RESULTS & DISCUSSION

Table (1): Wheat properties.

Wheat	Moisture %	Ash* %	Protein* %	Test weight kg/hl.	Falling** No. sec.	1000 kernal weight g
Imported durum	11.02	1.88	13.80	80.50	350	45
Egyptian durum	9.90	2.00	15.00	81.00	404	51

* On dry weight basis.
** On 14% moisture.

1.3. 1000 kernel weight:

Data in Table (1) shows that the 1000 kernel weight for imported (Italian) durum and Egyptian durum were 45 and 51 grams. it reveals that there are a positive relationship between test weight and 1000 kernel weight. The same results mentioned by Irvine (1979) and Matsuo and Dexter (1980). One would expect a greater milling yield with larger kernels since the ratio of endosperm to bran would be greater (Matsuo, 1982), it is an indicator of potential milling yield.

1.4. Protein content:

Data in Table (1) indicates that the protein content for imported (Italian) durum and Egyptian durum were 13.8 and 15%. The advantage of wheat depends on its ability to form gluten which is a cohesive viscoelastic mass. which can be stretched, beside wheat contains valuable amounts from vitamins B and E (Simmonds, 1989). From the obtained results it can concluded that the Egyptian durum wheat have sufficient amount of protein to produce high quality pasta products as cited by Pitz (1992). A range of wheat protein between 12.0 and 15.0% (14% m.b.) can be utilized without any adverse effect on pasta quality (Donnelly, 1978).

1.5. Ash content:

Data in Table (1) showed that the Egyptian durum kernels have 2.00% ash content while the imported (Italian) durum has

1.88%. The difference in ash content between the imported durum and the Egyptian durum attributed to ecological and hereditary factors, there are many factors effect on kernel ash content such as soil, whether, irrigation and fertilization treatments (Matsuo, 1982). We can decrease the ash content of the Egyptian wheat by attention for N fertilization high rates and doses decreased the ash content of wheat from 2.15 to 1.73% (El-Bardeny 1981). The ash values of 1.80 to 1.86% usually seen in durum wheat the upper great plains in U.S.A. (Donnelly, 1978), wheat grown in Europe have a higher ash content than wheat grown in Canada. The same variety grown at different locations in western Canada or in different years can range from 1.20 to 1.80%. where there is a limit on semolina ash content, wheat ash content becomes important, in Italy semolina ash content be higher than 0.90% (dry matter basis). To keep within this limit, Italian millers often blend North American durums with local durums to lower semolina ash (Matsuo, 1982).

1.6. Falling number:

The falling number of the imported (Italian) durum and Egyptian durum were 350 and 404 sec. (Table 1), means that Egyptian durum have less α-amylase activity which are required in manufacturing of good quality pasta. The Egyptian standard cited that the falling number of wheat kernels must not less than 200 sec. (Anon 1991). Falling number values less than 250 seconds generally indicate the presence of sprouting (Donnelly 1978), severely sprout damaged wheat can affect the marketing quality of the wheat, it can adversely affect the milling of the wheat and pasta properties. For the Egyptian durum wheat have a good quality as results revealed.

2. Semolina production:

2.1. Diagram of semolina production:

Data in the diagram of flour mill (diagram 1) showed that it has only four purification stages, they are used for purification of farina from particles.

After that it is milled or grinded to fine granules in smooth rolls giving the final product as flour with the desired extraction. In semolina mill (diagram no. 2) There are 25 stages of purification and sizing semolina granules. These are in agreement with those reported by Matsuo and Dexter (1980).

The diagram of semolina mill (no. 2) comprises of 6 stages for breaking wheat with fluted rolls, 7 stages to sizing semolina that is helping for maximizing semolina yield, and 2 stages for grinding flour which minimize the yield of flour. This system are ensuring that stocks with a minimum spread of granularity are sent to each purifire, enabling the purifires to work at maximum efficiency. Oversized semolina are reduced on two sizing passages where the cleanest and majority of coarse semolina is made. A further four sizing passages deal with the intermediate stocks, Finally, Three reduction passages ensure the rescue and reduction to flour of the endosperm contained in the branny overtails from the purifires and other low quality passages. This in agreement with Matsuo *et al.* (1980) and Banasik (1981).

The aim of durum milling in Egypt is to produce good quality semolina from the Egyptian durum which mainly cultivated in upper Egypt. Semolina quality requirements vary from country to country. In Egypt gluten quality and the colour of pasta products are very important factors. Egyptian durum with strong gluten characteristics, produce spaghetti with good cooking quality. Pasta manufacturer wants to produce economically, a very uniform product with a consistently high standard of quality, these objectives can be achieved only by: good cleaning of durum wheat, correct conditioning of durum and correct milling to produce correct granulation and purity of semolina.

