IV- Results and Discussion

IV-I. Physical and chemical characteristics of wheat, flour and pasta:

IV-I.1. Physical characteristics of different wheat varieties:

The physical characteristics of local and imported wheat types are shown in table (6). Egyptian Triticum durum , wheat stork's variety has hectoliter and 1000 kernel weight of 81.1 Kg/HL and 53.75 g respectively. These values indicate that stork's kernels have high endosperm percentage and consequently produce high flour percentage. Also the local variety stork's showed higher values for hectoliter weight and 1000 kernel weight than that of T. Durum canadian amber grade three and hard red spring canadian grade three (C.W.R.S.). These results table 6), are in agreement with those reported by Matsuo (1982) and Anon (1985).

According to Dick et al.(1980) Egyptian Tritcium durum stork's variety could be classified as Amber durum wheat , because it has 60-75% vitreous kernel of Amber colour.

Triticum durum canadian Amber grade three characterized by the highest vitreous percentage (79.70%)followed

Table (6): Physical characteristics of different wheat varieties (on dry basis)

Wheat types	Colour	Endosperm texture	Vitreous %	Hectoliter weight Kg / HL	1000 Kernel weight gram
<u>T.Aestivium</u>					
C.W.R.S. 3 degree*	Red	Hard	62.24	76.5	28.60
Australian soft	white	soft	0.00	84.0	34.10
<u>T. Durum</u>					
Canadian Amber 3 degree	White	Hard	79.70	78.8	40.40
Egyptian Stork's (Commercial)	White	Hard	65.30	81.1	53.75
" " vitreous	White	Hard	100.00	80.2	52.50
" " starchy	White	Soft	0.00	82.8	54.20

* Canadian west red spring wheat number 3, degree

by Egyptian stork's (65.30%), while Triticum aestivium (C.W. R.S.) (62.24%) and Australian soft white wheat are without vitreous and has the highest hectoliter weight (84.0 Kg/HL). The vitreousness are herdeting characteristics affected by the ecological cultural conditions as mentioned by Staudt and Zieglar (1973), and Kent (1983).

Table (6) indicate that stork's vitreous kernels had less hectolitre weight and 1000 kernel weight than starchy kernels. This positive relationship between test weight and 1000 kernel weight results are in agreement with those obtained by Dexter and Matsuo (1981) and Matsuo (1982). In general nitrogen fertilizers at heading stage and NPK fertilizers increase the vitreous percentage, crude protein and gluten contents (Percival, 1921, Golik 1976, Mineev et al. 1977, and Kent 1983).

IV.I.2. Chemical constituents of wheat and their effect on flour quality:

I. 2.1. Moisture, ash and Fiber contents:

Table (7) shows that Egyptian stork's vitreous kernels had the lowest moisture content (10.6%) while, starchy kernels, C.R.W.S. 3 degree, and Australian soft had higher moisture content (10.7, 11.5 and 11.8%). The obtained results show that wheat kernels moisture content was in

Table (7): Moisture, ash and crude fiber content of different varieties wheat kernels, flour and semolinas (on dry basis).

Wheat varieties	Moisture %		Ash %		Crude fiber	
	Kernels	Flour	Kernels	Flour	Kernels	Flour
A) T. aestivium						
C.W.R.S. 3 degree	11.5	14.0	1.80	0.63	2.50	0.22
Australian	11.8	14.2	1.50	0.42	2.00	0.20
B) T. Durum						
Canadian Amber 3 degree	11.0	14.3	1.93	0.89	2.40	0.21
Egyptian stork's(commercial)	10.6	15.8	1.94	1.05	2.40	0.35
Egyptian stork's(vitreous)	10.6	14.0	1.97	1.18	2.60	-
Egyptian stork's(starchy)	10.7	14.0	1.88	0.99	2.10	-
C) Imported durum semolina						
Turkey semolina (Roma)	-	11.8	-	0.73	-	0.27
Turkey semolina((Buitoni)	-	12.0	-	0.72	-	0.37
Turkey semolina((Capri)	-	12.0	-	0.76	-	0.39

the safty moisture horizon according to deterioration factors during storage (Rafai, 1965, Abu El Nasr, and El-Nahal 1968 and Anon 1976).

Flour moisture content of wheat varieties were 14% 14. 2%, 14.3%,and 15.8% in C.W.R.S.3,for Australian soft, canadian Amber 3, and Egyptian durum stork's respectively. The obtained results indicate that stork's flour had high moisture content, it might be due to its high water absorption during conditioning process. Hence enzymatic activity could be higher in the kernels and obtained flour and affects alternatively on pasta quality. Flour moisture must not exceeded 14% (Refai 1965, and Anon 1984).

Imported semolina had 11.8, 12.0, and 12.0% moisture content in Roma, Buitoni, and Capri respectively. These results are in agreement with the Egyptian standard quality (Anon,1987).

Table (7) indicates that durum wheat varieties contained higher quantities of ash than aestivium varieties, stork's vitreous kernels had the highest ash (1.97%) and crude fiber content (2.60%) comparing with other varieties. Egyptian stork's flour contained the highest ash content (1.05%) while other wheat varieties flour ash content ranged between 0.42% (australian soft flour) and 0.89% (Canadian amber 3, flour). The imported Turkey semolina; Roma , Buitoni, and Capri contained close ratio of ash 0.73, 0.72, and 0.76% respectively. From these results ,it could be concluded that imported semolina contained lower quantities of ash than local durum. Stork's flour ash content is higher than aestivium varieties wheat flour. High ash content has negative effect on the colour of produced macaroni,(Manser 1981 , Dexter and Matsuo, 1981, and Matsuo 1982). Standard quality for Egypt, Italy, and U.S.A. cited that maximum ash content must not exceeds 0.6% and 0.9% for macaroni made from patent flour and semolina,(Anon,1983 ,and Kent 1983).

The remedy of this problem-perior mentioned - is the attention for N fertilization, high rates and doses decreased the ash content of wheat from 1.98% to 1.47%, (Hana et al.,1970).

Data concerning crude fiber content are shown in Table (7), Crude fiber ranged between 2.0-2.6%. Stork's vitreous kernels showed the highest fiber content (2.6 %) while Australian soft wheat had the lowest (2.0%).

The crude fiber content of the extracted flour and imported semolina (except stork's variety) are in agreement with the Egyptian Standard Quality Low Anon(1983), (must not exceeds 0.2 and 0.45% on dry basis for pasta made of flour and semolina).

Stork's high crude fiber content (0.35%) could be attributed to higher flour extraction more than 72%. Also bran powder produced in milling due to dryness of wheat kernels surface.

Pasta quality is affected by ash content and bran contamination, so ash and crude fiber contents must be reduced.To reduce ash content and crude fiber of stork's flour the wheat must be moisted for one hour perior to first break roller to tough the outer layer of kernels to minimize the amount of bran fiber powder, (Refai, 1965) ; Anon , 1969; Gobky, 1972; and Anon,1976). Also Stork's flour extraction rate must be under control ,not exceeded 72% with less ash content using table of commulative ash content in the mill of stork's.

I.2.2. Protein content:

1.2.2.1. Protein and Gluten contents:

Data regarding total protein, table (8),shows that wheat kernels protein of different varieties are 13.60 , 8.84, 15.69, and 14.85% in C.W.R.S. degree 3, Australian soft, Canadian Amber degree 3, and Egyptian stork's respectively. Durum wheats contained higher protein content than aestivium wheats, similar results were obtained by Simmonds (1978), and Tawfik and Mansour (1983), Stork's vitreous kernels had higher protein content than starchy. Results demonstrated that the Egyptian durum wheat Stork's had 14.85% protein which was higher than T. aestivum (13.60 and 8.84% for C.W.R.S. and Australian soft)and was lower than Canadian durum wheat (15.69%).

All the extracted flours contained lower protein content than the kernels. These results are in agreement with those obtained by Kulp et al.,(1980). Flour and semolina extracted from hard and durum wheats had higher protein content than the flour extracted from soft wheat (Table 3). Also stork's vitreous flour showed higher protein content (14.90%) than starchy stork's (11.82%).

On the other hand gluten content have relation with total protein; Canadian west red spring wheat degree 3 showed the highest wet and dry gluten content (48.80 and 16.72%). While Australian flour had the lowest wet and dry gluten (25.0 and 10.0 %). Durum flour and semolina had wet gluten contents 46.39 , 29.70, 27.50, 31,50, and 30.50% for canadian Amber grade 3, Turkey semolina, Roma, Buitoni , Capri, and Egyptian durum stork's respectively. Dry gluten followed the wet gluten up and down. Stork's vitreous flour showed more gluten content than starchy flour.

According to Refai (1982) the quantity of gluten is not so very important as the quality. Gluten suitable for pasta products should be strong and may be shorter and less resilient than gluten suitable for bread flour.

The obtained results are in agreement with Manser(1981) and Matsuo (1982) except Australian soft flour which contained lower protein content (7.96%). Egyptian stork's protein

Table (8): Protein content of different wheat varieties,kernels , flour and semolian.
(on dry basis).

Wheat varieties	Total protein %		Flour non-protein nitrogen	Gluten content of flour	
	Kernels	Flour		Wet %	Dry %
A) T. aestivum:					
C.W.R.S. 3 degree	13.60	12.25	0.155	48.80	16.72
Australian	8.84	7.96	0.185	25.00	10.00
B) T. Durum					
Canadian Amber,3 degree	15.69	14.90	0.170	46.39	15.73
Egyptian Stork's(commer.)	14.85	13.43	0.420	30.50	14.98
Egyptian stork's(vitreous)	15.90	14.90	-	32.80	16.13
Egyptian stork's(starchy)	12.60	11.82	-	26.00	12.70
C) Imported durum semolina					
Turkey semolina (Roma)	-	14.00	0.181	29.70	14.50
Turkey semolina (Buitoni)	-	13.65	0.159	27.50	11.20
Turkey semolina (Capri)	-	14.80	0.175	31.50	11.00

content (13.43%) is in the ratio reported by the Egyptian standard quality for macaroni, Anon (1983). The recommended ratio is not less than 13% in semolina flour.

Cooking quality is related to protein content, it improves with increasing protein content (Dexter and Matsuo 1977, and 1978a; Gravelaned *et al*, 1982, and Refai 1982) During pasta manufacture and cooking, pasta which contains enough protein and gluten do not stretch and fall during process and have good cooking quality.

Patent flour from Australian soft wheat (under investigation) was not suitable for pasta production. It had 7.96% and 25% protein and gluten contents. Its suitability for pasta production showed that the dough strings stretched and many of it broke during drying, in the first stage of drying process. Unfavourable stretching happened in spite of its enough gluten (25%), (Manser, 1981). The low protein content (7.96%) is the responsible of this behaviour. It is suggested that protein content is more important than gluten content in pasta manufactured. This conclusion agree with Frey and Holliger (1972) and Manser (1981). Therefore, gluten content have less important role than total protein in pasta dough.

From the obtained results (Table 8) it could be concluded that stork's have sufficient amounts of protein and gluten to produce high quality pasta products. Wheat milled locally must have sufficient protein (more than 10% in the flour), suitable conditioning lying time and moisture content are important to extract flour or semolina suitable for pasta production.

1. 2.2.2. Protein fractions:

The results concerning the protein fractions content of the different wheat types calculated as percentage of total protein are presented in table (9). Data in table (9) show that Australian soft wheat flour contained approximately equal quantities of albumins and globulins (7.16, and 7.88) while in the other hard wheat flour varieties albumins is higher (ranged between 8.37 and 12.28) than globulins (ranged between 4.07 and 7.88). Also, soluble protein fraction (alb. + glob.) shows slightly difference between different varieties and ranged between 13.49% and 16.61%. Gliadins represent the major proportion of protein fractions for flour and semolina (ranged between 43.25 and 52.20%). Durum semolina gliadins (52.20 and 50.44%) were higher than durum flour's gliadins (44.44 and 45.02%) which could be due to flour high extraction rate. Notable differences in glutenins percentage were observed in soft, and hard wheat, soft wheat flour showed higher glutelins (27.93%) comparing with hard wheat flour of the same variety (21.39%).

Table (9): Protein fractions of T. aestivium and T. durum wheat flours (% of total protein)[1]

Type of wheat flour	Total protein %	Albumins %	Globulins %	Albumins + Globulins	Gliadins %	Glutenins %	Residue %
T. aestivium							
Australian soft wheat[2]	7.96	7.16	7.88	15.04	45.70	27.93	11.33
C.W.R.3 degree flour[2]	12.25	8.3 7	5.12	13.49	43.25	21.39	21.86
T. durum							
Imported semolina (Roma)	14.00	10.58	4.07	14.65	52.20	20.36	12.78
Imported semolina (Buitoni)	13.65	11.9 8	4.17	16.15	50.44	20.88	12.53
Amber canadian 3 flour[2]	14.90	11.11	4.21	15.32	44.44	28.35	11.88
Egyptian stork's flour[(2)]	13.93	12.28	4.39	16.61	45.02	25.38	12.97

(1) On dry basis

(2) Laboratory milled.

This indicate that glutenins content of flour samples were independent of the total protein content but differs among cultivars, (Doekes and Wennekes 1982).

Both gliadins and glutenins are the main constituents of gluten (Vakar, 1961), therefore, their amount in different varieties were about 70% of the total protein fractions. Such results are in agreement with those reported by Simmonds (1978) and Dexter and Matsuo (1979b).

I.2.3. Carbohydrates content of different wheat varieties kernels, flour and semolina.

I.2.3.1. Reducing, non-reducing and total sugars:

The mentioned data in table (10) reveal that durum wheats contained higher percentage of reducing, nonreducing and total sugars than that of *T. aestivum* wheats. Total sugars were 1.36, 1.82, 2.30 and 2.20% in wheat of C.W.R.S. grade 3, Australian soft, Canadian Amber grade 3, and Egyptian stork's varieties respectively. The extracted flour contained 0.89, 1.10, 2.23 and 2.20% for the same wheat varieties respectively.

