LABORATORY INVESTIGATION TO THE PHYSICAL PROPERTIES OF DOUGH USING VARIOUS TYPES OF MILLING

By

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INTRODUCTION

The physical properties of flour doughs play an important role in relation to the quality of the baked product.

The objective of this research is to investigate the effect of milling procedure on the physical properties of wheat flour dough.

The farinograph and extensograph tests are the most widely used for recording the flour dough behaviour during mixing and changes in physical properties under standardized conditions. The experiments of these tests was operated in the national agriculture researches center at Cairo. (Cairo University Streeet, Giza Governorate).

1. MATERIALS AND METHODS

Two varities imported Egyptian wheats, Giza 155 and Giza 157, were milled on each of a stone flour mill and on a pneumatic Buhler experimental laboratory flour mill (roller mill) and hammer mill.

1.1 SAMPLING:

1.1.1 Wheat Grains:

A sample of Giza 155 wheat with 12.4 percent moisture content (on dry basis), 11.5 percent moisture content (on dry basis) for Giza 157, were used in this study.

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The wheat was cleaned through cleaning equipments existing in the unit operation (sieve separator, scourer, aspiration and washer), conditioning to 15 percent moisture content.

1.1.2 Flour: Three samples of wheat 72 percent extraction.

2. SAMPLING PROCEDURE

Samples were collected in plastic bags in order to protect the flour from moisture changes and probable infections with weavils until the analysis. Each sample in the plastic sack was placed in a paper bag marked with the proper identification of the sample.

3. Physical Dough Tests

3.1 Farinograph Test: (Brabender Farinograph)

Farinograph was used to study dough characteristics during mixing flour with water. The test was conducted by the constant flour method at 30°C, by mixing 300 gm, flour with sufficient water to give maximum consistency centered around 500 B.U. line.

Water absorption percentage was determined directly from the farinograph pipetted. From the farinograms, physical dough characteristics such as dough development time dough stability weakening of dough, were computed. Valorimeter values were obtained by means of special template supplied by the manufacturer of farinograph equipments and according to the specific direction of A.A.C.C. (1962).

Fig. (1) shows the BRABENDER FARINOGRAPH apparatus.

3.2 Extensograph test was used to determination:

1 - The Dough Energy (E)

The energy (E) is represented by the area in Cm^2 outlined by the curve, it stands for the total force required for stretching the piece of dough (the area was measured with a planimeter).

2 - The Dough Resistance to Extension (D_w)

The resistance to extension is determined by the height of the extensogram in E.U. (extensograph units) after 50 mm. of stretching for characterizing the force counteracting the extension of the dough.

3 - The Dough Extensibility (D_b)

The extensibility (D_b) is determined from the length of the extensogram in mm. for characterising the stretchability of the dough.

4 - The Proportional Number ($P_n = \frac{D_w}{D_b}$)

The proportional number calculated as quotient of resistance to extension to extensibility.

These factors provide definte conclusion in respect of the baking behaviour.

Fig. (2) shows the BRABENDER EXTENSOGRAPH apparatus.

4 - RESULTS AND DISCUSSION

4-1 Physical Properties of Flour

The forinograph and the extensograph data of the wheat flours are presented in Table (1). The farinograms and the extensograms of Giza 155 wheat variety are showing in Figs. (3-8).

4-1-1 Farinograph Data

1. Water Absorption

The amount of water necessary or required to develop the flour (water dough) to the optimum consistency as determined by farinograph is known as water absorption.

The amount of water absorbed is affected by the protein and the starch content and many other factors. Water absorption plays an important role in the quality of baked products. As shown from the Table (2), the water absorp was significantly affected by the method of milling used.

The water absorped by both the stone and hammer milled flours indicated an increased of about 7% in its water absorption capacity than it was for those roller milled flours.

Both the stone mill and hammer mill allows wheat bran to be milled with the flour. Moreover both the two procedures leads to more damaged starch granules and more fine flour granules with more surface area. All these factors resulted in more absorped water.

2 - Dough Development Time and Stability

Dough development time is the time nearest half minute, for the first addition of water to the development of the maximum consistency of the dough and the minimum mobility of the dough immediatly before the first indication of weakening as indicated on the farinogram. Dough stability is defined as the difference in time, to the nearest half-time, between the point where the top of the curve first intercept the 500 B.U. line and the point where the top of the curve leaves the 500 B.U. line.

The effect of milling procedure on dough development time and stability is presented in Table (2). Both stone and hammer milled flours caused an increase in dough development time, however for the roller milled flour, the dough development time was nearly out to half of the other procedures. Increasing the dough development time will necessiate a proportional increase in mixing time during bread making to obtain the optimum consistency required for good bread. This would add to the cost of production.

Dough stability was highly increased when the hammer milled flour was examined. This indicates that hammer milled flour have more tolerance to mixing than roller milled flour.

4-1-2 Extensograph Data

Comparison of the data corresponding to the extensograph test which is summarized in Table (2), it was clear that the energy indicating the strength of the dough was about 62, 158 and 47.5 Cm^2 for stone, roller and hammer milled flour respectively. Such data showed that the flour milled by the roller mill was the strongest flour when compared with the other two types. The extensibility value was highest for hammer milled flour, while the roller milled flour had the lowest value. The might be due to that both stone and hammer milled flours especially the hammer milled flour contained the bran layers and embryo which contain most enzymes which upon mixing the flour with water could act on the protein complex of flour and resulted on weakening the dough strength. The hammer milled flour also had the lowest resistance to extension.