2.2. Granulation of semolina:

Data in Table (2) indicates that there are a variation between the semolina particles size according to the purification stage. There are a gradual decreasing in semolina particles size, particles size effect on the absorption properties of pasta dough and its quality. (Matsuo and Dexter, 1980 and Kim *et al.*, 1986).

Table (2): Granulation of semolina.

Semolina mill		Flour mill	
Source of sample	**granulation µm**	**Source of sample**	**granulation µm**
P_1	630-1250	M.S	500-800
P_2	630-1250	F.S	400-500
P_3	600-900	3.S	280-350
P_4	500-800	Flour	118-400
P_5	315-630		
P_6	450-500		
$R.S_1$	150-350		
$R.S_2$	150-350		
$R.S_3$	150-350		
D.S	125-350		
Semolina	125-350		
Flour	112-132		

Granularity is a key factor in the production of top quality pasta, it is important that the semolina should be as narrow in range of particles size as possible, all particles should in the range of 132 μm to 376 μm (Murray 1991). The particles size distribution of semolina obtained from semolina mill (Souhag) ranged from 125 to 350 μm, it is finner than that of Italy, Switzerland and Germany (Matsuo 1982). it is now possible to mill semolina to yield 65 to 70% with fairly coarse granulation. In Egypt commercial semolina must not contain more than 3% flour and all semolina must pass through a 20 m screen (Anon 1988). it is the same of U.S.A (Murray 1991). In flour mill results shows (Table 2) that it posible to produce semolina in three tybes fine, medium, and coarse, which the flour had a coarse particles (118-400). Most macaroni manufactures prefer semolina that has a uniform fine particles size rather than a coarse-ground semolina, semolina with fine granulation can be mixed more easily to form a uniform dough for extrusion. If the semolina is not uniform, consisting of fine and coarse particles, then the fine particles will absorb more water and faster than the coarser particles, consequently, the coarse particles remain dry throughout the mixing operation and tend to coarse white specks in the final pasta product. The pasta manufacturers also wants to have semolina as clean as possible from bran particles. Any bran specks will be very visible on the dried pasta surface, also bran specks will provide a point of weakness and pasta become easy to ckrack.

3. Chemical components of semolina:

3.1. Moisture content:

Data in Table (3) shows that moisture contents of break stages semolina (ranged from 15.1 to 15.9%) were higher than those of the reduction stages (ranged from 14.2 to 14.7%), while the final product moisture content was 14.8%. The different attributed to the effect of the reduction process and the pneumatic transportation which reduced the moisture content to be in balance with the surrounding air relative humidity (Refai 1965). The obtained results indicate that the flour and semolina of both imported and local durum wheats had high moisture content (14.8 and 15.6%), it might be due to its high water absorption during process. Hence enzymatic activity could be higher in the kernels and obtained flour, and affects alternatively on pasta quality. Flour moisture content must not exceed 14% (Refai 1965, and Anon 1984) while semolina must not exceed 14% as cited by the Egyptian standard quality (Anon 1988). To obtain semolina with a good quality, durum wheat must conditioned at 15-16% moisture content for 5-6 hrs conditioning time (El-Bardeny 1989). While Murray (1991) reported that the conditioning time of *T. durum* can vary from 2 to 12 hrs. depending on the quality of the durum and the colour required in the finished pasta, The longer the conditioning time, the lighter will be the colour of the resulting pasta. The conditioning objectives of durum wheat are: (1) to facilitate the production of the maximum amount of clean, bright, granular semolina, (2) to mentain the bran in large enough flacks

Table (3): Moisture and ash contents.

Source	Moisture %	Ash %
	Semolina mill	
P_1	15.5	0.75
P_2	15.1	0.94
P_3	15.1	2.10
P_4	14.9	0.65
P_5	15.9	0.95
P_6	15.5	0.65
$R.S_1$	14.7	0.50
$R.S_2$	14.3	0.67
$R.S_3$	14.2	0.64
D.S	15.1	0.85
Semolina	14.8	0.66
Flour	15.6	1.23
	Flour mill	
M.S	15.6	0.53
F.S	15.3	0.63
3.S	16.1	0.84
Flour	15.2	0.86

so as to avoid contamination of the semolina, (3) to provide the conditions whereby maximum whole germ removal is attained, (4) to minimize the production of flour and fines.

