resistance value ranged between 294 to312, 415 to 498 and 412 to 566 at 45,90and 135min respectively. At 45min ranged between 294 to 312 BU. sample 1%WPC gave the highest value (312BU). Control sample gave the lowest (294BU), while the other samples 2%WPC and 3%WPC ranked in an intermediate position (302and 310BU). At 135min ranged between 412 to 566 BU. the highest value (566BU)gave with control Sample .the lowest value (412BU) obtained by sample 1%WPC , while the other samples 2%WPC and 3%WPC ranked in an intermediate position (508and 513BU).

The addition on wheat flour blends with WPC showed increase in extensibility (mm) at 45min, 90min and 135 min compared with control cake flour . the extensibility value ranged between (161 and 131) (136 and 151) and (131 and 144) at 45,90,and 135min, respectively. ranged between 131 to 144mm. the highest value recorded (144mm) obtained by samples 2%WPC. The lowest value (131mm) found with control sample and sample 3% WPC, while the other samples 1% WPC ranked in an intermediate position (141mm).

The result shown similar with Indrani et al.,(2007) who studies the Influence of whey protein concentrate on the rheological characteristics of dough, microstructure and quality of unleavened flat bread (parotta) and found the increase in the extensograph resistance to extension and area under curve values up to 10% WPC and decrease in the extensibility values were observed with the increase in the level of WPC from 0% to 15%. This could be due to dilution of gluten content as well as interaction of whey protein with wheat protein fractions, which resulted in a short dough.

Zadow (1981) also reported that addition of WPC in the preparation of bread resulted in a weaker and less elastic dough. He further opined that the weakening of the wheat flour dough is due to interference of WPC sulphydryl groups in the nor-mal sulphydryl/disulphide interchange reactions occurringduring wheat flour dough development.

Bloksma,(1992) found it is generally accepted that the rheological properties of dough and its three-dimensional network are dependent on the arrangement and number of disulfide bonds and sulfhydryl groups of the protein. The vital contribution of disulfide bonds to dough stability has been shown in rheological studies by the addition of either sulfhydryl compounds or sulfhydryl-blocking reagents. A small amount of cysteineor reduced glutathione dramatically increases the extensibility of dough.

Bloksma (1992) showed that both the viscous and elastic component of dough deformation was increased by reduced glutathione.

Table 4: Extensogram Readings of the cakes Flour

Sample / Item	Proving time(min)	D (control)	WPC1% (A)	WPC2% (B)	WPC3% (C)
Energy(cm^2)	45	65	95	91	93
	90	117	102	125	107
	135	128	107	133	116
Resistance (cm)	45	294	312	310	302
	90	498	415	452	434
	135	566	412	513	508
Extensibility (min)	45	131	166	161	166
	90	136	138	151	142
	135	131	141	144	131

Were:-
Sample (D) 100% wheat flour
Sample (A) 99% wheat flour 1%WPC
Sample (B) 98% wheat flour 2%WPC
Sample (C) 97%wheat flour 3% WPC

4.4. Baking Test

Baking characteristics of cakes control and cakes containing WPC by deferent's percentage were presented in Table (4). The cake volume of the control was 1.807cc.significant increase among the different percentages of WPC, cake in. 1, 2 and 3 % WPC showed 1.588, 1.712and 1.465cc, respectively .The cake with 2% WPC gave the highest value even with no significant different with the control; whereas 3% WPC volume was the lowest. This result agreement with (Jorgensen,1939) who Reported that volume increased, and cakes had better crumb grain most current theories on the improver action of reducing(Jorgensen,1939).The lowest value of cake specific volume was(1.46 cm^2/g) obtained by 3%WPC adding reduced agent materials in very small amounts effect the action more than adding big proration, while the 1% and 2%WPC samples ranked in an intermediate position (1.71 cm^2/g and1.58cm^2/g).

The result showed similar with Jyotsna et al.,(2007) who were studies the effect of whey protein concentrate on the rheological and baking properties of eggless cake and found that, the specific gravity in control eggless cake was 1.40g/cm3, whereas eggless cake batter with 10, 20,and 30% WPC had a specific gravity of 1.10, 0.85,and 1.20 g/cm3, respectively, which were significantly lower (p ≤0.05).