Vitreous stork's kernels had more sugars (2.40%) than starchy (1.80%). These results are in agreement with those stated by Refai (1965) and El-Gindy (1982).

Table (10): Carbohydrates content and alpha-amylase activity of different wheat varieties Kernels, Flour, and Semolina (on dry basis).

Wheat variety	Reducing sugars %		Non-Red.sugars %		Total reducing sugars %		Starch %		Alpha-Amylase activity(1)	
	Kernels	Flour & semolina	Kernels	Flour & semolina	Kernels	Flour & semolina	Kernels	Flour & semolina	Kernels	Flour & semolina
A) <u>T. aestivitum</u>										
C.W.R.S.3 degree	0.46	0.82	0.85	0.06	1.36	0.89	61.51	82.85	25.64	23.16
Australian soft	0.72	0.33	1.04	0.73	1.82	1.10	69.12	87.29	13.95	16.76
B) <u>T. Durum</u>										
Canadian Amber 3 degree	0.88	0.43	1.35	1.71	2.30	2.23	58.61	78.52	19.93	21.35
Egyptian stork's(Commer.)	0.90	1.14	1.24	1.00	2.20	2.20	59.56	78.58	11.27	22.00
Egyptian Stork's(Vitreous)	0.99	0.34	1.33	-	2.40	-	56.90	75.57	9.97	9.00
Egyptiqn Stork's(Starchy)	0.73	0.44	1.02	-	1.80	-	64.60	79.40	13.99	17.54
C) Imported durum semolina										
Turkey semolina (Roma)	-	0.42	-	1.78	-	2.30	-	78.49	-	13.39
Turkey semolina(Buitoni)	-	0.28	-	1.48	-	1.84	-	78.70	-	15.50
Turkey semolina (Capri)	-	0.32	-	1.52	-	1.92	-	77.80	-	16.40

(1) on 15 % moisture basis.

The imported semolina contained 2.30, 1.84 and 1.92% total sugars for Roma, Buitoni and Capri respectively. The higher sugars content for both durum and hard aestivum wheats flour could be attributed to the higher starch damage content which occur during milling process, (Kingswood,1975) and alpha amylase activity alternatively. Reducing sugars were 0.82,0.33, 0.43, and 1.14% in flour of C.W.R.S. grade 3, Australian,Canadian amber durum grade 3 and Egyptian stork's. Commercial semolina varieties contained 0.42,0.28,and 0.32 % reducing sugars. Higher reducing sugars of stork's flour might be due to the longer conditioning lying time and higher humidity.

1.2.3.2. Starch content

Data in Table (10) show that T. aestivum wheat kernals have higher starch content than durum varieties, kernels starch content ranged between 61.51 and 69.12% in T. aestiv kernels varieties while it ranged between 58.61 to 59.56% in T. durum kernels varieties. Stork's starchy kernels showed higher starch content (64.6%) than vitreous kernels 56.90%, which indicate that there is a negative relationship between vitreousness and starch content. The same trend is shown in table (10) for the extracted flours from the same varieties, Also imported semolina had lower starch content (between 77.80 and 78.70%).

Comparing the starch and protein content of different varieties (tables (8) and (10)) it could be concluded that there is an inverse relation between starch and protein content. The obtained results are in good agreement with those reported by Fraser and Holmes (1959).

1.2.3.3. Alpha-amylase activity:

α-amylase activity data are shown in table (10), C.W.R.S. grade 3 variety showed the higher Alpha-amylase activity (25.64) followed by Canadian Amber durum grade 3 (19.9 3), while Australian soft and stork's had 13.95 and 11.27 . Also stork's vitreous kernels showed less activity (9.97) than starchy(13.99).

Table (10) show the alpha-amylase activity of the extracted flours and imported semolina, alpha-amylase activity for the extracted flours showed the same trend of the whole wheat kernels. Semolina alpha-amylase was 13.39,15.50 and 16.40 for Roma, Buitoni and Capri which was lower than stork's (22.00).

Stork's vitreous flour had lower alpha-amylase activity (9.0) than starchy flour(17.54). Higher alpha-amylase activity of stork's flour could be attributed to long conditionining lying time of wheat (Donnelly, 1982 and Kent 1983) in the flour mill.

Also alpha-amylase activity have a positive relationship with flour extraction rate (Kingswood, 1975). Stork's flour higher alpha-amylase activity could be due to its higher extraction rate, beside the long conditioning lying time.

1.2.4. Lipids and pigements content of different wheat varieties Kernels, Flour and Semolina:

1.2.4.1. Lipids content:

The results of crude lipids of wheat varieties are shown in table (11). The percentage of the extracted crude lipids were 2.20, 1.97, 2.30, and 2.3 % in wheat varieties C.W.R.S. grade 3, Australian soft, canadian Amber grade 3, and Egyptian durum stork's. Respectively while it was 1.23, 1.12, 1.28 and 1.21% in the extracted flours.

Imported semolina had 1.40, 1.04, and 0.96% of lipids for Roma, Buitoni and Capri. From the obtained results it is clear that Australian soft wheat and extracted flour had the lowest percentage of crude lipids (1.97 and 1.12%). The whole wheat kernels had higher crude lipids content than the extracted flour or semolina because of the higher lipids content of the germ and bran as reported by Refai (1965), Crampton and Harris (1969) and Morrison *et al*., (1975).

1.2.4.2. Pigments content:

Data in table (11) show that *T. aestivum* variety is lower in its pigment content than *T. durum*. Pigments

Table (11): Lipids and pigments content of different wheat varieties kernels, flour and semolina.

Wheat variety	Lipids[1] %		Pigments[2] p.p.m.	
	Kernels	Flour & semolina	Kernels	Flour & semolina
A) <u>T. Aestivum</u>				
C.W.R.S. 3 degree	2.20	1.23	4.12	3.1
Australian soft	1.97	1.12	2.8	2.60
B) <u>T. Durum</u>				
Canadian Amber 3 degree	2.30	1.28	6.68	6.00
Egyptian stork's (commercial)	2.30	1.21	7.88	7.10
Egyptian stork's (vitreous)	2.50	1.89	8.57	7.65
Egyptian stork's (starchy)	1.94	1.68	5.78	4.32
C) <u>Imported durum semolina</u>				
Turkey semolina (Roma)	-	1.40	-	6.70
Turkey semolina (Buitoni)	-	1.04	-	7.40
Turkey semolina (Capri)	-	0.96	-	7.00

1 on dry basis.

2 on 12% moisture basis.

content of starchy Egyptian durum kernels (5.78 p.p.m.) is lower than Vitreous kernels (8.57 p.p.m.) . Pigments loss during milling is about 10-25% therefore flour contains less pigment content than kernels. Pigment content of Egyptian durum flour (7.1 p.p.m.) has the same trend of the imported semolina (between 6.70 - 7.40p.p.m.).

From the previous tables the results revealed that vitreous kernels characterized by its higher ash, fiber, total protein, sugar, lipid, and pigment content than starchy kernels. These results are in good agreement with Matsuo (1982).

Also, there must be a way to increase the quality of Egyptian T. durum stork's by increasing the vitreousness and reducing ash content.

For increasing the vitreousness there are two complemental ways. The first One by using the difference in specific weight between vitreous kernel and starchy by using specific gravity separators like Kipp-Kelly tables. Also similar machines which are used in rice sizing or wheat cleaning and grading, depending on kernels specific weight (Anon , 1976). The second way by increasing N fertilization rate, especially giving a dose at heading stage, as mentioned above to reduce endosperm ash content. Heavy nitrogen fertilization have another effects, which

It reduce copper content in wheat as cited by Buckman and Brady,(1960).

II. Effect of conditioning lying time

Triticum durum, Egyptian stork's and Triticum aestivium Australian soft wheat, were used for studying the effect of conditioning lying time (1,5,12,18 and 24 hours at 16 % moisture content) on the extraction rate,the chemical composition and reological properties of the flour. The aim of this study is to find out the most suitable conditioning time for each variety to produce pasta of high quality.

II.1. Effect of conditioning lying time on Triticum Durum, Egyptian stork's.

II.1.1. Effect of conditioning on flour yield and flour chemical composition:

Data in table (12) show that after 1 h lying time moisture penetration into the central endosperm was incomplete. Flour obtained after 1 h lying time contains higher amount of ash content (1.0%) indicating that separating of husk and endosperm during milling was not complete . Also after 1 h lying time the enzymatic activity of alpha-amylase, protease and lipoxidase was at minimum. These results are in a good agreement with those

Table (12): Conditioning lying time effect on T. Durum. (Egyptian stork's)[1]

I- Flour yield and its chemical composition (on dry basis)

Lying Time (Hours)	Flour yield ext. rate %	Moisture %	Ash %	Lipids content %	Sugars: Reducing	Sugars: Non reducing %	Sugars: Total reducing sugars %	Alpha-amylase activity (PLN)(2): Wheat	Alpha-amylase activity (PLN)(2): Flour	Non-protein nitrogen %	(3) Pigment ppm	Browning at 400nm A	(4) Reducing sugar / non protein nitrogen
1	72.09	12.9	1.00	2.40	0.38	1.66	2.13	13.27	11.75	0.156	6.6	0.150	control
5	72.69	14.2	0.89	1.98	0.78	1.31	2.16	13.92	12.13	0.184	7.1	0.160	4.88:1
12	72.88	14.3	0.88	1.53	1.38	1.20	2.64	18.52	13.13	0.234	6.7	0.178	3.10:1
18	72.15	14.2	0.88	1.40	1.46	0.93	2.44	29.00	14.74	0.270	6.5	0.180	2.25:1
24	71.78	14.2	0.88	1.32	1.24	1.00	2.30	32.00	16.57	0.305	6.4	0.188	1.46:1

(1) Wheat conditioned at 16% moisture content, milled in lab.

(2) on 15 % moisture basis.

(3) on 12% moisture basis.

(4) Reducing sugar/non protein nitrogen = $\dfrac{\text{Reducing sugar}}{(\text{Non protein nitrogen at time} - \text{non protein nitrogen at 1 hour}) \times 5.7}$

reported by Staudt and Zieglar (1973). Pigments concentration was low after 1 h lying time (6.6 p.p.m.),according to Dexter and Matsuo (1978b)observation that pigment loss increase with increasing extraction rate.

To calculate the ratio of reducing sugars to non-protein nitrogen samples of 1 h lying time proposed to be the control for studying the non-enzymatic browning during different lying times (5, 12, 18 and 24 h).

Also, data in table (12) show that increasing lying time was accompanied by slight decrease in the extraction rate (72.09 to 71.78) in the same time a slight increase in flour moisture content was observed (from 12.9% to 14.2%) Also, ash content fell sharply with increasing wheat moisture content (from 1.00 to 0.88). The lowest ash content (0.88%) is approximately equal to the ash maximum limit (0.9%) reported by the Egyptian standard quality (Anon 1983). These observations may be due to the easier separation of the endosperm from the bran coat at high moisture contents leading to less contamination of the flour by aleurone layer and hence to lower ash values. The same observations were recommended by Hook _et al._,(1982a).

Increasing conditioninig lying time, activate different hydrolysing enzymes (Refai, 1965). Therefore reducing sugars increased from 0.38% after 1 h to 1.24% at the end of 24 h . At the same time non-reducing sugars decreased from 1.75% to 0.98% after 18 h then start to increase. Also, total sugars content reached its maximum (2.64%) after 12 h Reduction in total sugars after 18 and 24 h could be due to their mobilization and consumption during conditioning. Alpha amylase activity increased in both wheat kernels (from 13.27 to 32.00) and flour (from 11.75 to 16.57) by increasing lying time from 1 hr. to 24 h The alpha-amylase activity was higher in wheat kernels than flour. This phenomenon is due to the fact that α-amylase activity is restricted to the aleurone and scutellum layers of mature wheats. Even at relatively high levels of alpha-amylase activity in the whole grains, there is initially very little activity within the inner endosperm. So that the level of alpha-amylase is reduced considerably on milling. These observations are in good agreement with those reported by Refai (1965).

Results in table (12) show that during conditioning, non-protein nitrogen increased from 0.156% after 1 h and reached its maximum 0.305% after 24 h due to increasing proteases activity by increasing moisture content.

Also, total lipids content showed gradual decrease during conditioning and reached its minimum value after 24 h. (from 2.4% to 1.32%). The reduction could be attributed to lipase activity. The obtained results concerning lipids reduction which was accompanied by increasing soluble carbohydrates are in agreement with those reported by Mayer and Anderson (1952).

Pigment content reduced by advancing the time up to 24 h (after 7.1 to 6.4 p p m). Pigment reduction could be attributed to pigment destruction by lipoxidase elongation as conditioning progressed. Also Brennan (1982) found that longer periods of conditioning cause pigment changes resulting in loss of colour.

Data in table (12) show the ratio of reducing sugar to the amino acids which released during stork's conditioning lying time. The obtained ratios were (4.88:1),(3.10:1) (2.25:1) and (1.46:1) after 5, 12, 18 and 24 h conditioning lying times respectively. The reducing sugar/amino-acids are of great importance in maillard reaction. According to Abd El-Salam (1982), brown colour production is relatively slow at reducing sugar/amino acids of 10.1 or even 2:1 but, at ratios of 1:1 and 1:5 brown colour is strongly accelerated.

II.1.2. Effect of conditioning on rheological properties:

The effect of conditioning lying time on Farinograph test is presented in table (13) and illustrated in fig.(1). Water absorption percentage for the extracted flour after 1 h conditioning lying time showed the higher ratio (63.14%).

Dough development (1.75 min), arrival (0.5 min) and stability (5.1 min) times and valorimeter value (41) were higher in the sample conditioned for 5 h , while water absorption (60.87%) and weakening of the dough (75 B.U.) showed its lowest value after 5 h conditioning.