3.2. Ash content:

Data in Table (3) indicate that ash content of semolina as a final product was 0,66% in semolina mill, and in flour mill it was 0.86% for the flour as a finished product. Standard quality for Egypt. Italy, and U.S.A cited that maximum ash content must not exceed 0.6% and 0.9% for macroni made from patent flour and semolina (Anon, 1983 and Kent 1983). High ash content has negative effect on the colour of produced macaroni (Manser, 1981, Dexter and Matsuo 1981, and Matsuo 1982).

Pasta quality are affected by ash content and bran contamination, so ash and fiber contents must be reduced. To reduce ash content and fiber of flour and semolina, the wheat must be moisted for one hour prior to first break roller to tough the outer layer of kernels to minimize the amount of bran fiber powder, (Refai, 1965)

The kernels outer layers (bran) at time of falling to the first break rolls should be at around 18% moisture content while the endosperm should be conditioned to around 15% moisture content (Murray 1991), this differential is essential to allow maximum removal of the bran layers.

The values in Table (3) agreed with those published by Irvin, (1971), Anon (1988) and Pitz (1992).

The percentage of ash in P_1 and P_2 were 0.75 and 0.94% while it was 2.10% in P_3, this is caused by the bran adherent with the semolina particles which can be removed in the next process. These observation agree reasonably well with published data reported by Irvine (1971).

The semolina ash content varied from stage to another according to the chemical and physical variations of endosperm layers as reported by Kent (1983), Simmonds (1989), El-Bardeny (1989) and El-Bardeny *et al.* (1993).

3.3. Protein and gluten contents:

Data regarding total protein in semolina (Table 4) shows that the protein content of semolina and flour as final products were 13.14 and 12.60%. Protein content of semolina produced from different stages were in range of 11.67-18.14%, whereous in the flour mill the range was 11.55-14.70%. These variations in semolina protein content produced from one variety of wheat attributed to the chemical constituent difference between endosperm layers. These are in agreement with Irvin (1971), Walsh and Gilles (1974), Manser (1981), Matsuo (1982) and El-Bardeny (1989).

Table (4): Protein and gluten content.

Source of sample	Protein* %	Gluten	
		Wet %	Dry %
Semolina mill			
P_1	14.79	19.72	6.94
P_2	15.90	21.68	8.00
P_3	18.13	15.08	5.64
P_4	16.22	27.40	9.40
P_5	15.93	29.88	11.20
P_6	17.82	26.40	8.64
$R.S_1$	15.70	25.70	8.46
$R.S_2$	11.67	25.24	8.52
$R.S_3$	12.23	26.80	8.84
D.S	17.70	28.44	10.40
Semolina	13.14	26.88	8.84
Flour	13.39	26.96	8.94
Flour mill			
M.S	11.55	21.62	10.33
F.S	11.98	27.51	12.23
3.S	14.70	27.40	11.44
Flour	12.60	31.00	13.00

* on dry weight basis.

Data in Table (4) shows that there is a positive relationship between the gluten content and the protein content as reported by Frey and Holliger (1972) and Tawfik and Mansour (1983). According to Refai (1982), the quantity of gluten is not so very important as the quality.

Gluten suitable for pasta production should be strong and may be shorter and less resilient than gluten suitable for bread flour.

Cooking quality is related to protein content and gluten strength, it improves with increasing protein content (Matsuo et al 1972, and Autran *et al.* 1986).

Durum pasta manufacture and cooking, pasta which contains enough protein and gluten do not strech and fall during process and have good cooking quality.

Data in Table (4) shows that the gluten contents of P_1, P_2, P_6, and semolina are 19.72, 21.68, 26.4 and 26.88%.

Gluten content has less important role than total proteins in pasta dough (Frey and Holliger 1972, and Manser 1981).

From the obtained results (Table 4) it can be concluded that semolina of the Egyptian durum has sufficient amounts of protein

(13.14%) and gluten (26.88%) to produce high quality pasta products.

The proteins and gluten of flour or semolina suitable for pasta production must be higher than 10% and 23% as cited by Manser (1981), while Matsuo (1982) reported that semolina must have at least 11% protein to produce pasta of good quality.

Proteins in semolina is ordinarily 0.5% lower than the parent wheat. Consequently, low protein wheat will result in semolina with correspondingly lower proteins which can result in pasta processing problems (Donnelly 1978).

3.4. Protein fraction:

The results concerning the protein fraction contents of semolina produced from the different stages in semolina mill calculated as percentage of protein content are presented in Table (5).

