Infestations by *Sitophilus granarius* (L.) and *Rhyzopertha dominica* (F.) on durum wheat, and their influence on the rheological characteristics of the semolina[1]

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Abstract

This study aimed to identify the extent of some alterations of the physical, chemical and rheological features of durum wheat flours and semolinas caused by infestations of *Sitophilus granarius* (L.) and *Rhyzopertha dominica* (F.) in West Bred 881 and Primadur wheat varieties. The following semolina characteristics were studied: humidity, ash, colour, proteinaceous fractions, gluten, black specks, farinogram, falling number and, by use of an alveogram curve, strength and elasticity. Under experimental conditions, infestation by the two species was limited, and did not cause significant variation in the parameters under observation.

Introduction

Flour derived from wheat that has suffered infestation by arthropods can be affected both in its nutritional value and hygienically. Rheological parameters can also be influenced. Each change depends on many variables, for example the type of wheat, the pest species, infestation level, and environmental conditions. Rheological characteristics are very important as regards the flour's final destination, and much research has been carried out into them. Research has also been carried out into the capacity of soft and durum wheat to maintain pest infestation (Sinha et al. 1988; McGaughey et al. 1990).

However, as regards changes to rheological parameters as a result of infestation, so far there are few data available for clarifying the relationship between pest species and the parameters. The influences of infestation on flour quality as regards bread and pasta production have been noted by several authors (Smith et al. 1971; Ahmed et al. 1982; Domenichini 1984; Trematerra et al. 1984; Swallow and Every 1991); more recently the consequences for other parameters, including rheological parameters, have also been reported (Lorenz and Meredith 1988); Fogliazza et al. (1993) investigated the influence different pest species have on the rheological features of soft wheat flour. As durum wheat is a significant worldwide food (Trentesaux 1979), the aim of this work was to examine any effects on analytical and rheological characteristics of semolina derived from durum wheat infested by insects.

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Materials and Methods

Two kinds of durum wheat were used: Primadur and West Bred 881. To ensure that the kernels were not already infested, and contained no residual pesticides, x-rays, chemical analysis and biological monitoring were first carried out; for residue testing, specimens of *Choetospila elegans* Westw. (Hymenoptera: Pteromalidae), which is very sensitive to pesticide residues, were used. Ten specimens of *C. elegans* were placed in petri dishes containing samples of the kernels to be used in the experiments. Almost all the Hymenoptera survived over a period of two weeks.

Forty 2 kg samples of each wheat variety were placed in 5 litre jars covered with 0.5 mm nylon netting. *Sitophilus granarius* (L.) and *Rhyzopertha dominica* (F.) were introduced into the jars: for each of the two kinds of wheat, there were three levels of infestation for each of the two species: 25, 50 and 75 adults, plus the control jars. The jars were kept at 25°C, at humidity varying between 75 and 80%, and 12 hours light in 24 hours. Each trial was repeated on five jars, and the trial period was 30 days. All insects were reared in the Institute of Entomology at Piacenza. The male/female ratio, checked over 500 insects after the trials, was 44/56 for *S. granarius* and 64/36 for *R. dominica*.

At the end of the trial period, all the samples were sieved to recover the insects. The kernels were then x-rayed using a General Electric X-Ray Grain Inspection Unit with a beryllium window x-ray tube at 5 mA, 21 kV for 5 minutes.

For x-rays of the West Bred 881, 120 g (approx. 2600 seeds) were required, and for the Primadur 110 g (approx. 3700 seeds). The damaged kernels were counted from the x-rays, and the percentages are shown in Table 1.