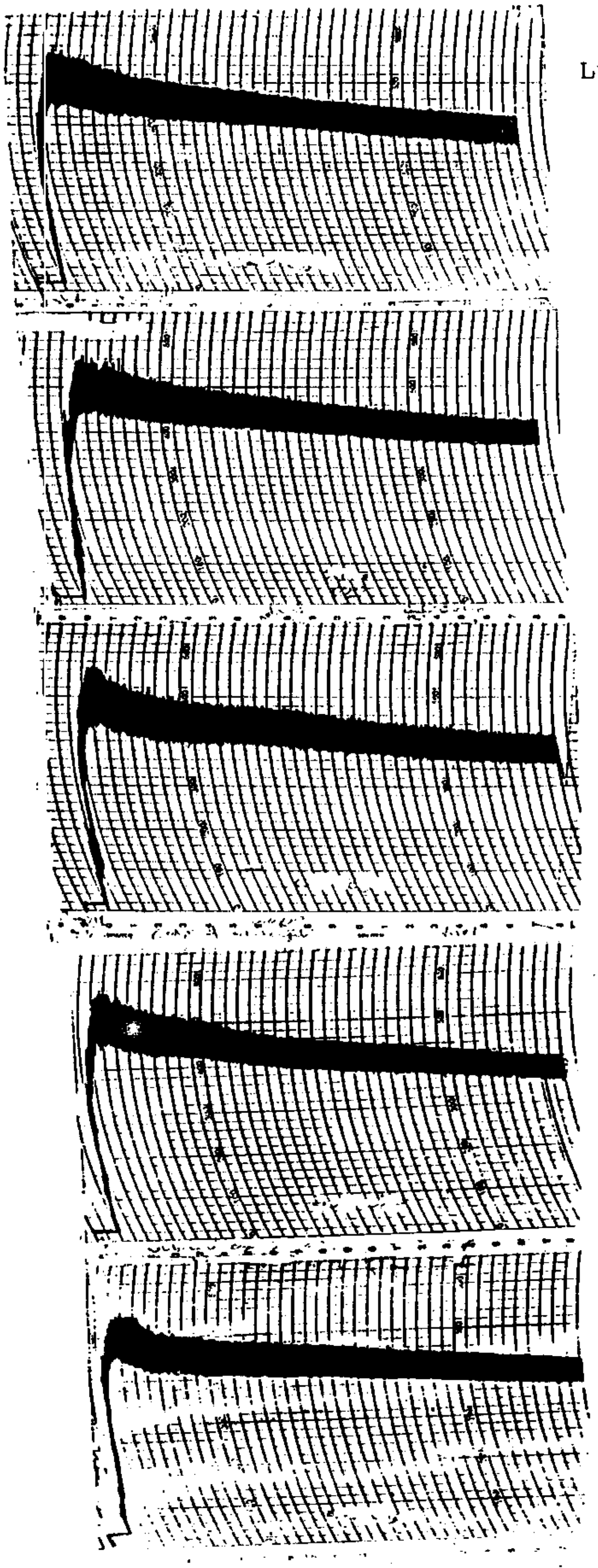
Semolina and flour which are low in Farinograph water absorption are of great demand for pasta dough property that give a homogenous dough mass for macaronia processing. The increase in mixing time for pasta dough is associated with stronger gluten (Irvine et al.,1961 and Dexter and Matsuo, 1978a) Also from table (12) lying time 5 h yield contains higher pigment content (7.1 p p m) and its browning reducing sugars and non-protein nitrogen is less than the later lying time. Also the ratio of reducing sugars/ amino acids is higher than the later lying times. Therefore conditioning lying time for 5 h is preffered for Egyptian durum stork's to yield pasta of good quality. These results are in good agreement with that obtained by Brennan (1982).

Table (13): Conditioning lying time effect on rheological properties of T. Durum (Egyptian stork's).

Farinogram

Conditioning lying time hours	Water Absorption (1) %	Dough development min	Dough arrival time min	Dough stability min	Weakening of the dough B.U.	Valorimeter value	Degree of softening after 10 min B.U.	Degree of softening after 20 min B.U.
1	63.14	1.3	0.4	5.5	80	41	65	110
5	60.87	1.75	0.5	5.1	75	41	60	105
12	60.96	1.4	0.5	3.0	105	38	70	115
18	61.44	1.3	0.3	3.75	100	36	85	140
24	63.09	1.3	0.3	2.75	90	40	65	110

(1) at 14% moisture content.



Lying time

1 hour

5 hours

12 hours

18 hours

24 hours

Fig (1)Effect of conditioning lying time on T. Durum stork's farinogram.

II.2. Effect of conditioning lying time on Triticum aestivium, Australian wheat:

II.2.1. Effect of conditioning on flour yield and its chemical composition:

Data in table (14) indicate that flour yield and ash content showed a slight decrease with increasing flour moisture content. Flour yield decreased from 74.27% after 1 h to 72.78% after 24 h , also ash content decreased 0.51% T. aestivium contains low amount of ash content due to its soft endosperm texture. The moisture content of flour increased from 13.9% after 1 h to 14.3% after 24 h . At one hour conditioning lying time, the moisture content of T. aestivium (13.9%) was higher than that of T. durum (12.9%) at the same lying time. This observation is due to the fact that endosperm structure is of primary importance in controlling water penetration rates and the soft endosperm structures permitted more rapid water movement than did hard endosperm structures. The reducing sugars increased (from 0.45 to 1.50%) till 18 h lying time and then began to decrease to 1.07% at 24 h non-reducing sugars decreased from 1.52 to 0.94% after 1 and 24 h . respectively.

Data in table (14) show also a positive relation between browning, alpha amylase activity and non-protein

Table (14): Conditioning lying time effect(1) on T. Aestiv

1- Flour yield and its Chemical Composition (on dry basis)

Lying time (hours)	Flour yield ext.rate (2)	Moisture	Ash	Lipids content	Sugars			Alpha-amylase(3) activity (P.L.N.)		Non protein nitrogen	(4) Pigment	Browning at 400 nm	Reducing sugar / non protein nitrogen (5)
					Reducing	non reducing	Total	Wheat	Flour				
	%	%	%	%	%	%	%			%	p p m	A	
1	74.27	13.9	0.77	2.29	0.45	1.44	1.97	15.00	13.95	0.0499	2.29	0.150	control
5	72.50	14.0	0.50	2.19	0.90	1.24	2.20	16.80	15.23	0.084	2.54	0.160	4.51:1
12	72.94	14.3	0.62	2.11	1.30	1.13	2.49	20.90	16.48	0.101	2.85	0.177	4.38:1
18	72.56	14.5	0.62	1.88	1.50	0.95	2.50	25.00	17.00	0.130	2.23	0.193	3.25:1
24	72.78	14.3	0.51	1.54	1.07	0.89	2.01	30.20	17.59	0.150	2.68	0.197	1.86:1

(1) Wheat conditioned to 16% moisture, and milled in lab.

(2) on 14% moisture content basis.

(3) on 15% moisture content basis.

(4) on 12% moisture content basis.

(5) Reducing sugar/non protein nitronge = $\frac{\text{Reducing sugar}}{(\text{non protein nitrogen at time} - \text{non protein nitrogen at 1 hour}) \times 5.7}$

nitrogen. The alpha amylase activity increased twice in wheat kernels (from 15.00 to 30.20) while its increment in flour was very slight , (from 13.95 to 17.59). Pigment amount showed a positive correlation between pigment content and the extraction rate, higher extraction rate yield high pigment content and vice versa. Total lipids content decreased by increasing conditioning lying time (from 2.29% to 1.54%). Such reduction in lipids content could be attributed to lipases activity at high moisture content.

The reducing sugar to amino acids ratios showed reduction in their ratios from 4.51:1 to 1.86:1 at 1 and 24 h respectively.

II.2.2. Effect of conditioning on rheological properties:

Table (15) and fig (2) show the rheological properties of *T. aestivium*, which is a soft wheat and used in producing farina or bread-making. The results showed that water absorption was low (57.0%) at 12 h . lying time. The mixing time and arrival time increased gradually by increasing conditioning lying time which indicate that *T. aestivium* contains stronger gluten content than *T. durum*. On the other side *T. durum* protein content (13.43%) is higher than *T. aestivium* (7.96%). Dexter and Matsuo (1978a) reported the same observations and concluded that pasta quality largely

Table (15): Conditioning laying time effect on rheological properties of *T. aestivium*.

2- Farinogram

Conditioning lying time (hours)	Water[(1)] absorption %	Dough developing time min	Dough arrival time min	Dough stability min	Weakening of the dough B U.	valorimeter value	Degree of softening after 10 min B u.	20 min B U.
1	55.3	2.3	1.2	5.0	105	40	85	110
5	57.5	2.0	1.2	4.8	105	40	95	115
12	57.0	2.2	1.0	4.7	110	40	80	105
18	57.7	2.2	1.25	4.5	115	39	95	115
24	56.9	2.7	1.5	4.7	80	40	70	100

(1) On 14% moisture basis.

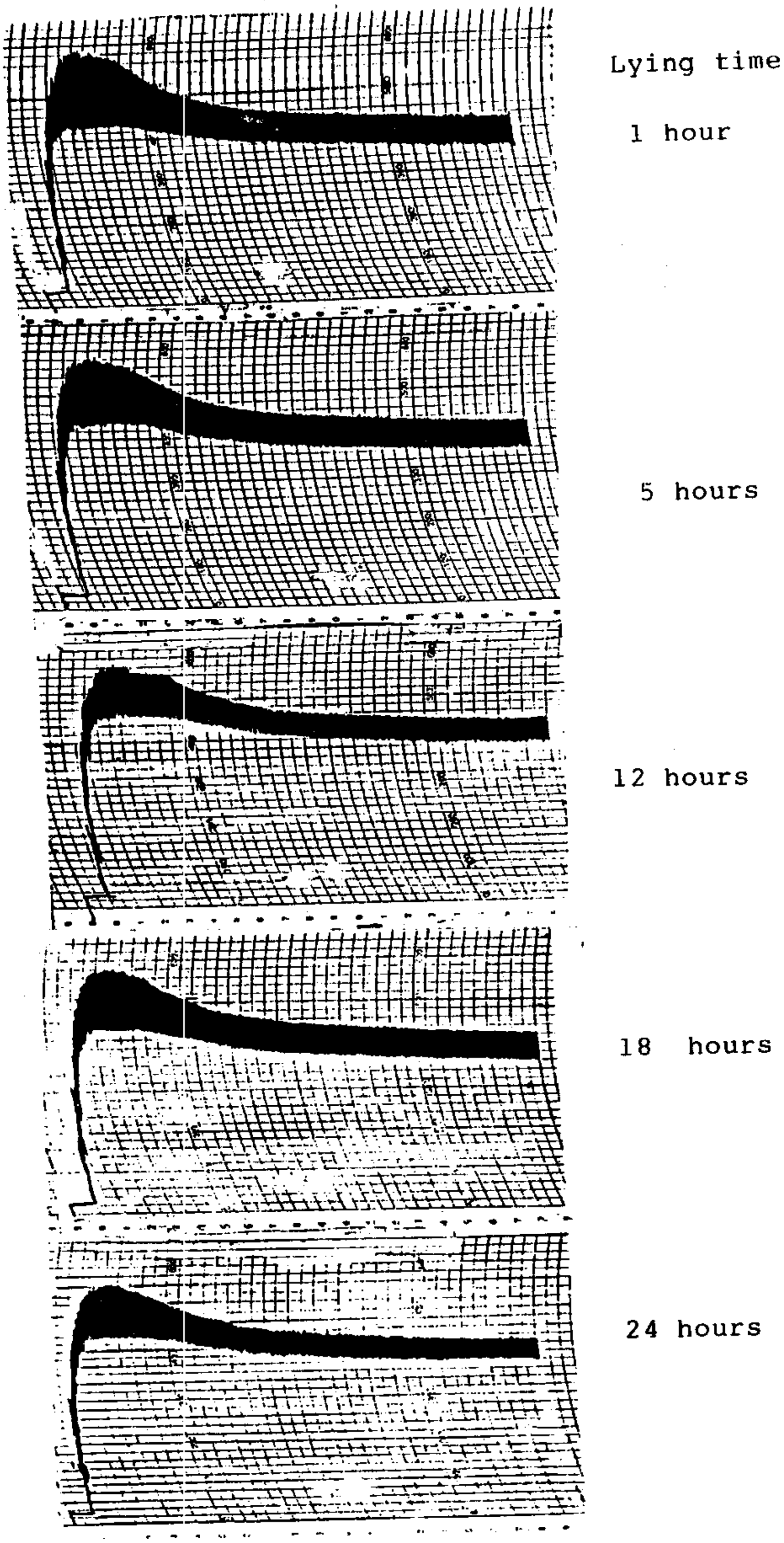


Fig (2) : Effect of conditioning lying time on
T. aestivium farinogram.

attributed to protein content and the nature of the protein within the gluten complex. Dough stability was high (4.7 B U.) at 12 h. conditioning, while valorimeter value was high (40 B U.) at the same conditioning time.

From tables (14) and (15) it can be concluded that 12 h. conditioning lying time is suitable for Australian T. aestivium to produce farina or flour with good quality. The obtained results are in agreement with those reported by Gobky (1972).

III- Pasta Browning:

Colour is an important indicator to pasta quality. This part of dissertation will concern to find reasons of browning in pasta produced from both Egyptian durum stork's, and common wheat flour (72%).

Results concerning the characteristics of spaghetti macaroni are shown in table (16). The obtained results indicate that T. durum stork's pasta was brown and had the highest grade colour value (10.6) while pasta made from imported semolina, Roma, Capri, and Buiotoni was yellow and had the lowest grade colour (3.5, 3.6 and 3.3). T. aestivium pasta; Amoun and Mataria had brown and bale brown colour and lesser grade values than stork's (8.4 and 4.1).