Data in Table (5) shows that gliadins represented the major proportion of protein fractions for semolina and flour (ranged between 42.01 and 54.35%), and the lowest protein fractions are the albumins (ranged from 7.13 to 11.66%).

Albumins and globulins are cytoblasmic components while glutenins and gliadins are storage protein (Simmonds, 1989).

Table (5): Protein fraction (% of total protein)*.

Source of sample	Total protein %	Albu-mins %	Globu-lins %	Albumins + globulins %	Gliadines %	Gluten-ines %	Gliadines/ glutenines	Residual protein %
Semolina mill								
P_1	14.79	7.75	4.25	12.00	44.25	22.50	1.96	21.25
P_2	15.90	7.78	15.28	23.06	45.53	21.50	2.11	9.91
P_3	18.13	10.30	14.77	25.07	46.47	23.70	1.96	4.83
P_4	16.22	8.55	11.26	19.81	54.35	23.45	2.28	2.40
P_5	15.93	7.60	10.60	18.20	49.80	23.75	2.09	8.30
P_6	17.82	8.80	14.71	22.91	46.62	22.40	2.08	8.81
$R.S_1$	15.70	7.75	10.62	18.37	50.90	22.15	2.29	8.58
$R.S_2$	11.67	7.80	10.51	18.31	45.40	20.80	2.18	15.50
$R.S_3$	12.23	11.66	9.80	21.46	43.05	21.90	1.96	13.64
D.S	17.70	8.80	12.56	21.36	51.27	23.75	2.15	3.67
Semolina	13.14	7.13	12.81	19.94	42.01	21.34	1.96	16.72
Flour	13.39	7.50	11.02	18.52	43.84	22.26	1.96	15.39
Flour mill								
M.S	11.55	7.54	6.52	14.06	45.02	20.90	2.15	20.00
F.S.	11.98	7.91	8.93	16.84	44.31	22.11	2.00	16.74
3.S	14.70	8.01	9.21	17.22	47.01	23.08	2.03	12.68
Flour	12.60	7.98	8.34	16.32	476.90	22.13	2.11	14.70

* on dry weight basis.

Data obtained in Table (5) shows that the highest gliadine of protein fractions in P_4 has the lowest insoluble residue (54.35, 2.40%) and the lowest gliadine in semolina, as finished product, has the highest insoluble residue (42.01, 16.72%) this with exception of P_1. shows that glutenin contents were independent of total protein content as reported by Doeks and Wennekes (1982).

Results showed that gliadins and glutenins are the main constituents of wheat protein, their amount ranged between 63.34 and 77.80% of total protein of semolina and flour. These are an agreement with those reported by Dexter and Matsuo (1979 b) and El-Bardeny (1989).

The special position of wheat among the cereals comes from its capability to form gluten by interaction between the less polar prolamins and the more polar glutelines (Belitz *et al.* 1986)

3.5. Alpha-amylase activity:

Data in Tables (1) and (7) show that the falling number for the imported and Egyptian durum wheat were 350 and 404 sec. while it increased in semolina mill samples from 526 to 653 sec. and in flour mill samples from 446 to 464 sec. It could concluded that wheat kernels have higher α-amylase activity (lower falling number) than semolina. These results are in agreement with Booth (1973).

Table (6): Colour and lipids content (on dry weight basis).

Source of sample	Carotenoids ppm	Browning A	Lipids %
Semolina mill			
P_1	8.850	0.797	1.000
P_2	10.470	0.926	1.330
P_3	3.130	1.444	2.000
P_4	3.010	0.569	1.000
P_5	3.130	0.730	1.330
P_6	2.320	0.468	2.000
$R.S_1$	2.530	0.347	2.670
$R.S_2$	2.830	0.545	1.330
$R.S^3$	2.860	0.507	2.000
D.S	3.310	0.810	1.000
Semolina	2.930	0.506	1.330
Flour	4.510	0.616	2.330
Flour mill			
M.S	1.083	0.768	1.081
F.S	1.775	0.874	1.640
3.S	1.595	0.772	1.310
Flour	1.896	0.843	1.070

Results revealed that the Egyptian durum produced bright yellow semolina. Semolina colour is a varietal factor (Matsuo, 1982). Yellow pigment level in the Egyptian durum semolina and flour were higher than of the imported durum flour, the aim in durum wheat milling is to produce a product with a bright yellow colour, a low specks count and uniform granulation, Because of these, semolina yield is never as high as flour yield.

Results in Table (3) and (6) show that there are a positive correlation between browning and ash content.