This might be due to the same mentioned reason.

CONCLUSION

From the Table (2), it can be concluded that:

1. The energy of dough was higher in roller-milled flour than stone-milled and hammer-milled flour (158, 62 and 47.5 Cm^2 respectively).
2. The extensibility of hammer-milled flour was higher than stone-milled and roller-milled flour (103.5, 107 and 82.5 mm. respectively).
3. The resistance to extension was higher in stone-milled flour than roller-milled and hammer-milled flour (480, 450 and 300 B.U. respectively).
4. The proportional number was higher in roller-milled flour than stone-milled and hammer-milled flour (5.5, 4.6 and 1.8 respectively).

5. The water absorption of stone-milled flour was higher than in hammer-milled and roller-milled flour (65.6, 65.5 and 57.8% respectively).

6. The mixing time (dough development) was higher in hammer-milled flour than stone-milled and roller-milled flour (4.38, 3.63 and 2.13 Min respectively).

7. The dough stability was higher in hammer-milled flour than stone-milled and roller-milled flour (2.63, 1.5 and 0.75 Min respectively).

8. The weakening of dough was higher in roller-milled flour than stone-milled and hammer-milled flour (120, 110 and 82.5 B.U. respectively).

9. The valorimeter number (as a number expressing the strength of dough) was higher in roller-milled flour than stone-milled and hammer-milled flour (52, 54 and 35.5 respectively).

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Table (1): **Mean Values of the Physical Properties of Flour for Two Varieties of Wheat Milled with three Different Types of Mills.**

Types of Milling Process	Wheat Variety																	
	Giza 155 Wheat									Giza 157 Wheat								
	Type Of Test																	
	Extensograph				Farinograph					Extensograph				Farinograph				
	Energy (E)(Area Under Curve)Cm^2	Extensibility (D_b) mm.	Resistance to Extension(D_w)B.U.	Proportional Number (P_n)	Water Absorption %	Dough Development Min.	Dough Stability Min.	Weakening of Dough B.U.	Valorimeter Number	Energy (E)(Area Under Curve)Cm^2	Extensibility (D_b) mm.	Resistance to Extension(D_w)B.U.	Proportional Number (P_n)	Water Absorption %	Dough Development Min	Dough Stability Min.	Weakening of Dough RTU.	Valorimeter Number
Roller Mill	197	80	460	5.75	54.6	2	0.5	110	68	119	85	440	5.2	61	2.25	1	130	40
Stone Mill	58	89	460	5.12	62.6	3.25	1	100	60	66	125	500	.4	68.6	4	2	120	44
Hammer Mill	53	165	360	2.2	62.5	4.5	1.75	80	45	42	170	240	1.4	68.6	4.75	3.5	85	26

Table (2): The mean Effect of Milling Procedure on the Physical Properties of Wheat Flour.

Types of Milling Process	Type of Test								
	Extensograph				Farinograph				
	Energy (E)(Area Under Curve) Cm^2	Extensibility (D_b) mm.	Resistance to Extension(D_w) B.U.	Proportional Number (P_n)	Water Absorption %	Dough Development Min	Dough Stability Min	Weakening of Dough B.U.	Valorimeter Number
Roller Mill	158	82.5	450	5.5	57.8	2.13	0.75	120	54
Stone Mill	62	107.0	480	4.6	65.6	3.63	1.50	110	52
Hammer Mill	47.5	103.5	300	1.8	65.5	4.38	2.63	82.5	35.5