Table 1. Percentage of damaged kernels in total x-rayed kernels

Species	Introduced insects (No.)	West Bred—damaged kernels (%)	Primadur—damaged kernels (%)
R. dominica	25	0.34	0.48
	50	0.88	0.62
	75	1.23	0.91
S. granarius	25	0.15	0.48
	50	0.19	0.62
	75	0.38	1.40

Analysis of the Semolinas

All the samples were re-sieved through a UNI 5 mesh with 2.5 mm square mesh for West Bred 881 and 2 mm round mesh for Primadur. The kernels were then brought to 17% humidity, calculating the additional water required by measuring the humidity of the dry grain with a thermobalance. The water

was added 80% in the evening and 20% the following morning; the grain was left for 3 hours and was then milled in a Bona laboratory mill (Crippa 1981). The semolina obtained was subjected to the following analyses: humidity, ash, colour, nitrogenous fractions, dry gluten (quantitative evaluation), dry gluten (manual evaluation), bran specks, black specks, sedimentation index (SDS), alveogram curve (P, G, W, P/L), falling number, farinogram (percentage absorbtion, stability in minutes, valorimeter value, arrival in 10 minutes).

The following methods were used: humidity: ISO 712 method, ashes: the method published in the European Community Official Gazette, no. 128, 26.6.1967 (rule no. 162/67/CEE, 23.6.1967), colour: Minolta CR 200 colourimeter with CR A 50 attachment, nitrogenous fractions: AACC no. 46–10 (Kjeldahl) method, gluten: AACC no. 38–10 method, SDS: AACC no. 56–61A method, alveogram: AACC no. 54–30 method, falling number: AACC no. 56–81B method, with instrument FN 1400, farinogram: AACC no. 54–21 method.

Results and Conclusions

The results of the analyses are given in Tables 2 and 3 for Primadur and Tables 4 and 5 for West Bred 881. The x-ray results are given in Table 1. The graphs from the alveograms and farinograms of the controls are given in Figures 1 and 2. The conclusions that can be drawn from the results of the analyses are as follows.

The colour, ash, nitrogenous fractions, gluten, sedimentation index, the W and P/L values and the farinogram do not show significant changes.

Only the falling number reveals significant change, both in increase and decrease compared with the controls.

This research shows that both *S. granarius* and *R. dominica* caused a limited and decreasing first generation (F_1): this is clear from the small number of damaged kernels in all of the 60 durum wheat samples (West Bred 881 and Primadur), into which the insects (3000) were introduced for a month and is evident also from x-rays of the different trial samples (Table 1). This confirms the results of studies aimed at determining the rate of development of different pest species on different varieties of wheat (Sinha et al. 1988; McGaughey et al. 1990). Thus, while rheological analyses on soft wheat flour (Fogliazza et al. 1993) reveal altered parameters after infestation of the grain, the same cannot be said for durum wheat semolinas, in which the insects reproduce and continue infestation with difficulty, and give rise to little damage to the cereal.