3.8. Sugars:

Data in Table (7) show the reducing and non-reducing sugars contents. Results obtained from flour mill (imported durum) are higher in its containing of both reducing and non-reducing sugars than obtained from semolina mill (Egyptian durum) and so in total sugars. It is in agreement with Kent (1983). In semolina mill, reduction stages $R.S_1$, $R.S_2$, and $R.S_3$ there is a positive correlation between reducing sugars and α-amylase activity where P_3 has the highest content of sugars it has the highest α-amylase activity (lowest falling number) attributed to aleurone layer contamination or bran contamination which also raised ash content, (Table, 3) lipids (Table, 6) and protein (Table, 4) while decreased wet and dry gluten (Table, 4).

Table (7): Sugar and α-amylase activity.

Source of sample	Reducing sugars %	Non-reducing sugars %	Total sugars %	Falling No. seconds	Perten liquefaction no.
Semolina mill					
P_1	0.41	1.76	2.17	526	12.60
P_2	0.25	0.53	0.78	534	12.39
P_3	0.51	3.57	4.08	419	16.26
P_4	0.41	1.57	1.98	635	10.25
P_5	0.41	1.61	2.02	563	11.69
P_6	0.41	1.48	1.89	524	12.68
$R.S_1$	0.46	1.43	1.89	577	11.38
$R.S_2$	0.56	1.61	2.17	582	11.27
$R.S^3$	0.31	1.95	2.26	510	13.04
D.S	0.46	2.18	2.64	653	9.95
Semolina	0.46	1.81	2.27	580	11.32
Flour	0.46	2.42	2.88	516	13.15
Flour mill					
M.S	0.519	0.950	1.99	446	15.15
F.S	0.476	1.822	2.30	419	16.26
3.S	0.341	2.060	2.40	464	14.49
Flour	0.267	2.330	2.60	359	19.41

* Perten liquefaction no. = 6000/(FN - 50)

From obtained results it can concluded that the increasment of sugars deals to the encreasment of browning as in P_3 stage it has 4.08% sugars and the highest browning 1.444 A (Table, 6).

3.9. Starch and damaged starch:

Data in Table (8) show the starch and damaged starch contents of semolina and flour from the different stages of purification process. It shows that the starch content of flour produced from the Egyptian durum and the flour produced from the imported durum were 68.25 and 77.08%. It also shows that the starch damaged were 3.83 and 3.62 in P_1 and P_2. These results are in agreement with Fraser and Holmes (1959) and Shuey *et al.* (1980).

Results obtained in Table (2), (8) and (11) indicate that the water absorbing capacity of semolina increased with finer granulation and higher starch damaged content. These results are in good agreement with Kent (1983), Riva *et al.* (1991) and Pitz (1992).

Results in Tables (2) and (8) show that the biggest granular size of semolina had the lowest damaged starch percentage and vice versa, it could concluded that there are a negative relationship between granular size of semolina and percentage of damaged starch, it is attributed to the number of roller processing, so there

Table (8): Starch, damaged starch and fibers.

Source of sample	Starch %	Damaged starch %	Dietary fibers %
Semolina mill			
P_1	76.04	3.83	5.25
P_2	74.04	3.62	6.01
P_3	64.64	4.21	9.05
P_4	73.64	4.25	6.51
P_5	73.98	4.74	5.79
P_6	65.73	4.69	11.91
$R.S_1$	74.26	6.70	4.98
$R.S_2$	78.89	7.10	5.27
$R.S^3$	78.75	7.21	4.12
D.S	65.02	8.13	12.79
Semolina	78.10	7.54	4.50
Flour	68.25	7.33	11.92
Flour mill			
M.S	80.24	7.83	4.61
F.S	78.70	8.42	4.75
3.S	75.05	8.69	5.70
Flour	77.08	10.12	5.79

are a negative relation between hardness of wheat and the amount of damaged starch.

Durum wheat is a very hard wheat, the difference in starch damaged between normally milled hard and soft wheats appears related to the degree of attachment between the starch granules and the protein matrix. Hard wheat endosperm is held to split initially along the plane of the cell walls and their with increasing pressure across the cell. This better cleavage appears to simultaneously split the starch granule in contrast on splitting open the cells of soft endosperm, the granules are readily released from their protein matrix (Kingswood 1975)