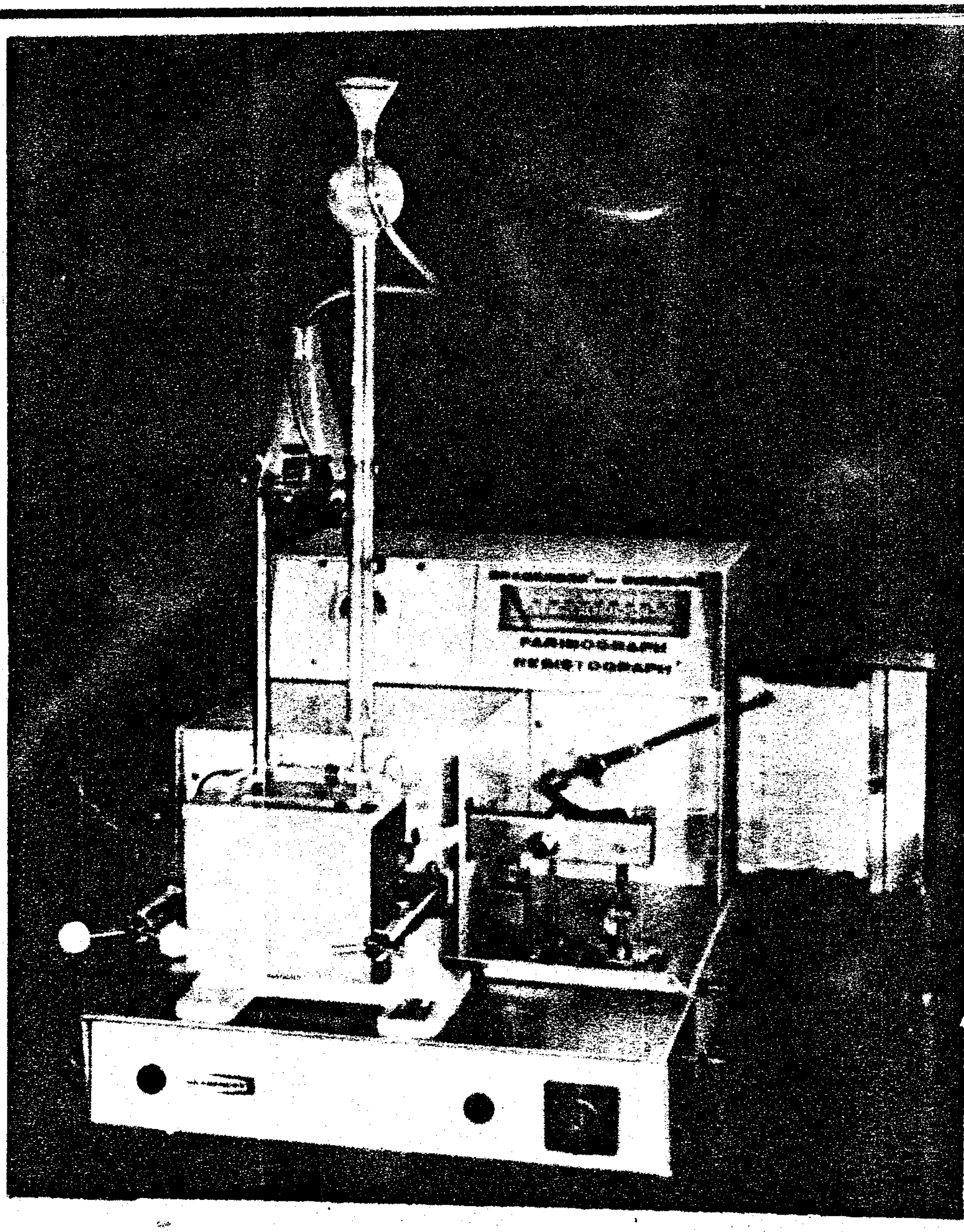

Fig. (1) A PHOTOGRAPH SHOWS THE BRABENDER FARINOGRAPH APPARATUS

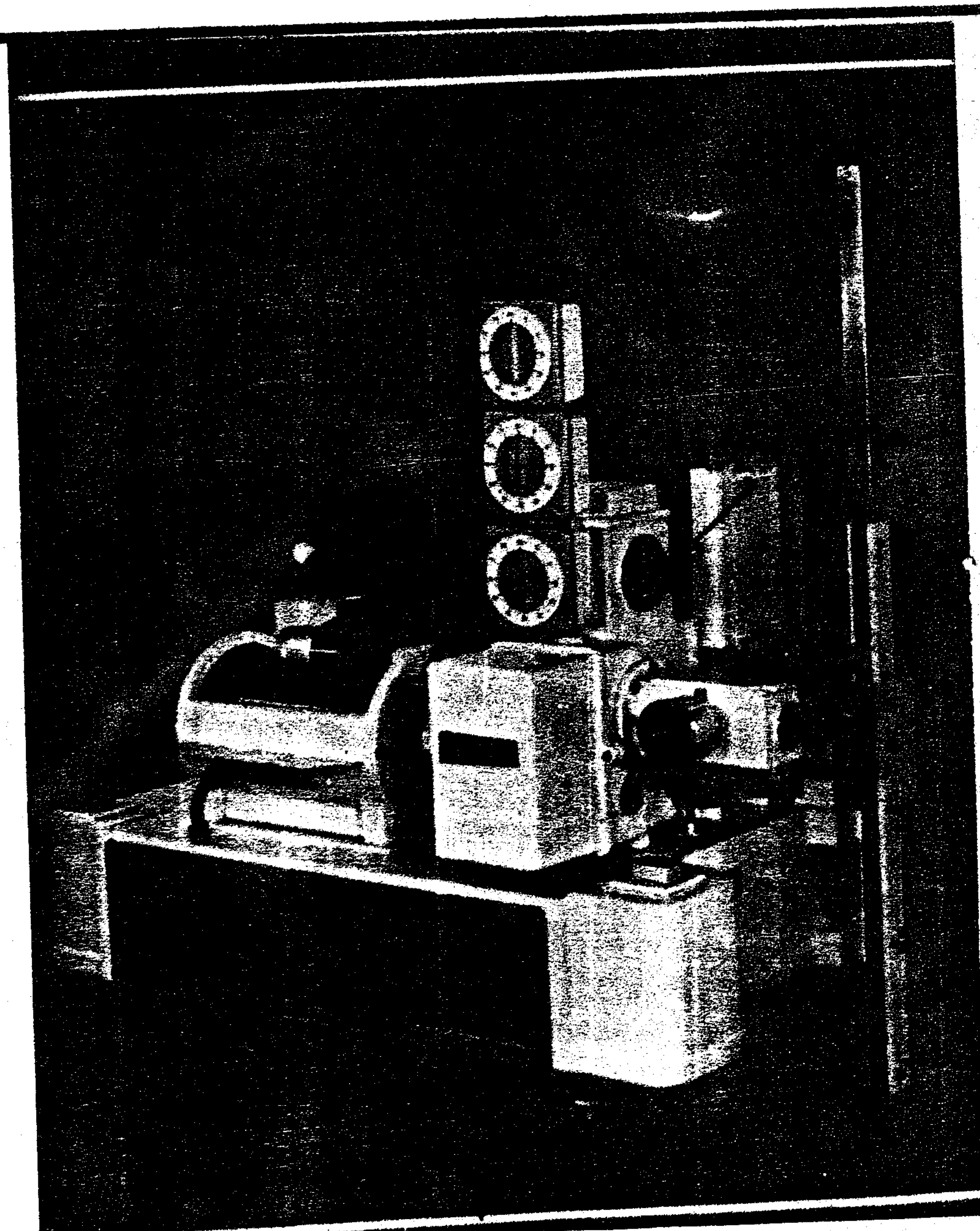

Fig (2) A PHOTOGRAPH SHOWS THE BRABENDER EXTENSOGRAPH APPARATUS.