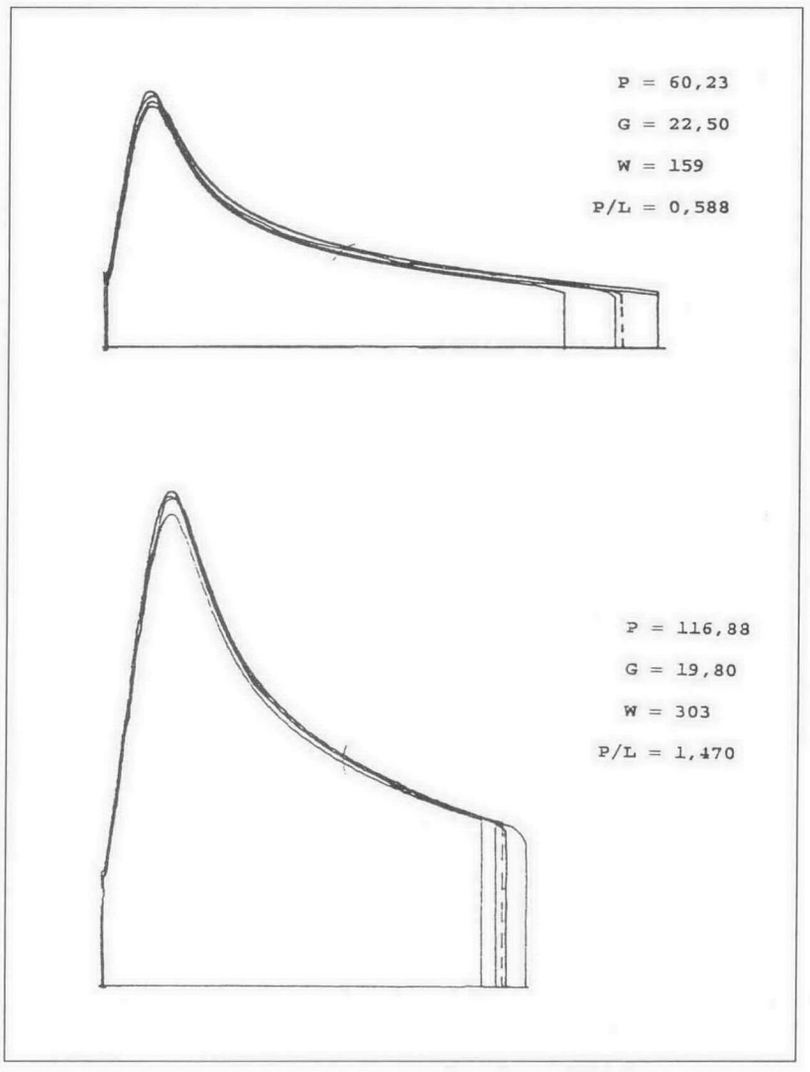

Fig. 1. Semolina alveograms (control samples) of durum wheat Primadur (top) and West Bred 881 (bottom).