4. Rheological Tests:

4.1. Farinogram characteristics:

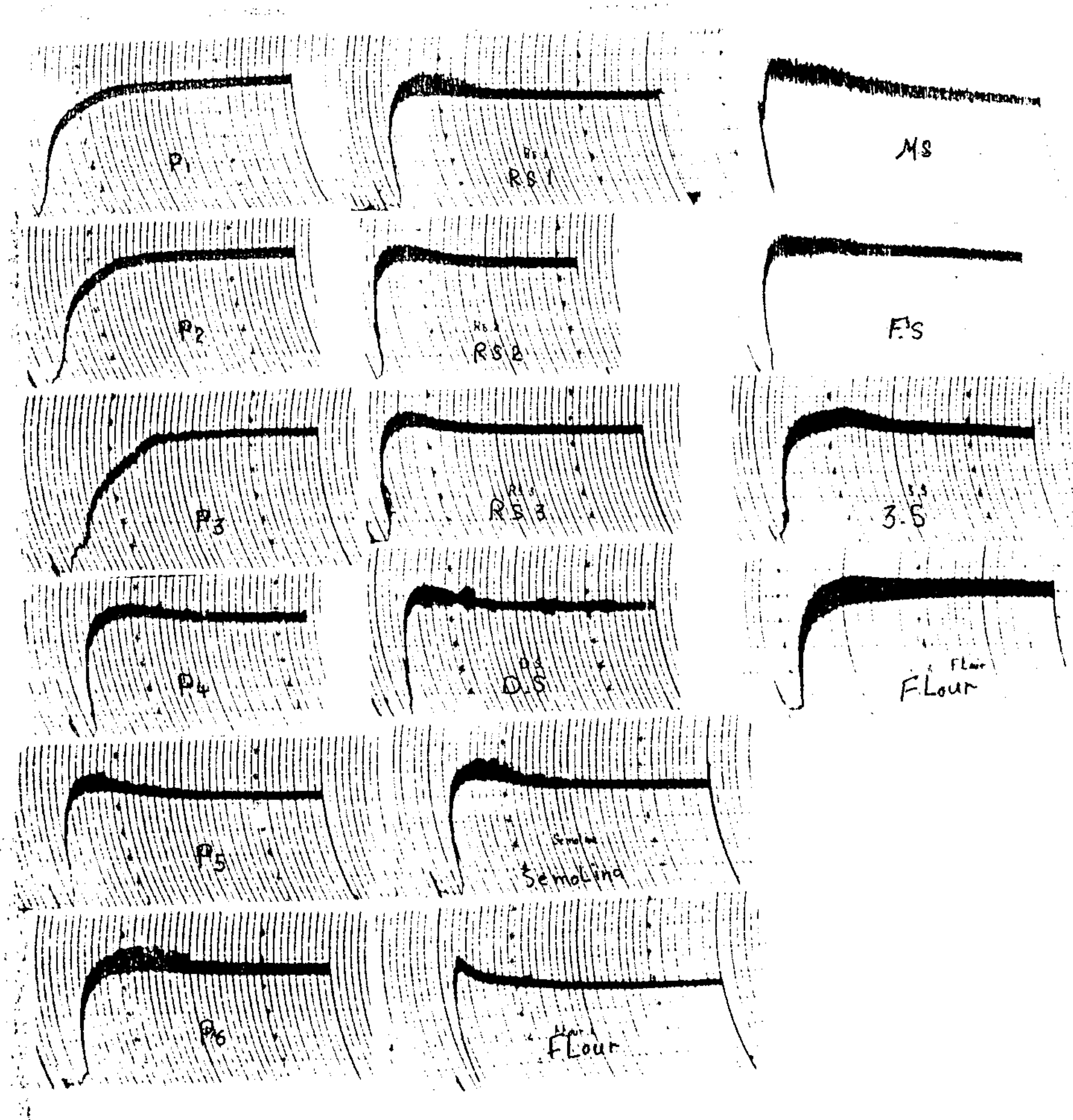
Data concerning farinograms properties presented in Table (9) and figure (1). It reveal that there is a relatively long D.D.T. in the three first purification stages and low T.I., while D.D.T. is decreased in the other stages and there was increasing of T.I. from the first to the last stages. These results are in good agreement with Dexter and Matsuo (1978).

The water absorbing influenced by the granulation of semolina, the arrival time increased in P_1, P_2 and P_3 (7,7 and 8 min respectively), while it decreased in P_4, P_5, and P_6 (2.5. 2.5

Table (9): Farinograms characteristics.