According to Thompson (1950) brownness in maccaroni was attributed to varietal, bran contamination, enzymatic

Table (16): Chemical characteristics of spaghetti Macaroni effective factors of colour (on dry basis).

Spaghetti	Appearance	Ash content %	Grade colour Figure	Browning A at 400 nm		Cu content p p m	Alpha Amylase activity (1)	Pigment of (2)			Reducing sugar %	Non N protein %	Available lysine		
				Flour	Pasta			Flour p p m	Pasta p p m	Loss %			Flour %	Pasta %	Loss %
T. aestivium															
"Amoun	Brown	0.46	8.4	0.159	0.113	0.302	16.26	3.16	2.05	35.12	0.27	0.121	0.27	0.22	18.5
Mataria	Bale brown	0.42	4.1	0.130	0.078	0.299	18.80	2.60	1.62	37.69	1.90	0.135	0.25	0.20	20.0
T. Durum															
Roma	yellow	0.73	3.5	0.153	0.103	0.590	16.39	6.70	5.21	22.24	1.08	0.120	0.30	0.24	20.0
Capri	yellow	0.76	3.6	0.145	0.092	0.936	13.10	7.00	5.98	14.57	0.80	0.110	0.30	0.255	18.3
Buitoni	yellow	0.72	3.3	0.150	0.095	0.806	15.26	7.40	5.70	23.00	0.71	0.100	0.30	0.255	18.3
Stork's	Brown	1.05	10.6	0.200	0.135	0.933	19.22	7.10	3.45	51.41	2.89	0.274	0.31	0.23	25.8

(1) Reported on 15% moisture content.

(2) Reported on 12% moisture content.

reaction and non-enzymatic (Maillard reaction). Both of these factors will be discuss in this chapter.

III.1. Factors affecting pasta brownness

III.1.1. Varietal

Browning determination of flour and semolina and their pasta (table 16) indicated that stork's flour and pasta had the heighest browning absorption, non protein nitrogen (0.274%) and copper content (0.933 p p m). Therefore stork's pasta brown colour could be attributed to cupper-protein complex as reported by Matsuo and Irvine (1967). Copper content was not the main factor for pasta browning because imported semolina of Capri and Buitoni had yellow pasta colour with the same copper content approximately (0.936 and 0.806 p p m) Roma pasta had lesser copper content (0.590 ppm). Amoun and Mataria (*T. aestivium*) had the lowest copper content (0.302 and 0.299 p p m) and had brown and bale brown colours. Macaroni produced from imported semolina with pasta pigment content ranged between (5.21-5.98 p.p.m). Roma, Capri, and Buitoni have a yellow colour appearance and its grade colour was 3.5, 3.6 and 3.3 respectively. On the other hand Macaroni produced from Stork's and *T. aestivium* flour (Amoun and Mataria) have a brown colour and its grade colour was 10.6, 8.4 and 4.1 respectively.

Although, Egyptian stork's flour pigment content was in the same amount of imported semolina (7.10 p p m) its pigment loss was 51.41% during pasta processes while the imported semolina loss was between 14.57 to 23.0%.

Flour pigment content of T. aestivium variety (3.16 and 2.60 p p m) was much lower than T. durum varieties (ranged between 6.70 and 7.40 p p m).

From table (16) it is clear that brown colour appearance is a varietal factor due to the lipoxidase(Kobrehel et al .,1974) which developed during grain maturation and activate during pasta processing.

III.1.2. Bran contamination:

Data in table (16) indicated that stork's pasta had the highest ash content (1.05%). Higher ash content beside high fiber content (0.35%) indicated that stork's pasta was processed from flour with higher extraction rate than (72%). Also ash content of stork's was higher than that reported by Ashour (1985) who found that stork's flour 72% extraction had 0.67% ash content. Pasta made from semolina Roma, Capri, and Buitoni had 0.73, 0.76 and 0.72% ash content respectively. The lowest ash content (0.46 and 0.42%) for Amoun and Mataria is due to its process from high starchy hard and soft wheat flours, which its ash content was low.

However, higher extraction followed by higher enzymes activity affected pasta browning during processing.

III.1.3. Enzymatic reaction:

Data recorded in Table (16) indicate that stork's pasta had the highest pigment loss during processing (51.41%) while, Roma, Capri, and Buitoni had the lowest loss (22.24, 14.57 and 23.00% respectively). Spaghetti processed from *T. aestivium* had 35.12 and 37.69% pigment loss for Amoun and Mataria respectively.

The obtained results indicate that pigment loss of Roma and Buitoni pasta is in agreement with those reported by Matsuo et.al (1970), who reported that pigment loss percentage during processing was 20-24.2% in pasta from durum, and 31.94 -33.49% in pasta from hard red spring wheat.

Due to stork's highest pigment loss during processing, stork's spaghetti had the lowest pigment content (3.45 p p m) comparing with other durum spaghetties (5.21, 5.98, and 5.70 p p m in Roma, Capri, and Buitoni respectively). The obtained results show that lipoxidase activity is higher in Egyptian durum stork's than that of the imported semolina. Thus pigment loss during pasta processing is caused by lipoxidase enzyme, (Irvine 1971, Dexter and Matsuo, 1978b and 1979a).

Data tabulated in table (16) reveal a positive correlation between pigment loss percentage and brownness during pasta processing, and this conclusion is in agreement with Matsuo et al.,(1982).

High lipoxidase activity could be attributed to varietal characteristics, (Walsh et al.,1970), high extraction rate (Dexter and Matsuo, 1978b, and Matsuo et al.,1982) and long conditioning lying time with high moisture content.

III.1.4. Non enzymatic reaction (Maillard reaction):

Data in table (16) show that stork's spaghetti had the highest lysine loss percentage (25.8%) during pasta processing while loss percentage ranged between 18.3-20.0 % in other spaghetties. Lysine loss could be attributed to Maillard reaction (nonenzymatic) which occured during pasta drying (Lysine blocking) in addition to some lysine destruction, (Manser, 1981). The highest lysine loss in stork's pasta could be attributed to its high reducing sugar content (2.89%) and high non protein nitrogen content (0.274%)which accelerate Maillard reaction. During storage, advances in Maillard reactions takes place and stork's spaghetti becomes browner and duller by time.

IV- Pasta Quality

IV-1- Rheological properties of different commercial macaroni samples:

Rheological properties of dough depends mainly on the chemical constituents of flour or semolina. Data in table (17) and figure (3) showed the farinogram of *T. aestivum* flour and *T. durum* flour and semolina under investigation. The results showed that the semolina samples had the lowest value (between 50.0 and 50.9%) for farinogram water absorption compared with the other three samples which had values of 63.4, 53.7 and 62.1% for the respective samples Amoun, Mataria and stork's. Semolina and flour which are low in water absorption are of greatest demand for pasta dough properity that give a homogeneous dough mass for macaroni processing. Dough development time (D.D.T.) was higher in semolina samples (between 3.1 and 3.2 m.n) than other flour samples under investigation. Stork's D.D.T. was the lowest one (1.2 mim.).Usually the decrease in mixing time for pasta dough is associated with weaker gluten (Irvine et al.,(1961)and Dexter and Matsuo (1978a).

Regarding dough stability and weakening,it was found that semolina and stork's showed short periods of dough stability (between 2.0 and 2.4 min.) while Amoun had the highest

Table (17): Farinogram of flour and semolina of commercial pasta[1].

Pasta Flour and semolina	Water absorption %	(D.D.T.) Dough development time min.	Arrival time min.	Dough stability min.	Degree of softening after 10 min.	 20 min	Valorimeter value
T. aestivium							
Flour of Amoun	63.4	2.6	1.6	6.7	55	95	45
Four of Mataria	53.7	1.5	0.7	4.0	90	130	35
T. durum							
Semolina of Roma	50.8	3.2	1.0	2.4	90	115	37
Semolina of Capri	50.0	3.1	1.0	2.0	90	120	36
Semolina of Buitoni	50.9	3.2	1.3	2.2	90	115	37
Flour of Stork's	62.1	1.2	0.3	2.0	125	165	30

(1) On 14% moisture basis.

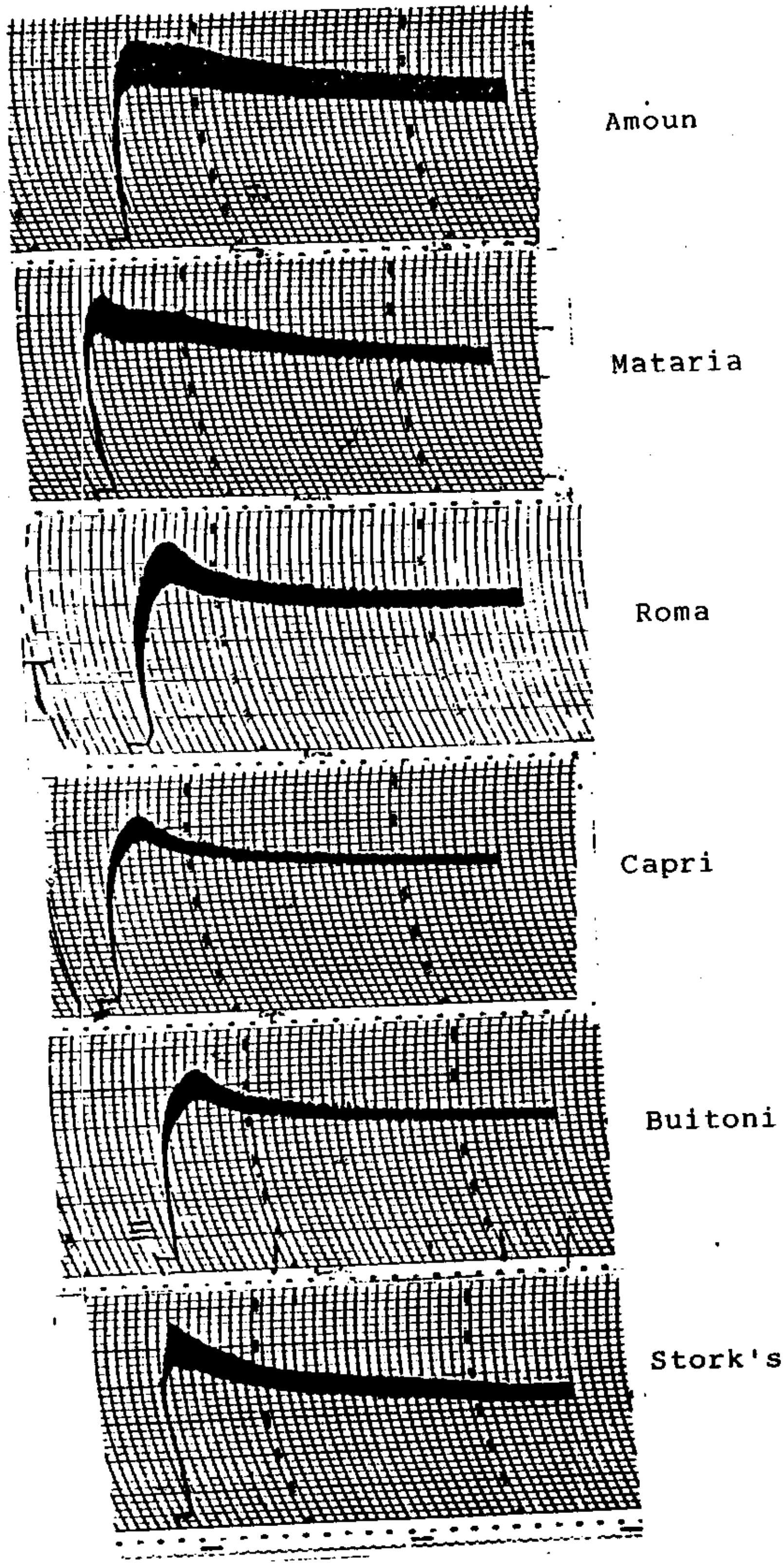


Fig (3) Farinogram of pasta dough

dough stability (6.7 min.). On the other hand semolina and stork's had the highest dough weakening (between 115 and 120 B.u for semolina and 165 B.u for stork's) ,while Amoun had the lowest dough weakening (95 B.u). Weaking of the dough (B.u) is a very important factor affecting its suitability for macaroni production. In this respect the ideal dough should rise to a peak fairly rapidly and should break slowly in the farinogram (Irvine and Anderson 1951). On the other hand, increasing dough weakening would in turn increase dough suitability for macaroni production (Morad et al., 1980).

Amoun had the highest valorimeter value (45) while, stork's had the lowest one (30), Other samples under investigation had valorimeter value between 35 and 37.

Table (17) and Figure (3) showed that Mataria has weaker gluten due to its low protein content (7.96 %). Also, Egyptian durum stork's has weaker gluten which attributed to protein quality and unfavourable milling conditioning which accelerate the enzymatic activity and weaked dough of stork's flour.

IV-2- Cooking quality of different commercial macaroni samples:

Data of macaroni cooking quality processed from *T. aestivium* and *T. durum* flour and semolina are presented in table (18).Results showed that water absorption,increasing of weight and swelling index for pasta processed from *T. aestivium* are lower than those from *T. durum*. Cooking loss are higher in *T. aestivium* pasta than those from *T. durum*. These results are in agreement with those reported by Anon (1983). It is clearly shown that semolina of capri, Roma, Buitoni and Stork's flour gave the greatest increase of weight 385, 368, 357 and 365, their swelling index was 5.1, 4.8 , 4.6 and 4.8 respectively. Other samples of Amoun and Mataria increasing of weight was 301 and 290 while their swelling index was 4.0 and 3.5 respectively. In considering the values of water absorption during cooking, it was found that semolina and stork's had the highest one, while Amoun and Mataria had the lowest one. The cooking loss (total soluble solids) showed a reverse correlation with water absorption . Samples higher in their absorption are lower in their cooking loss and vice versa. These results are in agreement with Pomeranz (1978) who reported that when comparison was made between macaroni products from durum semolina and those from soft bread wheat, the former products gave very small residue in their cooking liquor than those of the latter especially if they had high levels of proteins. Therefore, samples with lowest amount of total soluble solids, high protein content, slight weaking of gluten properties and high percentage weight, and volume after cooking were of a good cooking quality.