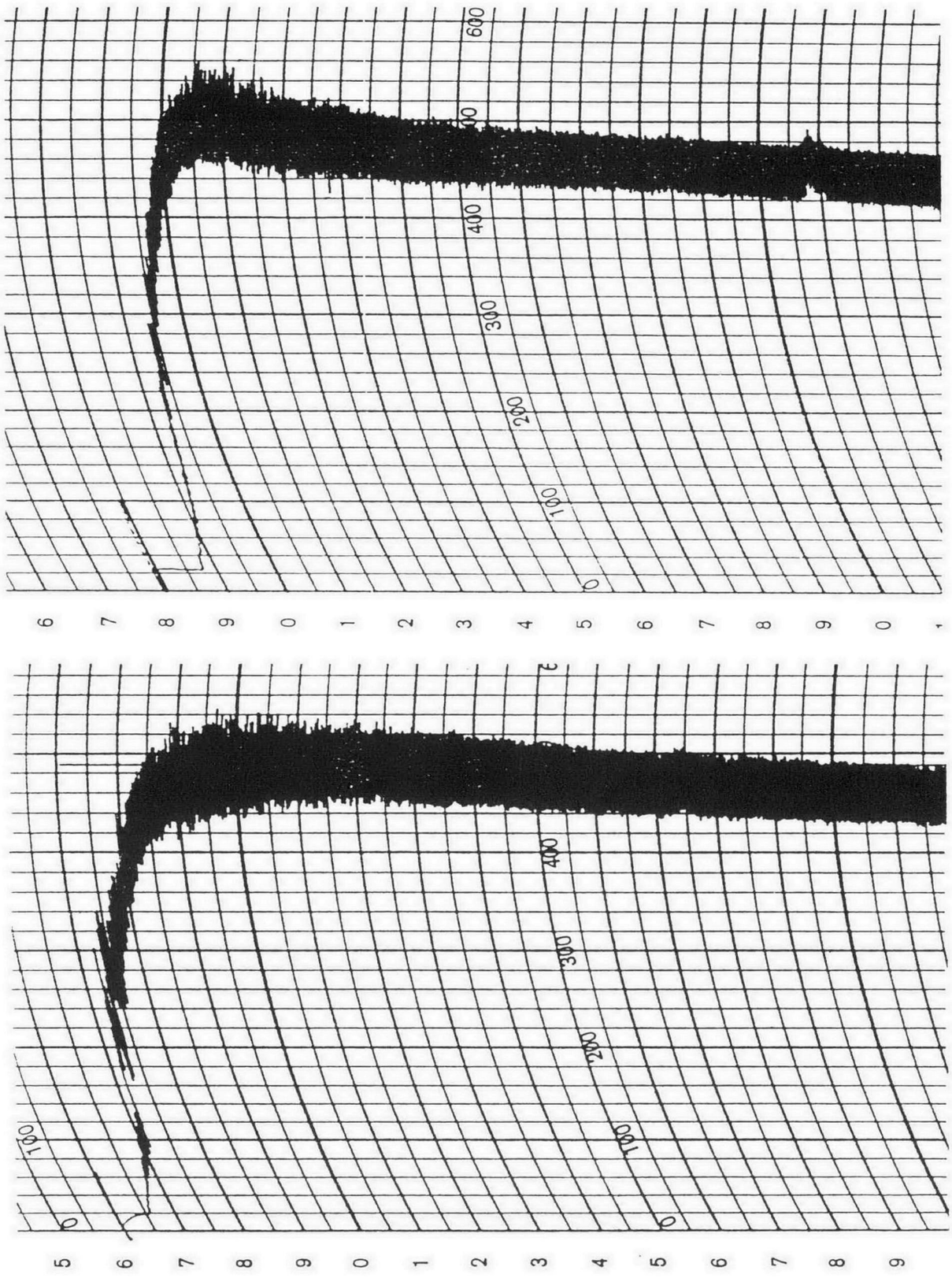

Fig. 2. Semolina farinograms (control samples) of durum wheat Primadur (top) and West Bred 881 (bottom).

Table 2. Results of the chemical-physical and rheological analysis on semolina from durum wheat Primadur (PD) infested by *Sitophilus granarius* (S.g.).

Sample code ↓	dry grain humidity	semolina humidity	semolina ashes	semolina colour	semolina nitrogenous fractions	semolina dry gluten quantit. eval.	semolina dry gluten manual eval.
PD S.g. 25	11,920	16,01	1,0680	27,576	12,814	10,764	6
PD S.g. 50	11,974	16,062	1,0516	27,562	12,982	10,772	6
PD S.g. 75	12,048	16,208	1,0476	27,380	13,180	11,140	6
PD control	12,110	16,86	1,0300	27,870	12,980	11,230	6

Sample code ↓	semolina bran specks	semolina black specks	semolina SDS	semolina alveogram P	semolina alveogram G	semolina alveogram W	semolina alveogram P/L
PD S.g. 25	20,0	1,6	11,060	61,546	22,71	175,8	0,5892
PD S.g. 50	18,6	2,8	11,784	60,206	22,40	164,4	0,5934
PD S.g. 75	21,4	2,4	10,572	62,922	22,95	176,6	0,5910
PD control	17,0	3,0	12,410	60,230	22,50	159,0	0,5880

Sample code ↓	semolina falling number	semolina farinogram absorption (%)	semolina farinogram stability (min.)	semolina farinogram valorim. value	semolina farinogram arrival time (10')
PD S.g. 25	584	52,0	4	50	40
PD S.g. 50	592	52,0	4	50	40
PD S.g. 75	600	52,0	5	52	40
PD control	571	50,5	5	52	30

Table 3. Results of the chemical-physical and rheological analysis on semolina from durum wheat Primadur (PD) infested by *Rhyzopertha dominica* (R.d.).

Sample code ↓	dry grain humidity	semolina humidity	semolina ashes	semolina colour	semolina nitrogenous fractions	semolina dry gluten quantit. eval.	semolina dry gluten manual eval.
PD R.d. 25	11,902	16,230	1,0384	27,500	13,128	11,30	6,0
PD R.d. 50	11,772	16,278	1,0476	27,744	13,180	11,15	6,0
PD R.d. 75	11,624	16,470	1,0548	27,874	13,146	11,30	6,5
PD control	12,110	16,860	1,030	27,870	12,980	11,23	6,0

