

INFLUENCE OF GLIADINS AND GLUTENINS ON WHEAT STRENGTH

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SUMMARY

Protein substances of ten Algerian and Bulgarian wheat (six soft wheat and four hard wheat) were fractionned. The content of different proteins, wheat strength, correlation ratio and correlation coefficient have been determined.

By using Blackman criteria, evidence has been pointed out in reference to relations between total proteins content and those of gliadins, total glutenins and insoluble in 0,05 N acetic acid glutenins. It was shown that gliadins, total glutenins and insoluble in 0,05 N acetic acid glutenins were correleated with wheat strength.

Insoluble in 0,05 N acetic acid glutenins are less influenced than gliadins and total glutenins by total proteins. They have the highest effect on strength of hard wheat. Gliadins, total glutenins and insoluble in 0,05 N acetic acid glutenins have the same influence on the strength of soft wheat.

RESUME

Les substances protéiques de dix variétés de blé Algériennes et Bulgares (six tendres et quatre durs) ont été fractionnées. Les taux des différentes protéines, la force du blé, le rapport corrélatif et le coefficient de corrélation ont été déterminés.

En utilisant le critère de BLACKMAN, il a été mis en évidence des relations entre les taux des protéines totales et ceux des gliadines, gluténines totales et gluténines insolubles dans l'acide acétique 0,05 N. Il a été montré que les gliadines, gluténines totales et gluténines insolubles dans l'acide acétique 0,05 N corrolent avec la force du blé.

Les gluténines insolubles dans l'acide acétique 0,05 N sont moins influencées que les gliadines et les gluténines totales par les protéines totales. Elles ont le plus grand effet sur la force du blé dur. Les gliadines, gluténines totales et gluténines insolubles dans l'acide acétique 0,05 N ont la même influence sur la force du blé tendre.

INTRODUCTION

The quality of grain can be explained by the properties expressed in definite quality index. On the basis of quality index, this is the protein complex with its fractions.

The protein composition of wheat is very heterogenous. There are albumins, globulins, gliadins and glutenins. There exist in an optimal content of the total proteins bound to the technological quality of wheat (3, 9). Gliadins and glutenins are the most abundant storage proteins of wheat endosperm (8). They have an important effects on the physical properties of wheat flour dough (6). Some authors indicate that the quantity of insoluble in 0,05 N acetic

acid glutenins have a fundamental significance in the bread-making (1, 5, 7).

The knowledge of proteins and the relationships between them and with the technological index allow us to appreciate more deeply the technological quality of wheat. The objective of this work is to highlight :

- The correlations between total proteins and gluten proteins.
- The correlations between gluten proteins and the wheat strength .
- The influence of gliadins and glutenins on wheat strength in soft and hard wheat.

MATERIAL AND METHODS

Table 1 . Showing types and origins of the studied wheat varieties.

Varieties	Type	Origins
SADOVO 1	Soft wheat	Institute of selection Sadovo - Bulgaria.
KATIA	"	"
POBEDA	"	"
STRAMPELI	"	I.T.G.C. Algiers, Algeria.
MAHON-DEMIAS	"	"
ANZA	"	"
ZAGORKA	Hard wheat	Institute of Hard wheat and Cotton, Tchirpan, Bulgaria.
GUERGANA	"	"
BIDI 17	"	I.T.G.C. Algiers, Algeria.
INRAT 69	"	"

The technological tests have been done by classical methods. Samples have been ground using a Chopper (type OC - 106) - Hungary. The maximum particules size was 400 µm.

Proteins fractionning has been made according to the diagramm of Chen and Bushuk (2). The

contents of total proteins and those of gliadins, glutenins and insoluble in 0,05 N acetic acid glutenins have been determined according to the method of Kjeldhal (% N₂ x 5,7).