Table (18): Cooking quality of different commercial macaroni.(on 12% moisture basis).

Macaroni type	Water absorption %	Increasing of weight %	Swelling index %	Cooking loss %
T. aestivium				
Amoun	210	301	4.0	8.9
Mataria	200	290	3.5	9.8
T. Durum				
Roma	275	368	4.8	6.7
Capri	292	385	5.1	7.0
Buitoni	268	357	4.6	7.0
Stork's	274	365	4.3	6.8

IV-3- Improvement of pasta quality processed from *T. aestivium* and Egyptian durum stork's:

Generally flour from bread wheat is the raw material used for macaroni production in Egypt by local sector. In the same time many efforts were done to processed macaroni from stork's cultivated in upper Egypt. Macaroni processed from common wheat or stork's have an unfavourable colour apperance (brown) and low grade of cooking quality. Therefore a trial was suggested to improve macaroni quality through the addition of ascorbic acid and wheat germ flour in different concentrations.

IV-3-1- Effect of ascorbic acid addition on pasta colour:

Ascorbic acid is an antioxidant,and commonly used to preserve the yellow colour of carotenoids pigment in pasta produced from durum and common wheat flour. (Walsh *et al.*, 1970). Ascorbic acid was added in concentration of 50,100, 1000 p p m. Results are shown in table (19) . Results showed that ascorbic acid has a superior effect for preventing pigment loss during pasta processing. In *T. aestivium* pigment loss was 56.70% in the original pasta sample and decreased geradually to 53.68%, 47.89 and 41.61% due to the addition of 50, 100 and 1000 p p m. of ascorbic acid respectively. the same time the browning reaction decreased

Table (19): Effect of ascorbic acid addition on pasta model systems colour[(1)]

	Addition of ascorbic acid p.p.m.	Addition + flour pigment p.p.m	Pasta model pigment p.p.m	Pigment loss %	Pasta appearance	Pigment increasement treatment/control %	Browning	
T. aestivium	-	2.85	1.234	56.70	White	100.00	0.177	Control
	50	2.85	1.320	53.68	pale yellow	107.00	0.159	
	100	2.85	1.485	47.89	yellow	120.34	0.117	
	1000	2.85	1.664	41.61	yellow	134.83	0.140	
T.Durum var. Stork's	-	5.80	2.79	51.89	not yellow	100.00	0.103	Control
	50	5.80	3.98	31.38	Pale yellow	142.65	0.083	
	100	5.80	4.07	29.83	yellow	145.88	0.078	
	1000	5.80	4.81	17.07	yellow	172.40	0.058	

(1) Flour moisture 14.2%, 5 h conditioning lying time for stork's.

Flour moisture 14.3%, 12 h conditioning lying time for Australian.

from 0.177 to reach 0.140 at 1000 p p m by adding ascorbic acid. In the case of stork's Pasta addition of ascorbic acid with 50, 100 and 1000 p p reduced pigment loss to 31.38, 29.83 and 17.07%, as a result of pigment increment pasta browning decreased from 0.103 to reach 0.058 at 1000 p.p.m. addition. Results showed also that ascorbic acid is more effective in preventing pigment loss of stork's pasta than australian wheat pasta due to the high pigment content of the former (5.80 p p m) than the later (2.85 p p m). Pasta colour appearance showed a yellow colour at 100 and 1000 p p m. addition. Colour improvement due to ascorbic a cid addition is due to fully competitive inhibition of wheat lipoxidase (Walsh et al.,1970).

IV-3-2- Effect of wheat germ addition on pasta colour:

Wheat germ processed contains carotenoids (12.76 p p m) vitamin B (thiamin, riboflavin, nicotinic acid, B_6, and folic acid) and tocopherol (0.025%) (Refai, 1965, and Wenlock et. al. 1983) . So, it was added to wheat flour to improve colour and nutritional value specially in high addition. Tocopherol is an antioxidant which will prevent pigment loss through its inhibition of oxidative enzymes (lipoxidase enzymes). Results in table (20) showed the effect of wheat germ addition (0.1, 1.0 and 10%) on pasta model systems colour. Results showed that T. aestivium pasta pigment loss decreased from 56.70 to 50.41% after 10% wheat germ addition. On the other hand pigment increasment was 155.1% (at 10 %

Table (20): Effect of wheat germ processed addition on pasta model systems colour[1].

	Addition of wheat germ processed %	Addition + flour pigment p.p.m.	Pasta model pigment p.p.m.	Pigment Loss %	Pasta appearance	Pigment increasment treatment / control %	Browning	
T. aestivium	-	2.85	1.234	56.70	white	100.00	0.177	control
	0.1	2.86	1.354	52.66	pale yellow	109.72	0.166	
	1.0	2.95	1.505	48.98	yellow	121.96	0.153	
	10.0	3.84	1.904	50.41	deep yellow	155.10	0.070	
T. durum var. stork's	-	5.80	2.79	51.89	not yellow	100.00	0.103	control
	0.1	5.81	3.30	43.20	yellow	118.07	0.075	
	1.0	5.87	4.23	27.94	yellow	151.54	0.064	
	10.0	6.50	5.59	14.00	deep yellow	203.07	0.026	

(1) flour moisture 14.2%. 5 h conditioning lying time for stork's.
flour moisture 14.3%, 12 h conditioning lying time soft australian.

addition), while browning of pasta decreased from 0,177 to 0.07.

Also, the obtained results showed that addition of wheat germ to stork's pasta decreased pigment loss from 51.89% to reach 14.0% at 10% wheat germ addition, The pigment increasment reached 203.07% while, browning of pasta decreased from 0.103 to 0,026 (at 10% addition). The abtained results showed that stork's pasta had higher improvement in pigment loss and pasta browning than aestivum pasta. Addition of 1% wheat germ to eastivum pasta yields a yellow coulour appearance of pasta. while 0.1% addition to stork's pasta yields the same yellow colour appearance. There are no available data about wheat germ processed addition. Addition of 1.0% wheat germ processed is suitable to avoid gluten dilution of dough.

IV-3-3 Addition effect of ascorbic acid and wheat germ on pasta colour:

To avoid wheat germ addition disadvantage (dough weakness), experiment was established to add ascorbic acid (dough and coulour improver at levels (50 and 100 PPM) to pasta dough containing wheat germ processed (0.1%).

Data in table (21) revealed that these combination reduced browning, pigment loss and increased bigment relative to the control alternatively even in aestivium and stork's pasta. Good results were obtained when 0.1% wheat germ processed plus 100 PPM. ascorbic acid were added to the dough.

Table (21): Effect of ascorbic acid plus wheat germ processed addition on pasta model systems colour.

	Addition		Addition + Flour pigment	Pasta model pigment	Pigment loss	Pasta appearance	Pigment increasment treatment / Control	Browning
	wheat germ processed %	Ascorbic acid p p m	p p m	p p m	%		%	
T. aestivium	0.1	50	2.86	1.40	51.04	pale yellow	113.45	0.113
	0.1	100	2.86	1.59	44.16	yellow	129.41	0.103
T. durum var *Stork's*	0.1	50	5.81	4.14	28.67	yellow	148.38	0.083
	0.1	100	5.81	4.34	25.30	yellow	155.55	0.079

IV-4-Rheological properties of pasta model systems:

To evaluate the affect of wheat germ and ascorbic acid addition the rheological properties of pasta dough were studied.

IV-4-1- Effect of wheat germ processed addition on farinogram :

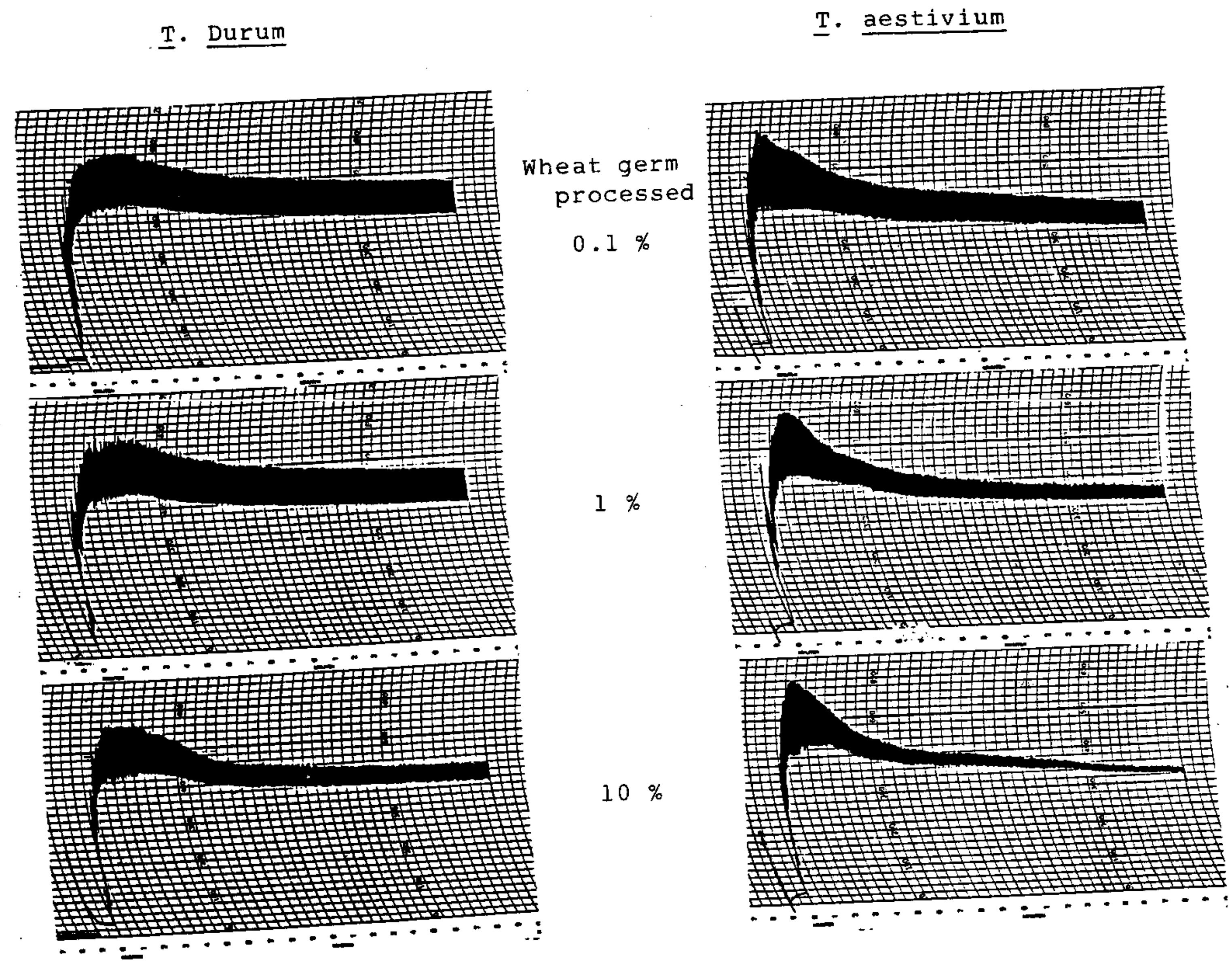
Data in table (22) and Figure (4) illustrated the affect of wheat germ addition on farinogram. In both aestivium and stork's dough, wheat germ processed addition weakened dough, it reduces dough development time (D.D.T.), arrival time, stability and valorimeter value. On the other hand water absorption and degree of softening increased. Weakened of the dough was attributed mainly to wheat germ glutathion content and gluten dilution. Glutathion activates dough protease enzymes which weakenes the dough (Refai, 1965 and Staudt and Ziegler , 1973). Weakness affect of the dough can be observed also by the decreasing of the width ratio. In *T. aestivium* width ratio was 0.294 in the control and decreased to 0.226 and 0.056 at 1.0 and 10% wheat germ addition. The same trend was also observed in *T. durum* stork's farinogram, the width ratio decreased from 0.65 to 0.59 , 0.47 and 0.31 in control, 0.1, 1.0 and 10% addition respectively.

Table (22): Effect of wheat germ processed addition on farinogram of *T. aestivium* and *T. Durum*.