Sample code ↓	semolina bran specks	semolina black specks	semolina SDS	semolina alveogram P	semolina alveogram G	semolina alveogram W	semolina alveogram P/L
PD R.d. 25	17,0	2,2	12,216	66,614	21,95	175,2	0,6852
PD R.d. 50	22,2	2,0	12,120	63,308	22,14	168,2	0,6392
PD R.d. 75	20,0	2,2	11,532	60,944	22,75	166,0	0,5826
PD control	17,0	3,0	12,410	60,230	22,50	159,0	0,5880

Sample code ↓	semolina falling number	semolina farinogram absorption (%)	semolina farinogram stability (min.)	semolina farinogram valorim. value	semolina farinogram arrival time (10')
PD R.d. 25	629	52,0	5	52	40
PD R.d. 50	616	51,5	4	50	50
PD R.d. 75	636	52,0	4	48	50
PD control	571	50,5	5	52	30

Table 4. Results of the chemical-physical and rheological analysis on semolina from durum wheat West Bred 881 (WB) infested by *Sitophilus granarius* (S.g.).

Sample code ↓	dry grain humidity	semolina humidity	semolina ashes	semolina colour	semolina nitrogenous fractions	semolina dry gluten quantit. eval.	semolina dry gluten manual eval.
WB S.g. 25	9,72	15,38	0,910	24,27	14,35	12,79	6,50
WB S.g. 50	9,67	15,76	0,900	24,16	14,22	13,01	6,50
WB S.g. 75	9,79	15,90	0,916	24,20	14,23	12,75	6,50
WB control	9,79	15,86	0,928	23,87	14,07	12,68	6,50
Sample code ↓	semolina bran specks	semolina black specks	semolina SDS	semolina alveogram P	semolina alveogram G	semolina alveogram W	semolina alveogram P/L
WB S.g. 25	20,60	3,00	13,31	107,93	20,52	294,60	1,262
WB S.g. 50	18,00	2,60	13,37	110,38	20,19	298,20	1,331
WB S.g. 75	20,20	3,20	13,39	110,39	20,33	311,80	1,321
WB control	24,00	3,00	14,31	116,88	19,80	303,00	1,470
Sample code ↓	semolina falling number	semolina farinogram absorption (%)	semolina farinogram stability (min.)	semolina farinogram valorim. value	semolina farinogram arrival time (10')		
WB S.g. 25	1338	59,0	9,0	58	25		
WB S.g. 50	1189	57,5	10,3	60	20		
WB S.g. 75	1157	57,5	10,0	60	30		
WB control	1325	58,0	12,3	60	20		

Table 5. Results of the chemical-physical and rheological analysis on semolina from durum wheat West Bred 881 (WB) infested by *Rhyzopertha dominica* (R.d.).

Sample code ↓	dry grain humidity	semolina humidity	semolina ashes	semolina colour	semolina nitrogenous fractions	semolina dry gluten quantit. eval.	semolina dry gluten manual eval.
WB R.d. 25	9,954	15,718	0,9272	24,042	14,222	13,098	6,5
WB R.d. 50	9,832	15,612	0,9216	24,178	14,180	12,896	6,5
WB R.d. 75	9,768	15,538	0,9108	24,190	14,190	12,882	6,5
WB control	9,790	15,860	0,9280	23,870	14,070	12,680	6,5
Sample code ↓	semolina bran specks	semolina black specks	semolina SDS	semolina alveogram P	semolina alveogram G	semolina alveogram W	semolina alveogram P/L
WB R.d. 25	18,4	2,8	14,082	101,168	21,26	298,0	1,1064
WB R.d. 50	16,6	2,4	13,656	108,726	20,37	300,8	1,2944
WB R.d. 75	17,4	2,4	13,848	107,782	20,73	306,2	1,2382
WB control	24,0	3,0	14,310	116,880	19,80	303,0	1,4700
Sample code ↓	semolina falling number	semolina farinogram absorption (%)	semolina farinogram stability (min.)	semolina farinogram valorim. value	semolina farinogram arrival time (10')		
WB R.d. 25	1316	57,5	9,0	60	30		
WB R.d. 50	1109	57,5	8,0	60	30		
WB R.d. 75	1256	59,0	7,0	58	30		
WB control	1325	58,0	12,3	60	20		

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