Source of sample	Water[1] absorpt-ion %	Arrival time min.	D.D.T.[2] min.	Dough stability min.	Weaking of dough after 10 min. B.U.[3]	Weaking of dough after 20 min. B.U.	Mixing tolera-ance B.U.	Volori-meter value
Semolina mill								
P_1	40.82	7.00	8.00	20.00	-	-	30	82
P_2	43.11	7.00	9.00	20.00	-	-	20	66
P_3	53.77	8.00	11.00	20.00	-	-	20	80
P_4	44.44	2.50	5.00	4.50	25	40	40	54
P_5	43.58	2.50	3.50	3.50	50	70	60	54
P_6	40.91	3.50	5.50	7.00	30	40	30	62
$R.S_1$	46.91	3.25	3.50	4.00	40	45	40	56
$R.S_2$	46.20	2.50	4.50	6.00	30	40	50	58
$R.S_3$	50.28	2.25	4.00	4.75	30	50	55	56
D.S	46.26	2.50	3.50	4.00	50	65	70	50
Semolina	47.48	2.25	3.00	4.25	65	85	60	53
Flour	49.35	1.25	1.50	1.00	110	130	100	38
Flour mill								
M.S	43.70	1.00	2.50	20.00	-	-	50	50
F.S.	47.58	1.50	2.50	7.00	20	50	30	64
3.S	45.82	2.00	5.00	5.00	60	100	40	62
Flour	55.72	2.00	5.50	15.00	-	25	60	68

(1) on 14% basis.
(2) D.D.T. = Dough development time.
(3) B.U. = Brabender units.


P1
RS 1
MS
P2
RS 2
F.S
P3
RS 3
3.S
P4
D.S
FLour
P5
Semolina
P6
FLour

and 3.5 min respectively). These observation agree reasonably well with those reported by Chiriotti and Pinerolo (1991).

4.2. Extensogram characteristics:

Data of extensograms in Table (10) and figure (2) reveal that there are a variation in the risistance to extension, extensibility and energy among the different stages of purification.

From Tables (4) and (10) it could be noticed that there are a relation between gluten content and risistance to extension, it is a relatively negative relationship. (El-Bardeny *et al.*, 1993).

Data indicate that there are a relatively positive relation between risistance to extension and energy, as reported by Cheriotti and Penerollo (1991).

5. Cooking quality:

Data of macaroni processed from the different purification stages and the final product are presented in Table (11). Results showed that there are variation in the cooking quality specially cooking loss, it attributed to the variation in protein contents and the quality of the gluten. It can be concluded that there are a negative relationship between the protein and gluten contents and the cooking loss, the higher the protein and gluten contents, the lower the cooking loss.

Table (10): Extensigrams characteristics.

Source of sample	Extensibility mm	Risistance to extension B.U.	Proportial number ela./ex.	Energy cm^2	Peak height B.U.
Semolina mill					
P_1	135	1020	11.8	224	1080
P_2	128	540	4.0	105	540
P_3	125	720	6.3	158	910
P_4	198	780	4.4	280	885
P_5	220	620	3.9	306	860
P_6	175	900	5.7	290	1000
$R.S_1$	190	920	4.8	282	1060
$R.S_2$	140	760	5.9	187	830
$R.S^3$	185	680	4.1	220	760
D.S	195	680	3.8	233	740
Semolina	170	820	5.1	236	890
Flour	157	580	4.2	169	670
Flour mill					
M.S	142	620	4.3	126	780
F.S	122	950	7.8	138	990
3.S	160	835	5.2	175	850
Flour	148	700	4.7	138	860

Table (11): Cooking quality.

Source of sample	Increasing of weight %	Swelling index %	Cooking loss %
Semolina mill			
P_1	276	275	6.8
P_2	244	250	5.2
P_3	261	275	7.8
P_4	368	412	9.6
P_5	273	287	5.6
P_6	387	375	6.1
$R.S_1$	466	487	8.8
$R.S_2$	389	425	8.5
$R.S_3$	377	375	9.4
D.S	349	425	8.3
Semolina	305	325	6.6
Flour	322	350	6.9
Flour mill			
M.S	210	400	5.0
F.S	360	480	4.9
3.S	310	400	8.5
Flour	260	300	8.6

The cooking loss is the percent of solids lost in the cooking water and it should not be more than 8% as cited by the Egyptian standard. (Anon, 1988).

The cooking quality of durum wheat pasta products depend mainly on gluten proteins. These results are in agreement with Dixter and Matsuo (1978), Dexter and Matsuo (1979) and Feillet (1986).

Starch damaged, a reflection of particles size distribution, appeared to have a significant influence on cooking loss (Table 8) as cited by Abercrombie (1980).

The semolina streams from flour mill exhibited a wide range in cooking quality, this provides further evidence that differences in gluten and protein are responsible for variations in cooking quality between streams as reported by Dexter and Matsuo, (1977).