Wheat germ addition %	Water(1) absorption %	Dough develop-ment time min.	Arrival time min.	Dough stability min.	Degree of softening after 10 min. B.U.	Degree of softening after 20 min. B.U.	Valorimeter value	Width ratio
T. aestivium								
-	54.5	1.4	0.7	3.8	100	140	34	0.294
0.1	54.7	1.3	0.6	3.7	105	140	33	0.297
0.1	54.8	1.7	0.7	2.7	125	155	31	0.226
10.0	56.5	1.3	0.7	2.7	120	170	30	0.056
T. Durum								
-	65.4	3	1.3	8.2	50	70	52	0.650
0.1	65.6	3	1.7	7.7	55	85	50	0.592
1.0	65.7	2.1	0.8	8.5	50	80	46	0.470
10.0	66.2	1.8	0.6	4.8	70	95	41	0.310

(1) on 14 % moisture basis

(2) $\text{Width ratio} = \frac{\text{width of the curve end (at 20 min.) in cm.}}{\text{width of the maximum width of the curve in cm.}}$



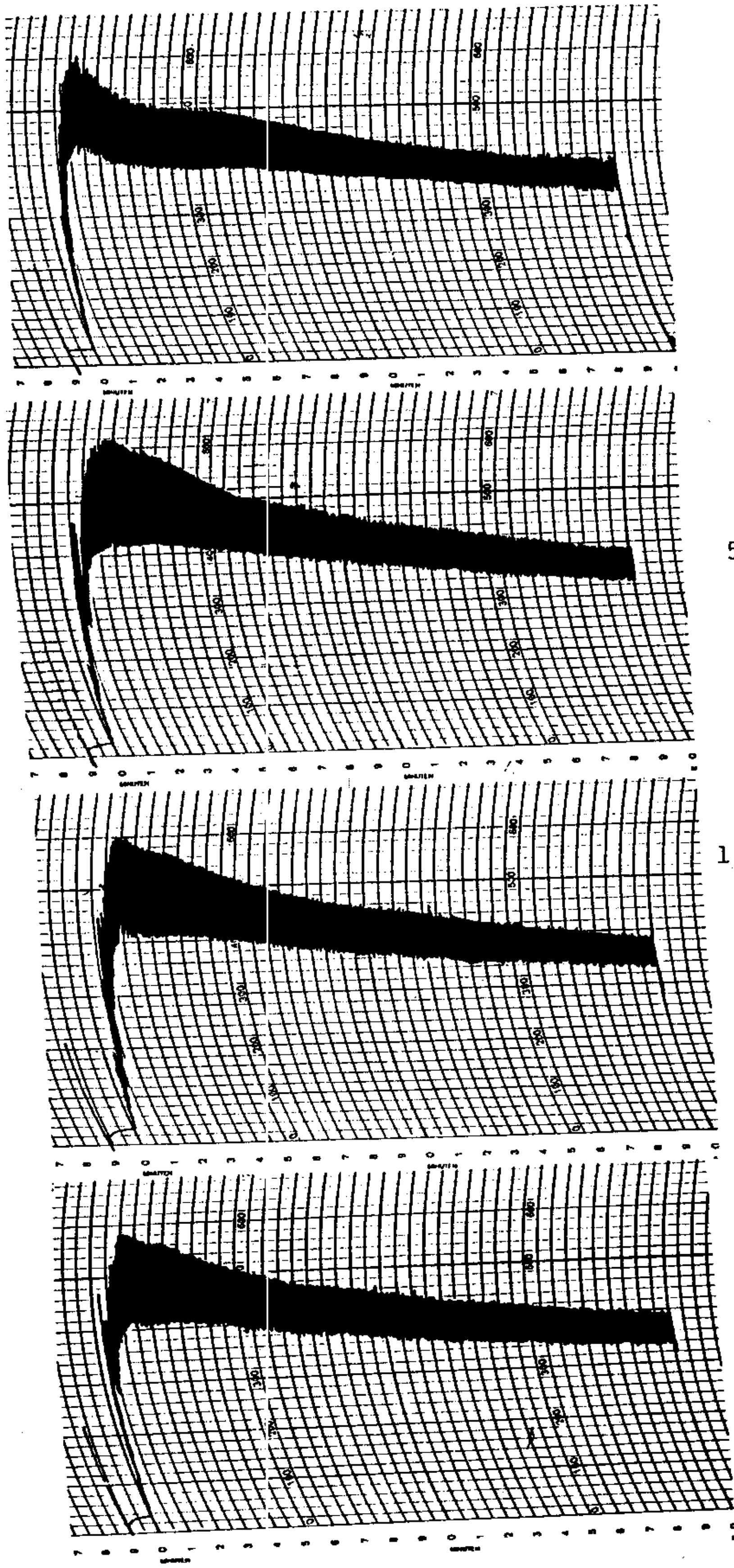
Fig(4) Farinogram of wheat germ processed addition

Table (23): Effect of ascorbic acid addition on farinogram of *T. aestivium* and *T. urum*.

Ascorbic acid addition p p m	Water(1) absorption %	Dough development time min	Arrival time min	Dough stability min	Degree of softening after 10 min. B.U.	Degree of softening after 20 min. B.U.	Valorimeter value	Width(2) ratio
T. aestivium								
-	54.5	1.6	0.8	3.9	100	140	34	0.294
50	55.8	2.0	1.0	5.0	90	160	34	0.275
100	56.0	1.4	0.5	5.2	95	145	35	0.294
1000	56.0	1.0	0.4	5.4	85	130	37	0.343
T. Durum								
-	65.4	3.0	1.3	8.2	50	70	52	0.650
50	65.5	3.6	1.8	9.7	15	80	50	0.517
100	65.4	2.5	1.2	12.7	40	75	48	0.567
1000	65.6	1.8	0.7	9.0	50	80	44	0.535

(1) On 14% moisture basis.

(2) $\text{Width ratio} = \dfrac{\text{width of the curve end (at 20 min.) in cm.}}{\text{width of the maximum width of the curve in cm.}}$



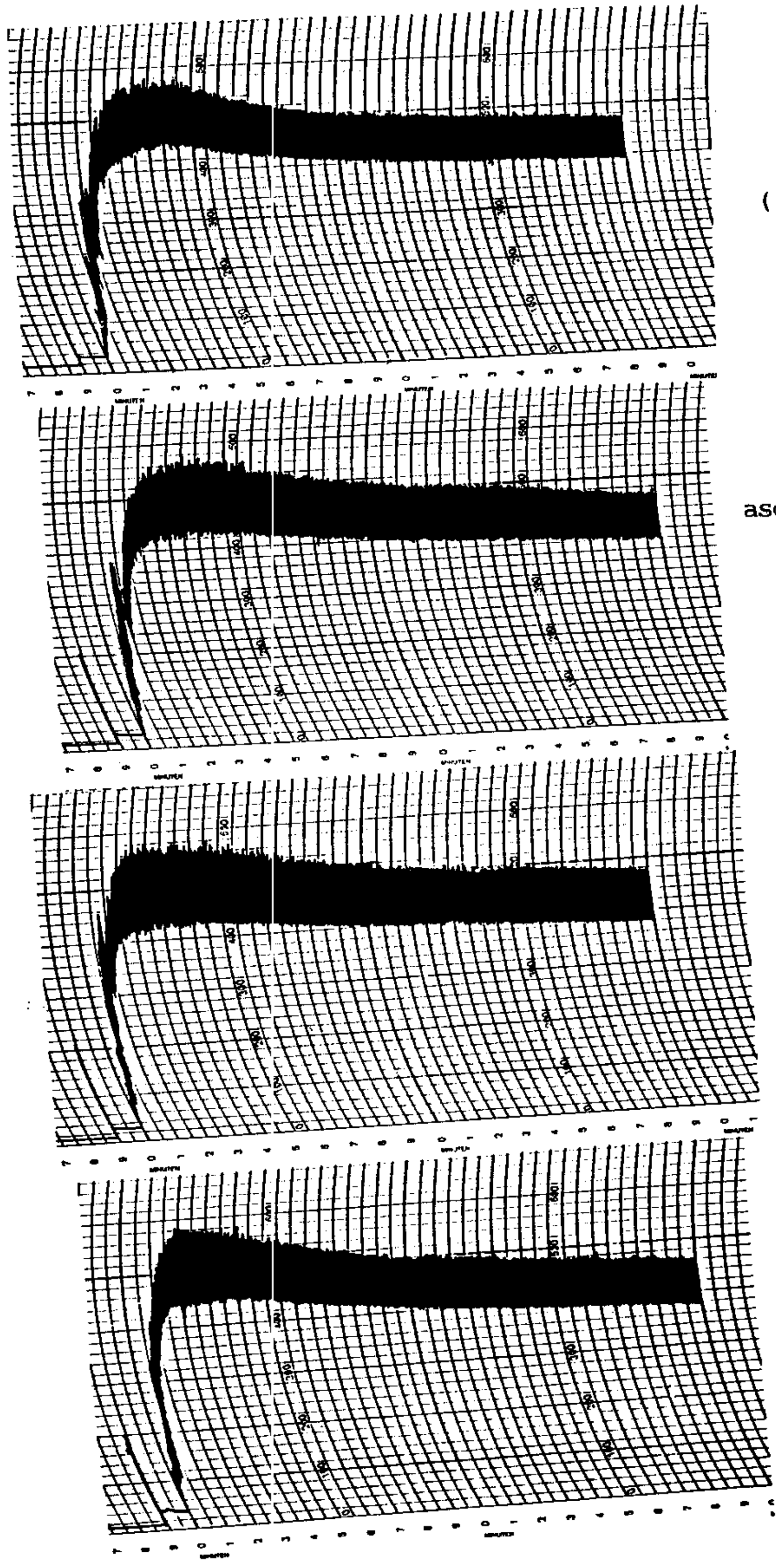
Control
(without addition)

50 p p m. ascrobic
acid

100 p p m ascoribc
acid

1000 p p m ascorbic
acid

ig(5) Farinogram of ascorbic acid addition to T. aestivium flour.



Control (without addition)

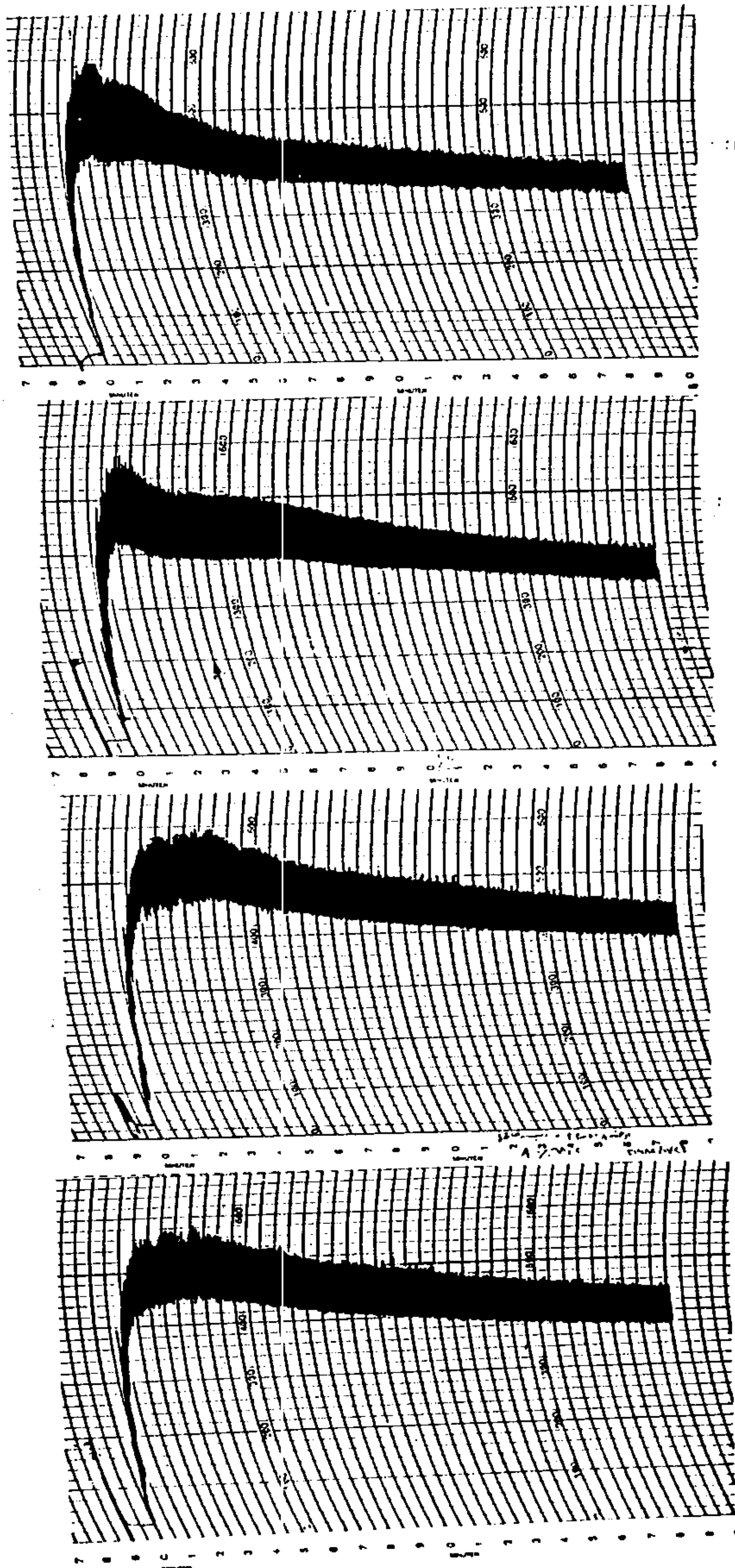
50 p.p.m. ascorbic acid

100 p.p.m. ascorbic acid

1000 p.p.m. ascorbic acid

Fig 5 (Cont.)

Farinogram of ascorbic acid addition to _T. durum_ stork's flour.



T. aestivium

0.1% wheat germ + 50 p.p.m. ascorbic acid.

0.1% wheat germ + 100 ppm ascorbic acid.

T. Durum

0.1% wheat germ + 50 p.p.m. ascorbic acid.

0.1% wheat germ + 100 ppm ascorbic acid.

Fig(6) Farinogram of ascorbic acid and wheat germ addition to *T. aestivium* and *T. Durum* .

Table (24): Effect of wheat germ and ascorbic acid addition on farinogram of T. aestivium and T. Durum.

Addition: Wheat germ %	Addition: Ascorbic acid p.p.m.	Water[(1)] absorption %	Dough development time min.	Arrival time min.	Dough stability min.	Degree of softening after 10 min B.U.	Degree of softening after 20 min B.U.	Valorimeter value	Width[(2)] ratio
T. aestivium									
0.1	50	55.4	1.3	0.6	3.2	100	150	34	0.323
0.1	100	55.5	1.4	0.6	5.0	85	140	35	0.433
T. Durum									
0.1	50	65.5	3.3	2.2	6.1	65	110	45	0.44
0.1	100	65.6	3.6	2.4	7.3	60	100	46	0.46

(1) on 14% moisture basis.