This indicates that the WPC batters were lighter because of better air incorporation. This could be attributed to foaming properties of WPC. Un denatured whey proteins are excellent foaming agents (Richert, 1979; Jyotsna et al., 2007),Variable foaming capacities have been reported for WPCs. By opening up globular structures of α– lactalbumin and β– lactoglobulin and exposing the –SH groups in the latter, the stability of whey protein foams may be increased without increasing overrun (William Evans, 1986). A significant decrease in batter density was noted in the case of 20% level of WPC replacement.

Funk et al.,(1970) reported that the rheological studies on batter viscosity indicated that thinnest batters were most stable when the performance of frozen, foam-spray, freeze, and spray-dried eggs in cakes containing fat were compared.

Table 4: Specific volume of cake samples

Samples	Specific volume
A	1.588 ±0.07[bc]
B	1.712 ±0.31[ab]
C	1.465 ±0.08 [c]
D	1.807 ±0.08 [a]
$Lsd_{0.05}$	0.2051*
SE±	0.06952

* Means's in the same column with the same superscript letters are not significantly different at level (P≤ 0.05).
Sample (D) 100% wheat flour, Sample (A) 99% wheat flour 1%WPC, Sample (B) 98% wheat flour 2%WPC, Sample (C) 97%wheat flour 3% WPC

4.5. Sensory Evaluation of cake

Aroma, taste, crust color, crumb color, Crumb cells uniformity and general acceptability of cake with WPC were showed in table (5).

The control sample and sample 3% WPC gave the highest score of Aroma the lowest score obtained by sample 2% WPC, while the other samples 1% WPC ranked in an intermediate position. The taste of cake was not significantly different (P≤0.05).

Crust color of cake gave the highest score by control sample and sample 3% WPC and sample containing 2%WPC, while sample containing 1% of WPC gave the lowest score. In Crumb color were not significantly different (P≤0.05).In Crumb cells uniformity were not significantly different. General acceptability control sample gave the highest score and sample containing 1% WPC gave the lowest score, while the other sample 2%WPC and sample containing 3%WPC ranked in an intermediate position.

Table 5: Sensory Evaluation of cake Samples containing WPC

Samples	Quality attributes					
	Aroma	Taste	Crust colour	Crumb colour	Crumb cells uniformity	General acceptability
Y	6.15 ± 2.32^{ab}	6.30 ± 2.20^{a}	$5.30^{b}\pm2.49$	$5.95^{a}\pm2.14$	$5.70^{a}\pm1.75$	$6.00^{b}\pm2.20$
D	$5.05^{b}\pm2.35$	$5.65^{a}\pm2.30$	$7.20^{a}\pm1.06$	$6.90^{a}\pm1.59$	$6.45^{a}\pm1.88$	$6.75^{ab}\pm1.65$
M	$6.45^{a}\pm1.61$	$6.50^{a}\pm1.73$	$6.80^{a}\pm0.95$	$5.90^{a}\pm1.48$	$5.95^{a}\pm1.64$	$6.80^{ab}\pm1.28$
P	$6.75^{a}\pm1.83$	$6.60^{a}\pm2.01$	$6.90^{a}\pm1.12$	$6.20^{a}\pm1.85$	$5.70^{a}\pm2.13$	$7.60^{a}\pm1.43$
$Lsd_{0.05}$	1.293^{*}	$1.306^{n.s}$	0.9714^{*}	$1.123^{n.s}$	$1.17^{n.s}$	1.056^{*}
SE±	0.459	0.4635	0.3449	0.3988	0.4154	0.375

Score(s) sharing same superscript(s) are not significantly different (P≤0.05).
Were:- Sample (P) control without WPC, Sample (Y) concentrate of 1% WPC, Sample (D) concentrate of 2% WPC , Sample (M) concentrates of 3%WPC