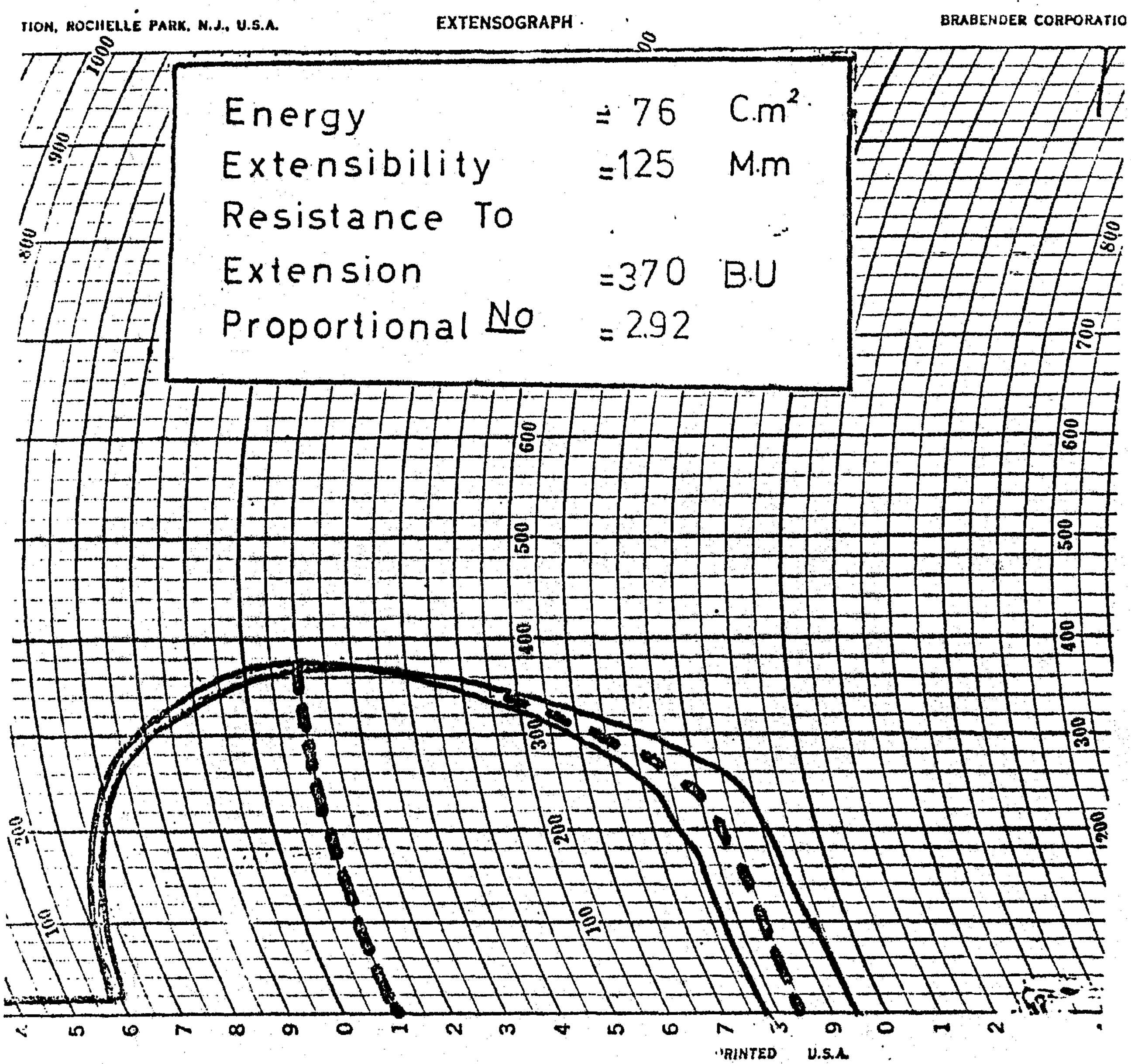

FIG.(3): EXTENSOGRAM OF HAMMER-MILLED FLOUR

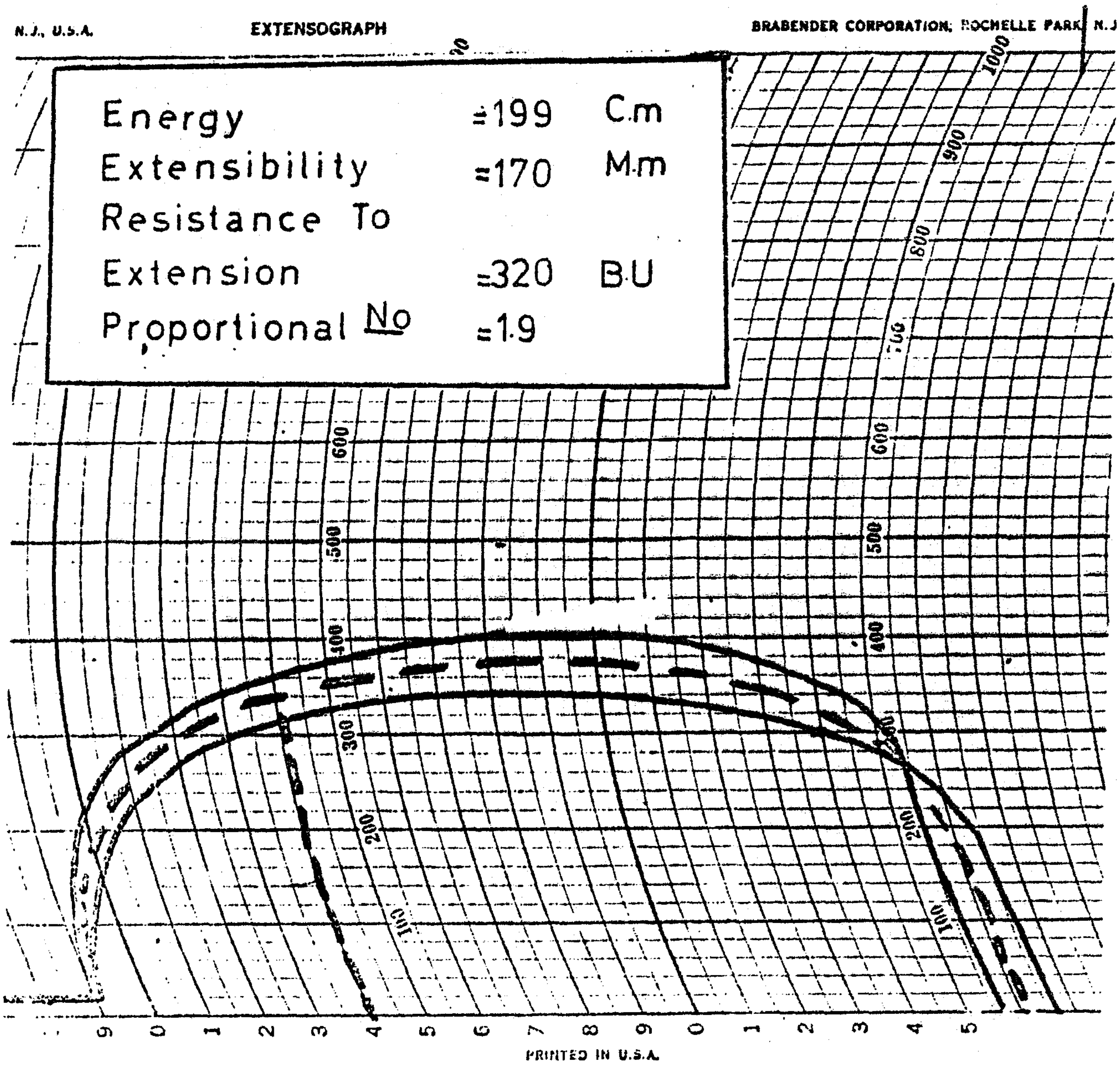

FIG. (4): EXTENSOGRAM OF ROLLER-MILLED FLOUR

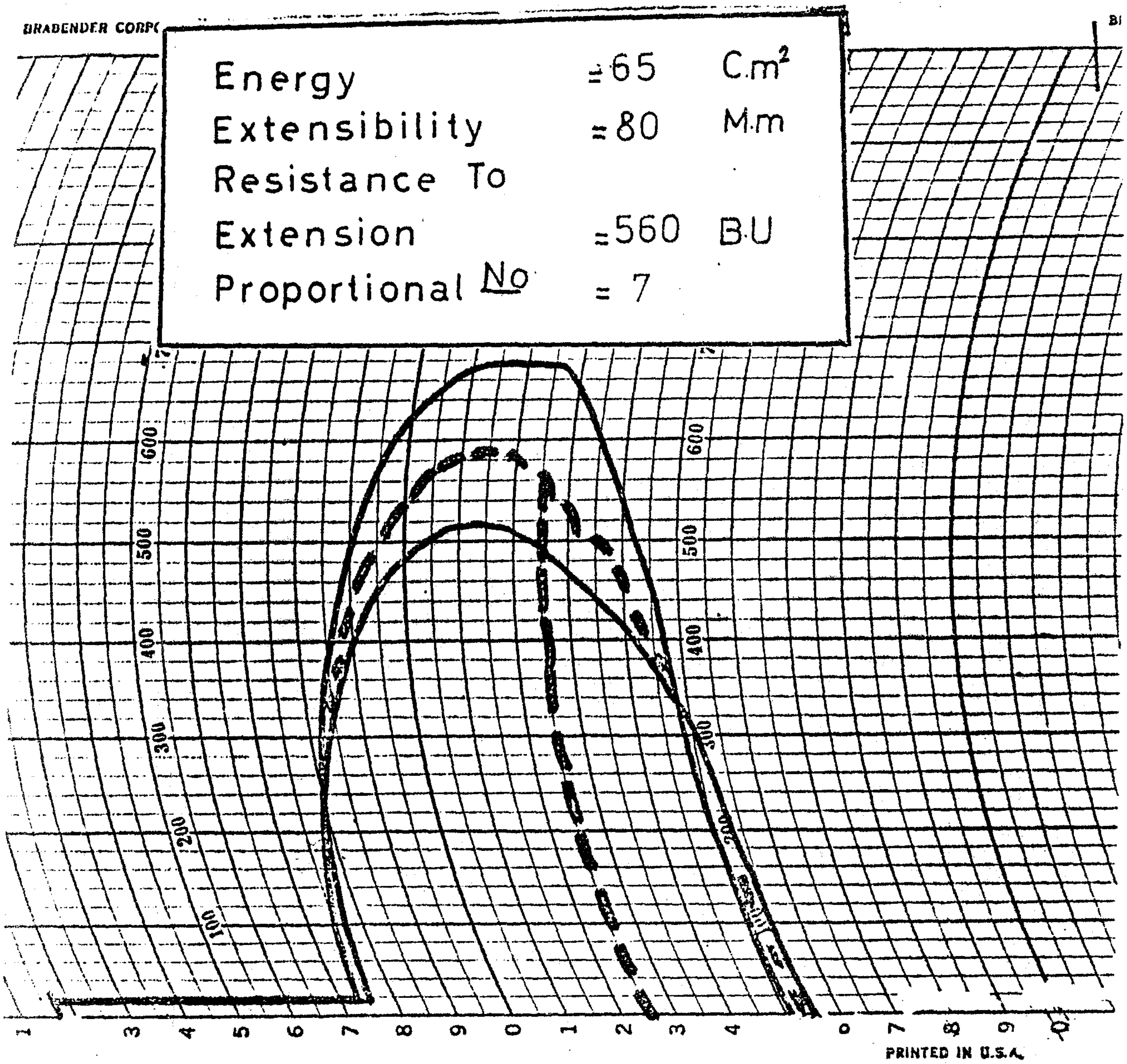

FIG.(5): EXTENSOGRAM OF STONE-MILLED FLOUR

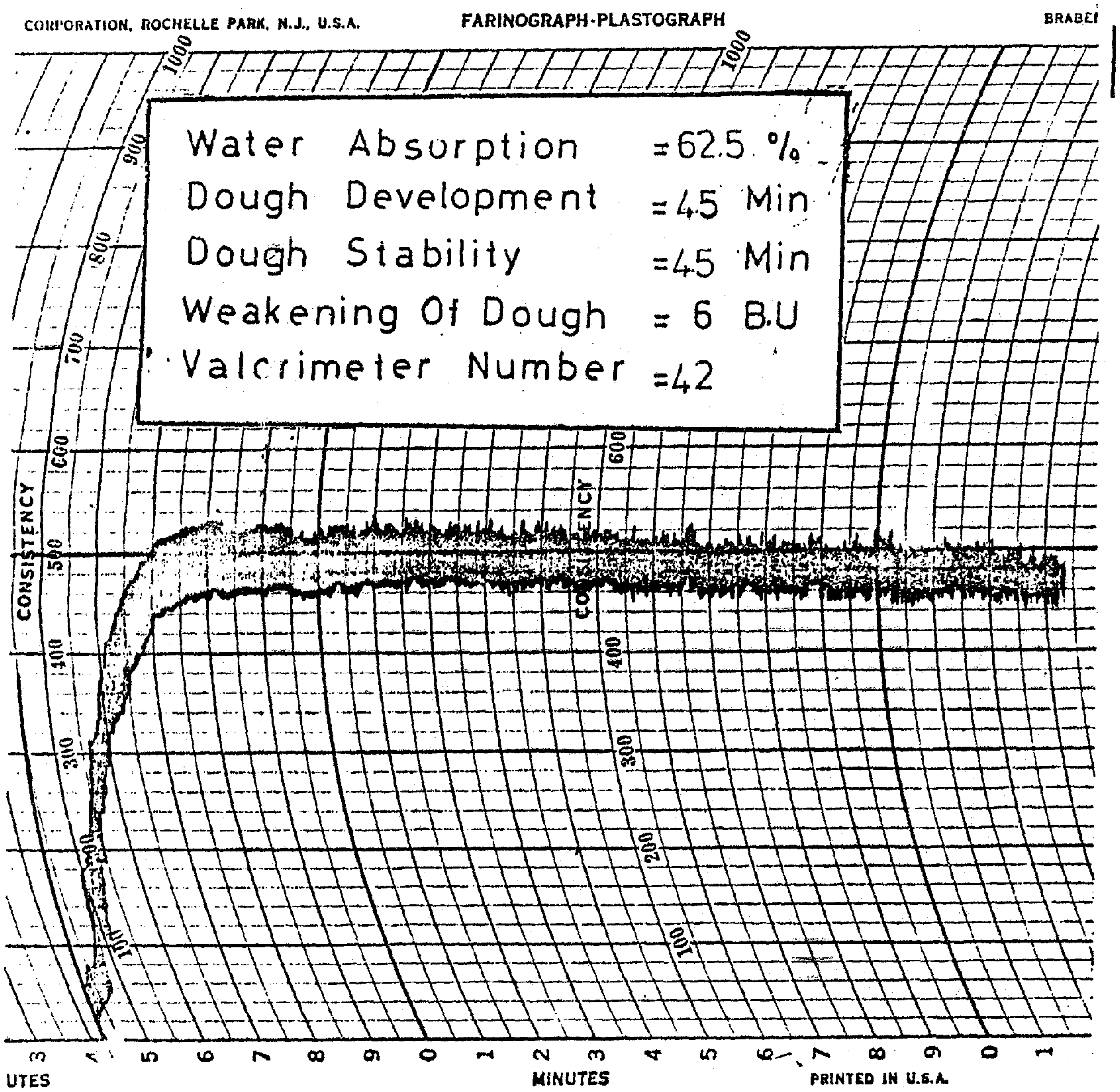

FIG. (6): FARINOGRAM OF HAMMER-MILLED FLOUR