(2) width ratio $= \frac{\text{width of the curve end (at 20 min.) in cm.}}{\text{width of the maximum width of the curve in cm.}}$

pasta dough containing 0.1% wheat germ. Results showed that addition of ascorbic acid 100 p p m. to pasta dough containing 0.1 % wheat germ produced better farinogram. In the case of _T. aestivium_ increasing ascorbic acid addition from 50 p p m to 100 ppm increased dough development time (from 1.3 to 1.4 min.) dough stability (from 3.2 to 5.0 min) valorimeter value (from 34 to 35) and width ratio (from 0.323 to 0.433), while the degree of softening decreased (from 100, 150 to 85, 140) . Also _T. durum_ stork's had the same trend in which increasing ascorbic acid addition from 50 p p m to 100 p p m increased dough development time (from 3.3 to 3.6 min.), dough stabilit (from 6.1 to 7.3), valorimeter value (from 45 to 4 6) and width ratio (from 0.44 to 0.46),while degree of softening decreased (from 65 ,110 to 60, 100). According to Irvin _et al._, (1961), exter and Matsuo (1978a) and Morad _et al._ (1980), Increasing in dough development time, dough stability and valorimeter value are favourable rheological properties for pasta processing. Also by comparing stork's pasta before addition (table 17) and after ascorbic and wheat germ addition the results can indicate that addition of ascorbic acid, 100 p p m to pasta doughh contains 0.1% wheat germ improved its rheological properties.

IV-5- Cooking quality of pasta model systems

The data in table (25) showed the effect of wheat germ

Table (25): Cooking quality of pasta model systems (on 12% moisture basis).

Addition		Swelling index		Increasing of weight		Water absorption %		Cooking loss	
Wheat germ processed %	Ascorbic acid p.p.m.	T.durum stork's	T.aestiviun	T. durum stork's	T.aestivium	T. durum	T.aestivium	T. durum	T. aestivium
-	-	3.85	3.3	292	253	200	160	5.8	7.3
0.1	-	4.57	3.9	345	304	250	212	6.6	8.0
1.0	-	5.37	4.6	388	352	306	262	7.3	9.1
10.0	-	5.70	5.0	422	372	332	285	9.2	10.3
-	50	5.50	4.7	418	365	324	275	5.8	7.4
-	100	5.10	4.6	378	350	285	260	6.2	7.9
-	1000	4.70	3.7	335	301	242	210	6.5	8.0
0.1	50	5.10	4.1	377	334	285	240	7.7	8.5
0.1	100	5.35	4.3	396	344	305	252	8.2	9.2

addition (0.1, 1.0 and 10.0%) and ascorbic acid (50, 100 and 1000 p p m) to pasta model system under investigation . Wheat germ addition showed increament in water absorption in both stork's (from 200 to 332) and aestivium (from 160 to 285) pasta. Although swelling index increased from 3. 85 to 5.70 and from 3.3 to 5.0 in both stork's and aestivium respectively. Increasing of weight had also the same trend , storks increased from 292 to 422 while aestivium increased from 253 to 372 . Cooking loss increased gradually (from 5.8 to 9.2 in stork's and from 7.3 to 10.3 in aestivium) by increasing wheat germ addition.

The effect of ascorbic acid addition to pasta dough showed that water absorption decreased in both storks (from 324 to 242) and aestivium (from 275 to 210). Swelling index and increasing of weight decreased gradually by increasing ascorbic acid addition, while cooking loss slightly decreased in both stork's and aestivium pasta. From the previous results it is clear that ascoribc acid reversed the effect of wheat germ on the cooking quality of pasta model system. Therefore mixing addition of both wheat germ (0.1%) and ascorbic acid (50 and 100 p p m) was suggested. The cooking quality of mixed wheat germ and ascorbic acid addition yielded pasta with better quality, specially when wheat germ 0.1 % and ascorbic acid 100 p p m were added to the pasta dough.

V- High Fiber Bread

One of the main goals of this investigation is to find the way for producing high fiber bread characterized with minimum phytate phosphorus and moderate protein contents.

V-I- Chemical constituents of commercial bread and low calories bread:

Samples of commercial common bread and high fiber bread obtained from different sources were subjected to comparative study. Results obtained are shown in table(26).

Europian white bread contained higher crude protein (10.11 % and carbohydrates (83.00 % than Balady bread. Balady bread characterized by its higher ash (1.98%), fiber (3.30%) and phytate phosphorous (0.103%) due to the addition of fine bran to the loaf. From energetic stand point, Europian white bread had higher calories content than other samples under investigation.

Moisture, crude protein, dietary fiber and phytate phosphorus were lower in Tep Tup tust than those of Regime tust (30.23, 12.31, 16.29 and 0.227%) comparied with 36.55, 22.20, 17.69 and 0.288% for the same respective constituents). On the other hand, ash, lipids and carbohydrates were higher in Tep Tup tust than those of Regime tust (3.26, 3.20 and 64.94% comparing with 2.98, 2.44 and 60.71%).

High lipid content in Europian white, Tep Tup and regime tust bread (2.50,3.20 and 2.44%) could be attributed to pan oil addition to prevent bread stickness with the pan.

Also, short bread showed some difference in its chemical constituents. Ash, carbohydrates and phytate phosphorus were higher in short bread of Great Cairo Company (2.61, 59.08 and 0.298%), while protein and lipids (18.87 and 1.80%) were higher in North Cairo short bread than great Cairo bread (12.89 and 1.30%).

High protein content of Regime tust and flatend short I bread could be attributed to the use of gluten (the residue after dough washing) in bread making. The low biological protein value may harm the kidney specially patients who suffer from renal diseases (Davidson et al., 1975).

Carbohydrates percentage in low calories bread were lower than white or balady bread but, reduction was not enough because it contained more than 50% carbohydrates , (Anon, 1978) and calories reduction were 14.5-18.4%.

Phytate phosphorus had a positive relationship with fiber content, it increased when fiber content increased in the meantime, calories content decreased. Shorts(II) bread had the lowest calories and the highest fiber and phytate content. Phytate ion chelates with several elements including copper, zinc, cobalt, magnesium, iron and

Table(26): Analysis of commercial ordinary bread and low calories bread (on dry basis).

Sources	Type of Bread	Moisture %	Ash %	Crude protein %	Dietary fiber %	Lipids %	Available carbohyd-rate (starch+ sugars)%	Phytate phosphorous %	Calories K.Calories
1- Common bread									
North Cairo Co.	Europian white	34.00	1.56	10.11	2.83	2.50	83.00	0.041	394.94
	Balady	37.08	7.98	9.90	4.37	1.30	82.45	0.103	381.10
2- Low calories bread									
Basic misr	Regime tust	36.55	2.98	22.20	17.69	2.44	54.71	0.288	329.60
Tep Tup	Tust	30.23	3.26	12.31	16.29	3.20	64.94	0.227	337.80
North Cairo Co.	Shorts I	36.68	2.61	18.87	17.64	1.80	59.08	0.298	328.00
Great Cairo Co.	Shorts II	36.00	3.19	12.89	17.90	1.30	64.72	0.452	322.14

calcium, (O'Dell et al., 1972; Ranhotra et.al., 1973; Lolas et al 1976 and Harland and Harland 1980). Therefore it is preffered to produce high fiber bread with low phytate and available carbohydrate content.

Wheat milling products were analysed to determine their phytate phosphorus, ash and diet fiber contents, in order to choose a fiber source which contains high fiber and less phytate content.

V-2- Distribution of phytate, fiber and ash contents of red and white kernels and their milling products:

Two distinct types of wheat (red and white) in addition to their flour (72 and 82% extraction rate) red dogs shorts, fine bran, coarse bran, and wheat germ were used to study their phytate phosphorous, crude fiber and ash contents distribution.

Data reported in table (27) indicate that red wheat kernels contained higher amounts of phytate phosphorous, crude fiber and ash content than white wheat kernels (0.32, 2.22 and 1.78% compared with 0.24, 1.96 and 1.51% for the same respective constituents). Also, wheat kernels milling products e.g. flour of 82% extraction rate, red dogs, shorts, fine bran and coarse bran of red wheat kernels had higher phytate, crude fiber and ash content than white wheat kernels, while flour of 72% extraction rate from both wheat

Table (27): Distribution of phytate, fiber, and ash among wheat kernels milling products. (on dry basis).

	Red Wheat				White wheat			
	Phytate phosphorous %	Crude fiber %	Ash %	Phytate phosphorous / Fiber	Phytate phosphorus %	Crude Fiber %	Ash %	Phytate phosphorus / Fiber %
Whole wheat kernels	0.32	2.22	1.78	14.41	0.24	1.96	1.51	12.24
Flour (72% ext.)	0.09	0.20	0.57	45.00	0.09	0.19	0.53	47.37
Flour (82% ext.)	0.18	0.40	0.81	45.00	0.14	0.30	0.72	46.66
Red dog	0.62	3.27	2.18	16.66	0.53	3.02	2.08	17.54
Shorts	1.173	7.60	2.78	15.43	0.77	6.20	2.55	12.42
Fine bran	1.306	10.66	3.81	12.25	0.96	8.46	3.20	11.35
Coarse bran	1.332	13.26	6.03	10.04	1.05	9.89	4.85	10.62
Wheat germ	-	-	-	-	1.42	2.62	3.79	54.20

types showed almost close ratios. Coarse bran contained higher phytate, crude fiber and ash contents percentage comparing with the other milling products (1.332, 13.26 , and 6.03% in red wheat and 1.05, 9.89 and 4.85% in white wheat). White wheat germ had the highest phytate (1.42%) and ash (3.79%). These results indicate that most of the phytate was in the germ and coarse bran. The obtained data are in good agreement with those reported by O'Dell et al (1972) and Kent (1983).

The ratio between phytate phosphorous and fiber were higher in red wheat fine bran and shorts (12.25 and 15.43%) than white fine bran and shorts (11.35 and 12.42%).

According to the obtained results, white wheat shorts can be chosen as a source of low phytate phosphorous and high fiber contents (0.77 and 6.20%).

Also white wheat shorts produced from wheat kernels of low ash content have ability for eating than coarse and fine bran.

V.3. Factors affecting phytate hydrolysis:

In order to reduce the phytate content, a new technique was established which depends upon the effect of incubation, yeast fermentation and toasting in bran phytase activity.

V-3.1. Wheat shorts incubation:

The results reported in table (28) show the effects of incubation on white and red wheat shorts by using tap water (pH 6.8-7) and acetic acid solution (pH 4.3) at 30, 40 and 50°C for 1,2,3 and 4 hours.

Phytate phosphorous loss increased by increasing time at all incubation temperatures for both tap water and acetic acid solution. The highest loss percentage was obtained after 3 h by using tap water at 40°C for white wheat shorts (91.6%) and 4 h at 40°C for red wheat shorts (71.9%). White wheat shorts incubation in acetic acid (pH 4.3) showed it's highest loss percentage (80.1%) after 4 h at 40°C while, red wheat shorts showed its highest loss (60.5) after 4h at 50°C.

These results indicate that tap water had higher favourable effect on shorts incubation at different temperatures and periods. Phytase activity of white wheat shorts was higher than red wheat shorts and these results are inagreement with that reported by Wang et al., (1980).

Shorts incubation before mixing with flour and other dough ingredients gave good results of phytate loss, in addition to dough strength preservation.

V.3.2. Effect of toasting on phytate phosphorous loss:

Results in table (29) shows the effect of toasting treatments on phytate phosphorous loss percentage of the

Table (28): Effect of incubation of shorts[1] on phytate destruction (on dry basis).

Incubation		Acetic acid solution (pH 4.3)				Tap water (pH 7)			
		White wheat shorts phytate phosphorous		Red wheat shorts phytate phosphorous		White wheat shorts phytate phosphorous		Red wheat shorts phytate phosphorous	
Temperature	Hours	Conc. %	Loss %	Conc. %	Loss %	Conc. %	Loss %	Conc. %	Loss %
30°C	-	0.775	-	1.173	-	0.775	-	1.173	-
	1	0.454	41.3	0.980	16.4	0.245	68.4	0.725	38.2
	2	0.385	50.2	0.803	31.5	0.190	75.4	0.517	55.9
	3	0.325	58.0	0.749	36.2	0.163	78.9	0.505	56.9
	4	0.254	67.2	0.640	45.4	0.136	82.4	0.492	58.1
40°C	1	0.259	66.6	0.899	23.4	0.155	80.0	0.626	54.4
	2	0.207	73.3	0.667	43.2	0.129	83.3	0.424	63.8
	3	0.168	78.3	0.545	53.6	0.065	91.6	0.378	67.8
	4	0.154	80.1	0.490	58.2	0.065	91.6	0.330	71.9
50°C	1	0.310	60.0	0.572	51.2	0.272	64.9	0.527	55.0
	2	0.293	62.1	0.545	53.6	0.258	66.7	0.483	58.8
	3	0.237	69.3	0.483	58.8	0.191	75.3	0.425	63.8
	4	0.198	74.4	0.463	60.5	0.082	89.4	0.335	71.4

(1) 30 g shorts + 70 cm water or solution.

Table (29): Effect of toasted high fiber bread on phytate phosphorus loss (on dry basis).

Shorts in bread %	Toast treatment %	Flour phytate phosphorus %	Bread phytate phosphorus %	Phytate phosphorus loss %	Phytate[1] toasted loss %
15	-	0.203	0.096	52.70	-
15	toasted	-	0.072	64.53	25.00
25	-	0.277	0.126	54.51	-
25	toasted	-	0.095	65.70	24.60
40	-	0.390	0.244	37.43	-
40	toasted	-	0.186	52.30	23.77
50	-	0.465	0.359	22.70	-
50	toasted	-	0.291	37.42	18.94

(1) Phytate toasted loss % =

$$\frac{\text{Bread phytate} - \text{bread phytate after toasted}}{\text{Bread phytate}} \times 100$$

bread produced by addition of 15, 25, 40, 50% short respectively. Toasted bread which contained 15 and 25% shorts showed almost the same phytate loss percentage (25.00 and 24.60) while 40 and 50% toasted short-bread showed lower phytate loss percentage (23.77 and 18.94%).