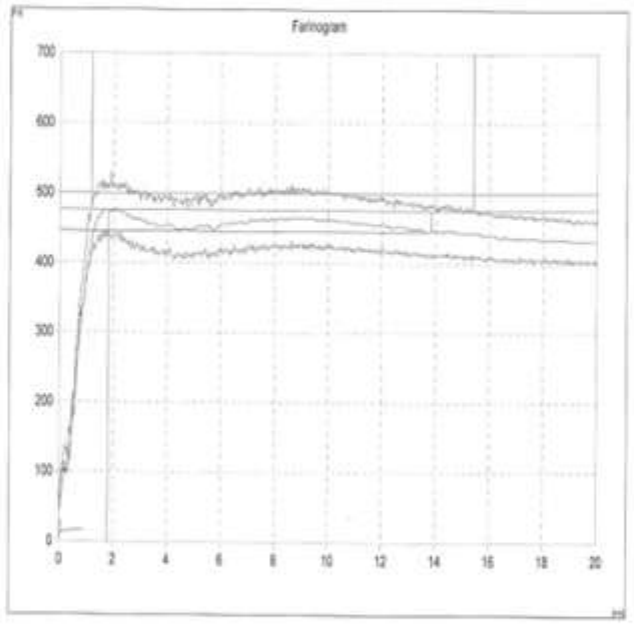

Figure 1: Farinogram ofdough prepare fromcake flour with 1% WPC

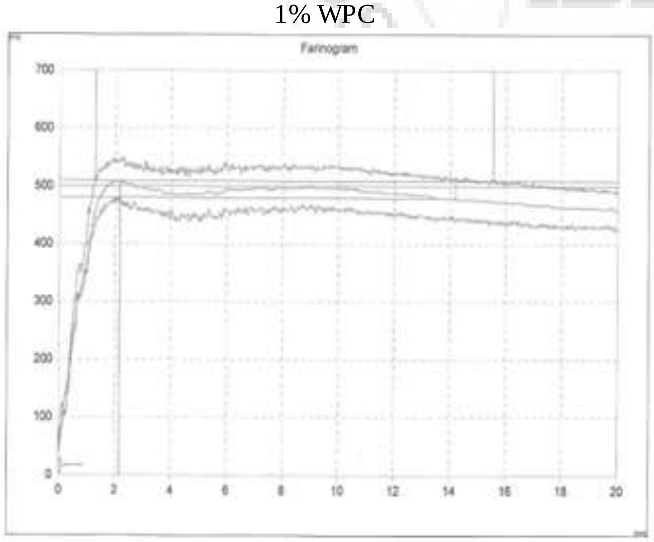

Figure 2: Farinogram of dough prepared from cake flour with 2% WPC

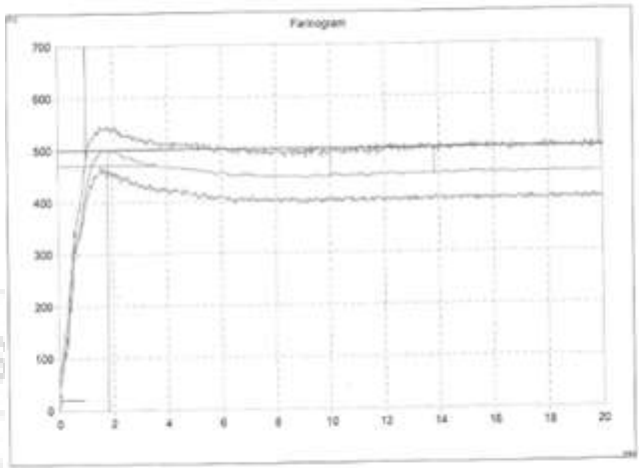

Figure 3: Farinogram of dough prepared from cake flour with 3% WPC

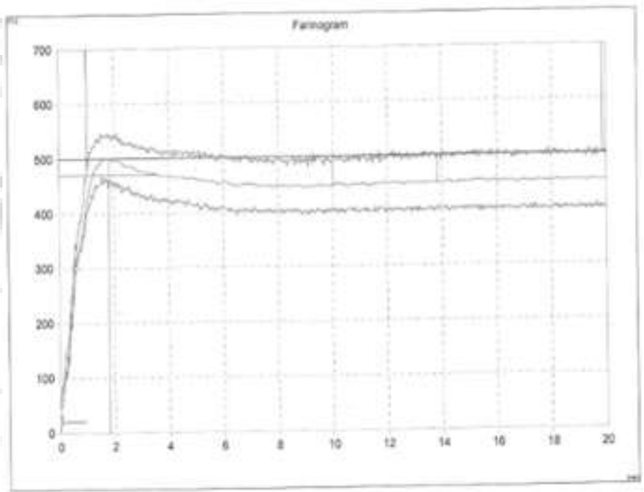

Figure 4: Farinogram of dough prepared from cake flour withoutWPC

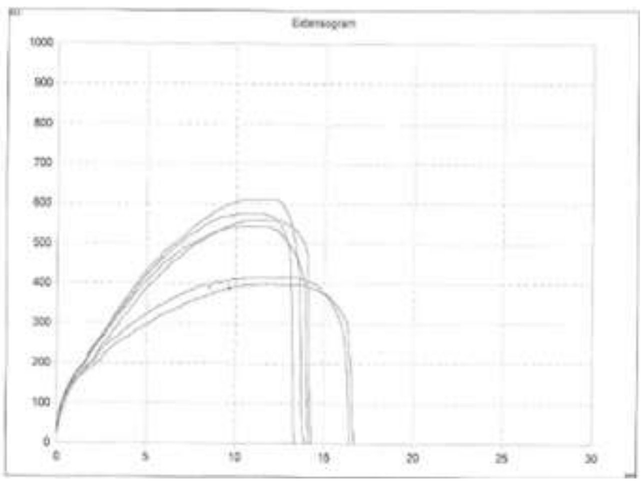