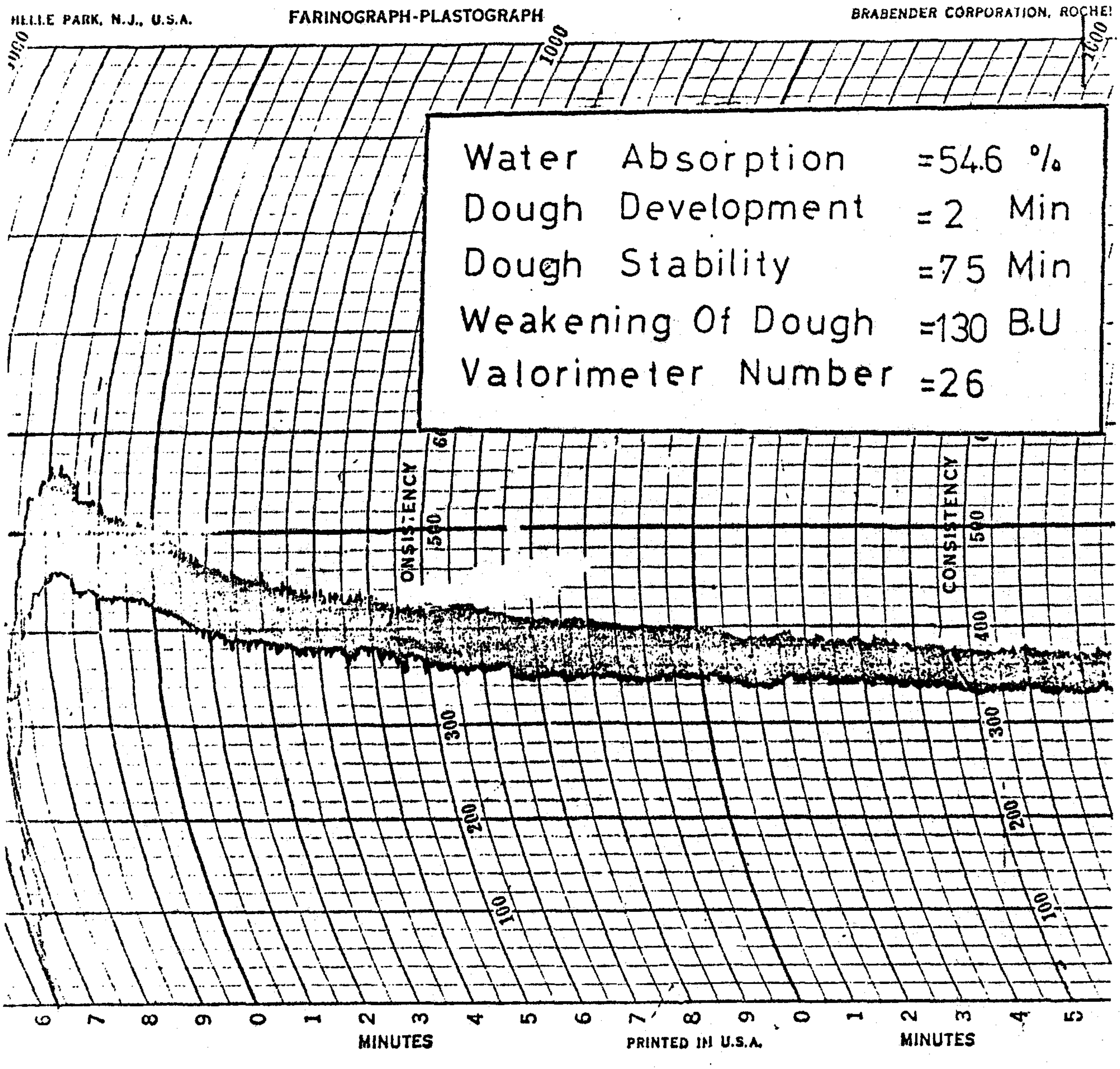

FIG.(7): FARINOGRAM OF ROLLER-MILLED FLOUR

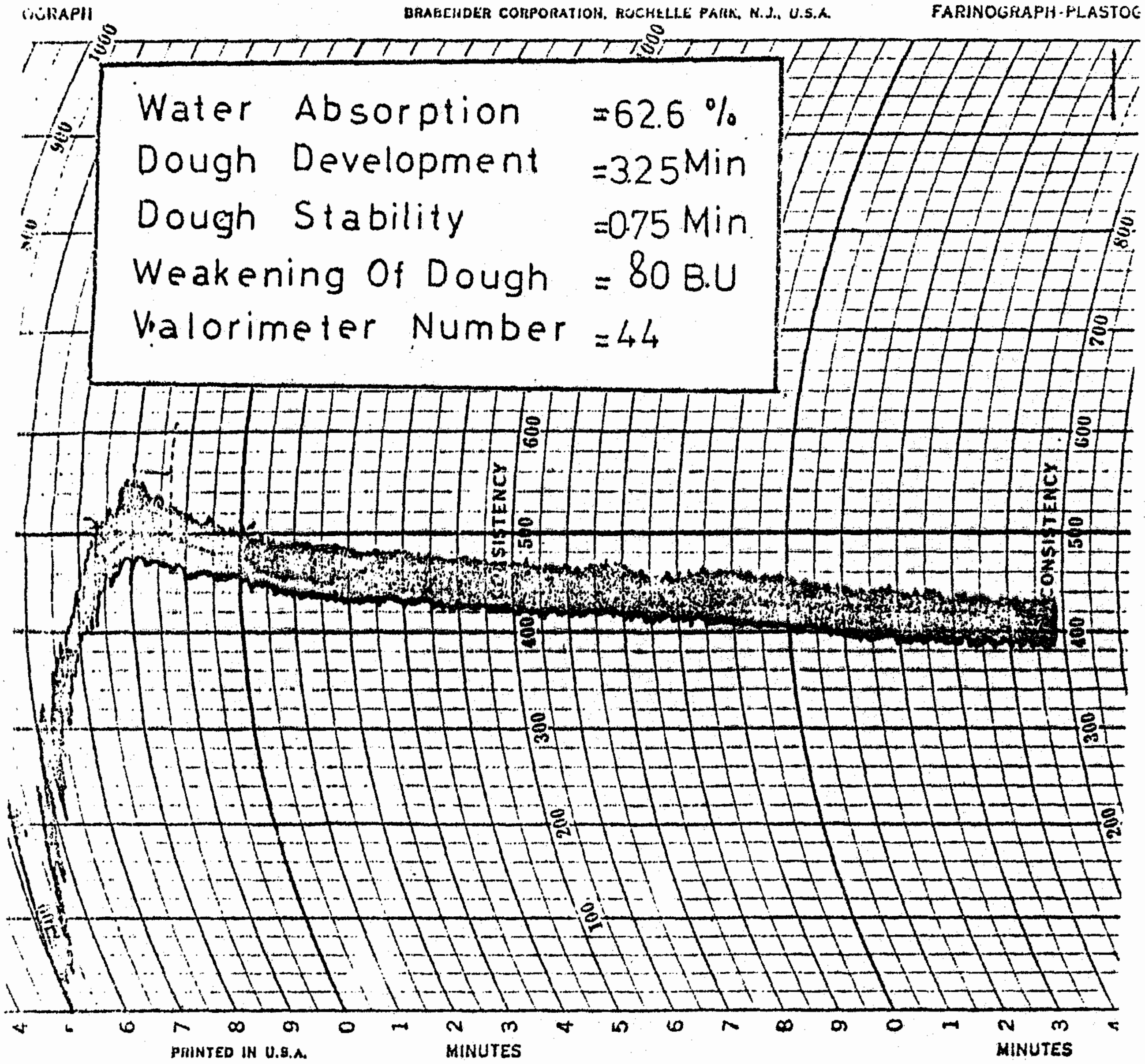

FIG. (8): FARINOGRAM OF STONE-MILLED FLOUR

" الملخص العـــــربــى "

" الدراســة المعملية للخواص الطبيعية للعجائن الناتجة من دقيق القمح المطحون

بطرق طحن مختلفـــه

أ ٠ د ٠ /عبد الهادى ناصــر   أ ٠ د ٠ / السيدعبدالجواد احمد   م/احمد موسى ابوالعينيين