These results indicate that toast treatment reduces phytate phosphorous content specially at low shorts adding concentration (not exceed 25%). At high shorts addition concentration (more than 25%). Results showed that phytate destruction was very slow, which indicate that toasting had a limited effect on phytate destruction rates. These results are in agreement with those reported by De Boland _et_ _al_., (19 75) and wozenski and Woodurn (1975).

V-3-3- Effect of yeast addition, shorts incubation, ascorbic acid addition and toasted treatment on phytate hydrolysis

Table (30) shows the effect of yeast on phytate phosphorous loss in the bread which contains 25% shorts with the following treatments:

1- Incubation of shorts and yeast addition during dough mixing.
2- Addition of yeast to shorts before incubation.
3- Non incubated shorts and yeast addition during dough mixing.

Phytate phosphorous content was 0.019, 0.207 and 0.095%

Table (30): Effect of different factros on phytate hydrolysis in high fiber bread[1].

(25% shorts) (on dry basis).

	Yeast addition to shorts during incubation	Shorts incubation time before dough mixing	Ascorbic acid addition to shorts	Toasted treatment	Bread Phytate phosphorus	Phytate loss
	%	hours	p p m		%	%
1	-	-	-	-	0.126	54.51
2	-	-	-	toasted	0.095	65.70
3	-	2	-	toasted	0.019	93.14
4	2	2	-	toasted	0.207	25.27
5	2	2	100	toasted	0.207	25.27

(2) Flour phytate phosphorus = 0.277 % (shorts contains 0.84% phytate phosphorus).
Fermentation time 1 hour and proffing time ½ hour.
Incubation temperature 40°C.

1- 2% yeast added at mixing of ingredients.
2- 2% yeast added at mixing and bread toasted.
3- 2% yeast added at mixing of the incubation shorts + flour + salt.
4- 2% yeast from (flour + shorts) added before incubation.
5- Yeast addition like (4) plus 100 p p m ascorbic acid addition.

in the first, second and third treatment respectively.

These results indicate that incubation of shorts for 2 h . before yeast addition have the highest value of phytate destruction (93.14%). This observation may be due to the extending time of the hydrolysis (2 h incubation+ 1.5 h. fermentation). On the other side addition of yeast to shorts before incubation,have the lowest value of phytate destruction due to hindering effect of added yeast on phytate activity. These results are in good agreement with those reported by Bianchetti and Maria (1967) and Ashour (1978) and in contrast with those reported by Harland and Harland (1980) and Tangkongchiter et al.,(1981).

To evaluate improvers effects on phytate destruction, ascorbic acid was chosen as a safety and widely applied for dough improvement. It was added in the concentration of 100 p p m. Results showed that addition of ascorbic acid has no effect on phytase activity, and phytate loss showed the same percentage (25.27%) like the former treatment which produced bread with non incubated shorts.

V.4 - Rheological properties of samples dough under investigation.

V.4 .1. Farinograph test:

The effect of mixing shorts (in the percentage of 15, 25 and 40%) with wheat flour on the farinograph test is presented in Table (31) and illustrated in Fig (7).

Absorption ratio, dough development time, arrival time, stability and valorimeter values were increased by increasing shorts percentage while, dough weaking was decreased and showed a negative relationship with the added shorts percentage. Such trend could be attributed to the high water absorption of hemicellulose (pentosane) content of bran as mentioned by Refai (1965). This behaviour gives a fals strength observation. In fact short's addition weaked the dough due to gluten dilution beside bran particles affects on gluten shearing. However, weaking of the dough is a result of the breakdown of gluten network after elapsing appropriate mixing time.

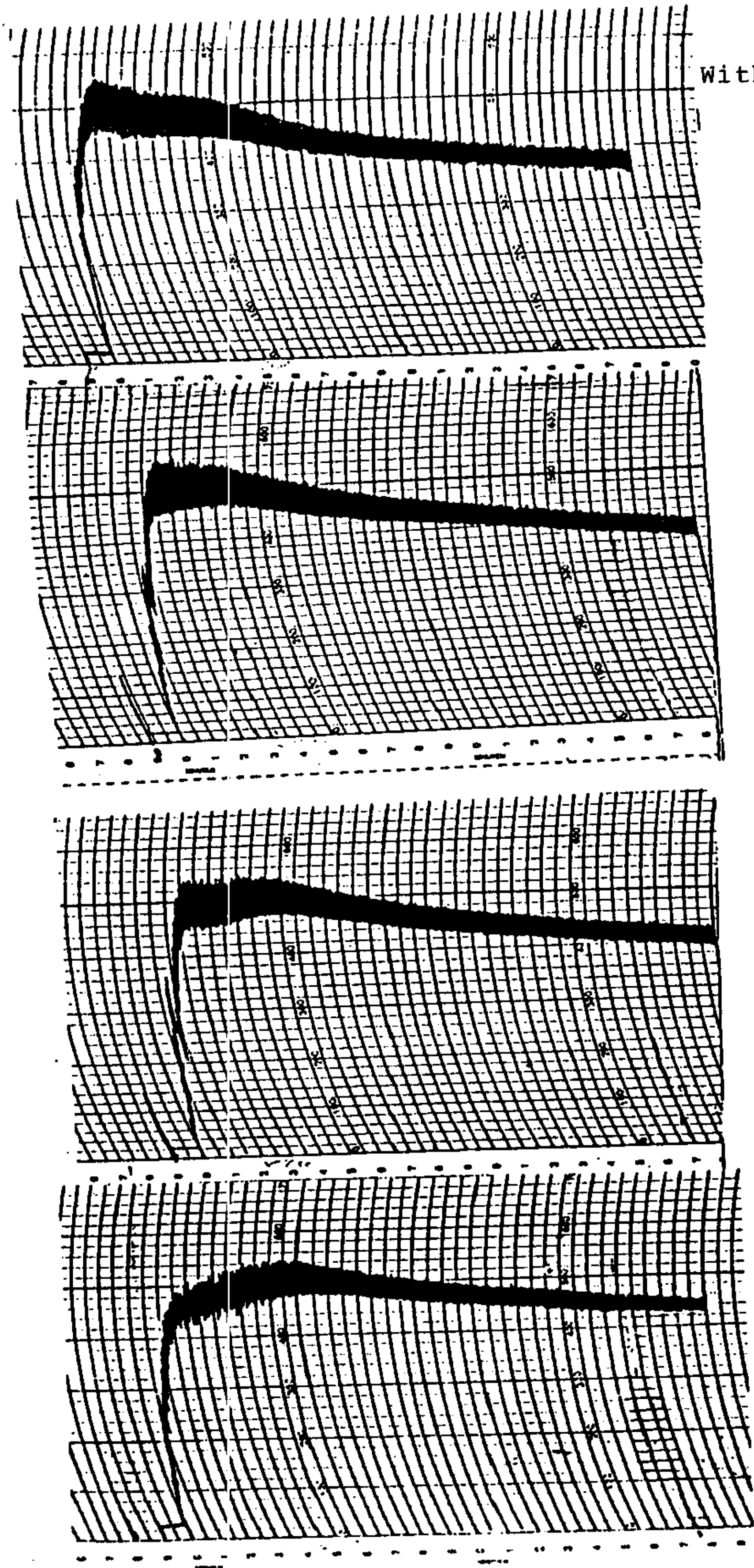
V-4 -2- Extensigram.

The results in Table (32) and Fig (8) proved that dough extensibility, resistance to extension, strength value and proportional number of the samples were in descending order in comparison with the added shorts. Shorts addition

Table (31): Farinogram of suggested high fiber bread[1].

	Water absorption %	Dough develop-ing time min	Arrival time min	Stability mixing tolerance min	Valorimeter value	Degree of softening after 10 min	20 min
Flour	52.1	1.6	0.6	5.2	37	80	130
85% flour + 15% shorts	54.5	3.0	2.1	5.5	42	65	125
75% flour + 25 shorts	58.4	3.5	2.2	6.7	50	40	85
60% flour + 40 shorts	62.7	6.0	4.1	8.5	55	20	60

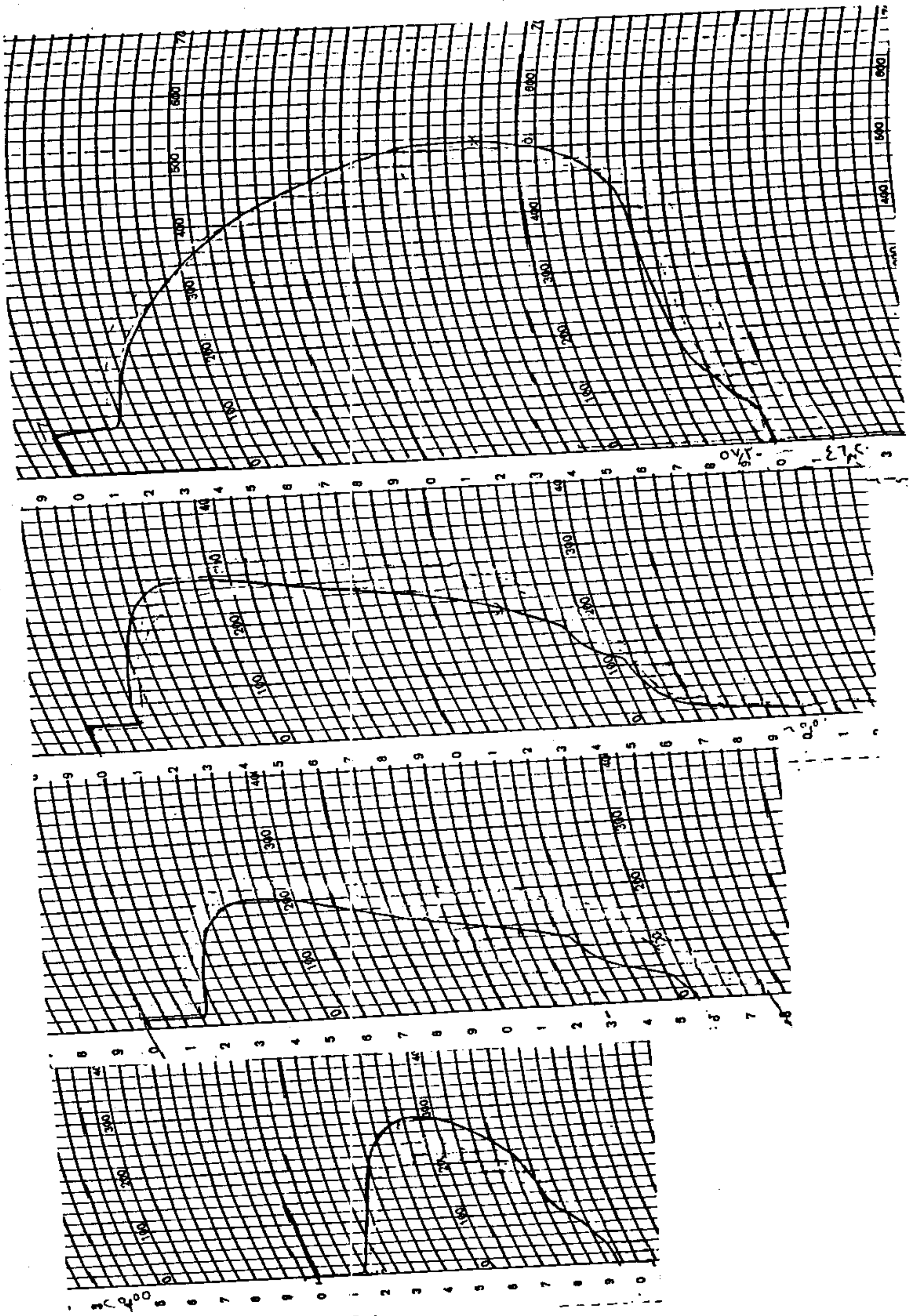
(1) on 14% moisture basis.



Fig(7) Farinogram of shorts addition to flour.

Table (32): Extensigram of suggested high fiber bread.

Contents	Extensibility mm	Resistance to extension B.U.	Proportional number	Dough strength cm^2
Flour	177	320	1.808	93
85% Flour + 15% shorts	153	220	1.438	45
75% flour + 25% shorts	138	160	1.159	25
60% flour + 40 shorts	75	180	2.25	20



Control (without addition)

15 % shorts

25% shorts

40% shorts

Fig(8) Extensigram of shorts addition.

Table (33): Nutritional constituents of suggested toasted high fiber breads (short bread)[1] (on dry basis).

Shorts %	Ash %	Dieatry fiber %	Total protein %	Lipids %	Available carbohydrate (starch +sugars) %	Phytate phosphorus %	Calories for 100 g K.Cal
15	2.17	6.63	11.40	1.80	78.00	0.013	373.8
25	2.55	11.18	12.25	2.20	72.45	0.019	358.6
40	3.12	17.70	12.97	2.80	63.41	0.047	330.72
Balady bread (control)	1.98	4.37	9.9	1.30	82.45	0.103	381.10

(1) Shorts incubated two hours at 40°C with water before dough mixing.

weaked dough strength and hence it is expected to produced bread of smaller volume than that of 100% wheat flour. Also dough strength value reduction could be due to dough gluten dilution.

V-5- Nutritional constituents:

Table (33) shows the effect of shorts addition in the percentage of 15,25 and 40% on the nutritional constituents of the high fiber bread produced by the new invented technique. The suggested high fiber bread showed a negative relationship between its calories and its ash, crude protein diatery fiber and lipids content. Also a positive relationship between its colories and available carbohydrate content. The obtained results revealed that the suggested shorts bread is lower in its phytate content than any other commercial high fiber bread due to phytase activity during shorts incubation before mixing. Also, from the nutritional point of view less phytate lead to high availability of calcium, zinc and other divalent metals (O'Dell et al.,1972; Ranhotra et al.,(1973) and Kent, (1983).

From the previous discussion it could concluded that high fiber bread with 25% shorts is preffered than others (15% and 40% shorts) due to its moderate amount of fiber 11.18%. Also, its extensigram properties showed that high shorts addition weakened dough strength and produced smaller volume bread.