Figure 5: Extensogram of dough prepared fromcake flour with 1% WPC

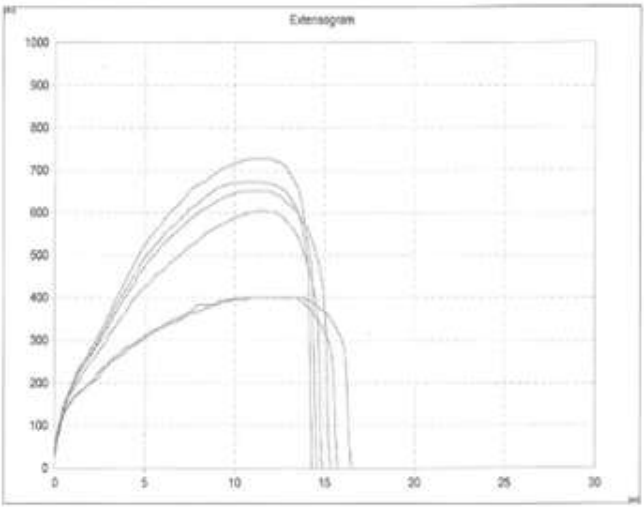

Figure 6: Extensogram of dough prepared fromcake flour with 2% WPC

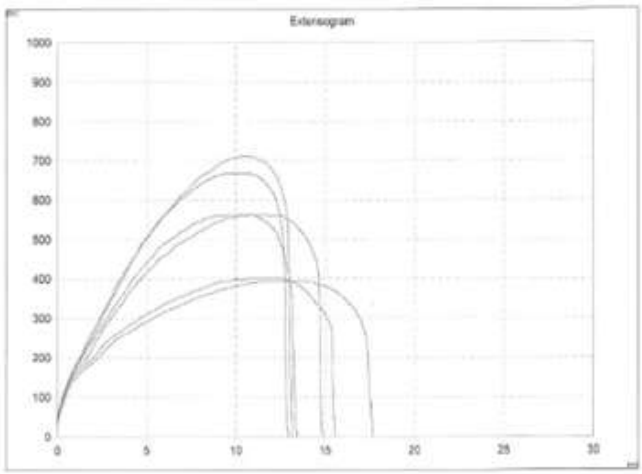

Figure 7: Extensogram of dough prepared from cake flour with 3% WPC

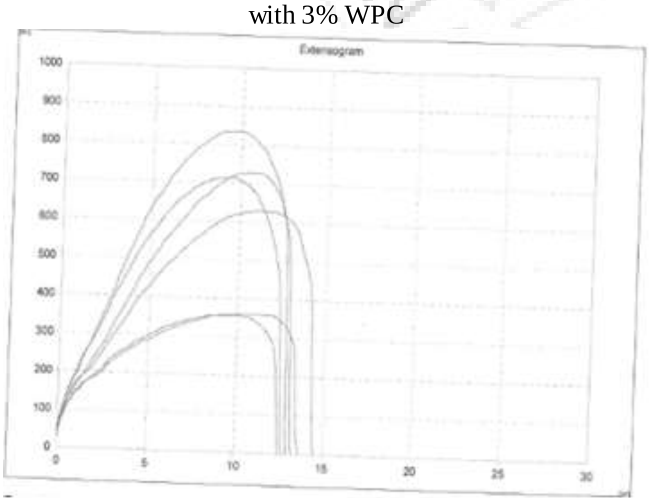

Figure 8: Extensogram of dough prepared from cake flour without WPC

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