تلعب الخواص الطبيعية للعجينه دورا هاما فى تحديد جودة المنتــج ٠ ويهــدف هذا البحث الى دراسة الخواص الطبيعية للعجائن الناتجة من دقيق القمح المطحون باستخدام مطاحن السلندرات والحجارة والسكاكين المطرقية وذلك لصنفين من الاقماح المصريـــــــــــة وهما القمح الجيزه ١٥٥ ، ١٥٧ ، وذلك بتسجيل خواص العجينه على جهازى الفارينوجراف والاكستنسوجراف وقد أجريت هذه التجارب فى مركز البحوث الزراعيه بالقاهرة ٠ وقد تم الحصول على النتائج الاتيــــة :

١ ــ ارتفاع طاقه العجينه الناتجه من الدقيق المطحون بالسلندرات عنه فى حالة الحجارة والسكاكين المطرقيـــة ٠

٢ ــ ارتفاع طاقة العجينه الناتجه من الدقيق المطحون بالسلندرات عنه فى حالة الحجارة والسكاكين المطرقيـــة ٠

٣ ــ ارتفاع مقاومة الشد بالنسبة لدقيق الحجارة عنه فى حالة السلندرات والسكاكين المطرقيـــة ٠

٤ ــ ارتفاع معدل امتصاص الماء بالنسبة لدقيق الحجارة عن السكاكين المطرقية والسلندرات ٠

٥ ــ ارتفاع معدل زمن العجن بالنسبة لدقيق السكاكين المطرقية عن دقيق الحجارة والسلندرات

٦ ــ ارتفاع ثبات العجينه بالنسبة لدقيق السكاكين المطرقية عن دقيق الحجارة والسلندرات ٠

٧ ــ ارتفاع معدل التدهور بالنسبة لعجينه السلندرات عن الحجارة والسكاكين المطرقيـــة ٠