Swelling index of semolina stream ranged from 275 to 487% (Table 11). The breaking stages P_1 - P_6 had the lower values while the reduction stages R.S_1, R.S_2, R.S_3, and D.S had the higher values.

The swelling index of macaroni which made from semolina must not less than 3% (Anon 1988). From Table (11), semolina as a finished product in semolina mill and the flour in flour mill, both are in agreement with the Egyptian standard quality of durum macaroni.

Sensory evaluation:

Data in Table (12) show the sensory evaluation for flavor, color, appearance, texture, and acceptability of samples P_1, P_4, R.S_2, semolina, and flour. Results reveal that there are a relatively improvements for the parameters from P_1 to flour except the colour which was better in P_1 and decreased towards P_4. these results are in agreement with those mentioned in Table (6) which indicate that the yellowniss was higher in P_1 than P_4. Results also indicate that texture and appearance improved from P_1 to P_4, its may due to the percentage of gluten as showed in Table (4). Semolina particles below 350 μm in diameter were easier to process into more homogeneous and translucent pasta than coarse semolina (Kim *et al.*, 1986).

Results reveal that there were improvements in flavor and acceptability in P_1 than P_4.

Table (12): Sensory evaluation parameters:

Sample	Flavour	Appearance	Texture	Acceptability	Color
P_1	7.6	9.1	5.8	5.6	8.4
P_4	6.8	8.3	6.5	6.1	4.6
$R.S_2$	7.8	7.8	7.3	7.3	3.5
Semolina	8.3	8.6	8.1	8.6	4.2
Flour	5.8	7.3	6.0	6.6	4.1

Amino acids:

Amino acids content of samples which had a variation in ash and protein ranges are presented in Table (13).

Results show that all samples have very high percentage of both lycine and glutamic acids. It is also noticed that the amino acids lycine, glutamic, proline and aspartic have the highest percentages among the samples.

Results indicate that in semolina mill, the semolina as a finished product had the highest percentage of lycine and the lowest of glutamic (6.177 and 22.211%, respectively) in comparison with other samples. Whereas the flour as a final product with 72% extraction had the highest percentage of glutamic and the lowest of lycine (50.48 and 2.738%, respectively).

These results are in agreement with El-Akel and Hussein (1993) and Jensen and Martens (1983).

Minerals:

Data in Table (14): indicated that the content of samples from Ca are relatively constant, specially in P_1, P_4 and R.S_2 (it is 0.40%), while these samples ranged in its content of ash from 0.67 to 0.75%.

Table (13): Amino acids (g/100 g protein)

Amino acids	P_1	P_4	$R.S_2$	Semolina	Flour
Therionine*	1.140	2.280	1.150	-	-
Cysteine*	-	-	-	3.740	7.760
Valine*	2.399	2.586	3.325	2.246	2.461
Glysine + Isoleucin*	-	9.420	9.300	4.097	9.420
Leucine*	1.430	6.260	6.210	5.915	8.380
Methionine*	-	-	-	0.524	6.210
Tyrosine*	2.257	2.733	2.803	3.740	3.550
Phenylalanine*	2.741	1.275	0.859	2.396	1.785
Lycine*	5.048	5.601	5.434	6.177	2.7.38
Aspartic	6.282	4.009	6.497	3.201	2.793
Serine	2.199	6.830	1.376	3.744	1.785
Glutamic	25.186	25.732	28.091	22.211	50.480
Proline	9.423	4.543	2.149	2.995	1.774
Alanine	2.860	0.205	0.468	7.480	1.110
Histidine	2.570	0.910	2.000	-	0.250
α-amino butyric	-	-	-	8.990	2.330

* Essential amino acids.

Table (14): Minerals (g/100 g sample).

Source	P	Ca	Na	K
P_1	0.093	0.040	0.166	0.139
P_4	0.067	0.040	0.166	0.123
$R.S_2$	0.087	0.040	0.166	0.123
Semolina	0.091	0.048	0.144	0.139
Flour	0.097	0.048	0.132	0.147

For semolina and flour Ca percentage was 0.48% while its ash content were 0.66 and 0.86%, respectively.

The level of Ca in flour depend mainly on the Ca content of the parent wheat (Lorenz *et al.*, 1980).

The content of Na was also constant in P_1, P_4 and $R.S_2$ and decreased in semolina as a final product in the semolina mill. In general, it cauld concluded that there are a positive relationship between the ash content and minerals as reported by Ranum *et al.* (1980).