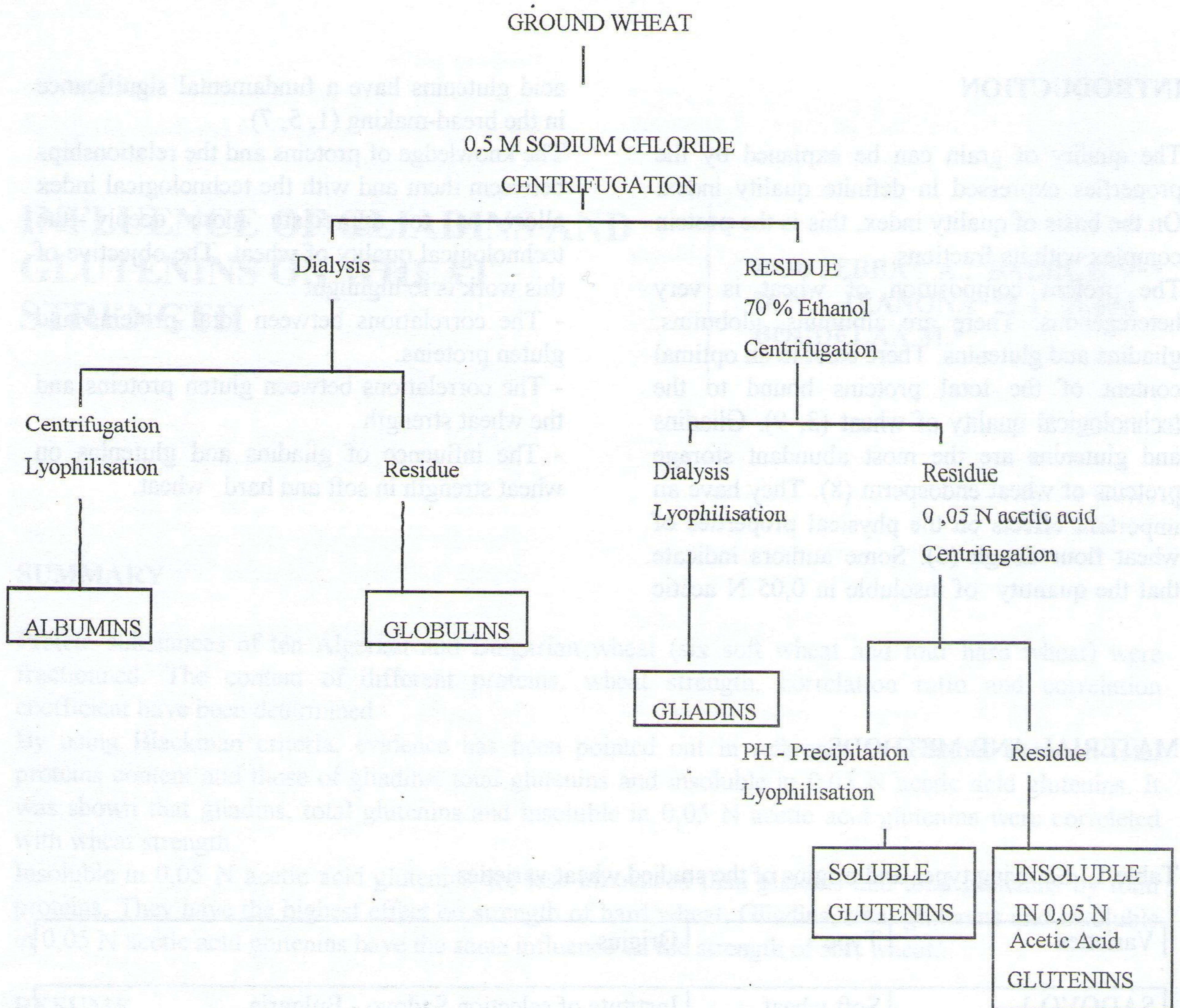


Fig. 1 Fractionning diagramm of Chen and Bushuk (2).

The correlation ratio h_{yx} is determined by using the equation:

$$h_{yx} = \frac{\sum f_x (y_x - \bar{y})}{\sum f_y (y_i - \bar{y})^2}$$

Where : $\bar{y}$ - general arithmetical means

y_x - group arithmetical means

f_y - frequency of the y row

f_x - frequency of the x row

The autenticity of the correlation ratio and the

correlation coefficient has been checked at $\alpha = 0,05$ and $\alpha = 0,01$, following Fisher's criterion (4). Relationships determination have been made by regression analysis, where the form of relationship has been made according to Blackman's criterion (4).

RESULTS AND INTERPRETATIONS

Results expressing the wheat strength and those of the contents of total proteins, gliadins, glutenins and insoluble in 0,05 N acetic acid glutenins are represented in table 2 and 3.

The wheat strength vary from 40,50 to 77,00 cond. units. The proteins are distributed as follows : total proteins 11,51 - 16,94 %; gliadins 3,78 - 6,17 %; glutenins 3,38 - 5,47 %; insoluble in 0,05 N acetic acid glutenins 3,22 - 4,49 %.

Data concerning the determination of the relationships between the contents of total proteins and those of protein fractions, on one hand, and the determination of the relationships between protein fractions contents and the wheat strength on the other hand are show in table 4 and 5 respectively.

Correlation ratios and correlation coefficients are significant at $\alpha = 0,05$ and $\alpha = 0,01$. The established relationships are of a linear type.

The obtained correlation coefficients concerning the relationships between the contents of total proteins and those of gliadins, glutenins and insoluble in 0,05 N acetic acid glutenins are $R = 0,94 **$, $R = 0,85 **$ and $R = 0,78 **$ respectively.

They show that wheat varieties having a high total protein contents have also a high content of gliadins, glutenins and insoluble in 0,05 N acetic acid glutenins. The correlation coefficients for the relationships between the wheat strength and the contents of gliadins, glutenins and insoluble in 0,05 N acetic acid glutenins are $R = 0,65 **$, $R = 0,84 **$ and $R = 0,83 **$ respectively. Accordingly, it is suggested that strong wheat varieties tend to have a high content of gliadins, glutenins and insoluble in 0,05 N acetic acid glutenins.

Figures 2 to 7 show the lines regression and the subsequent equations for the studied relationships for both hard and soft wheat. The equations confirm the linear characteristic. This seems extremely useful in drawing conclusions on; firstly, the differences on the influences of total proteins on different protein fractions, and secondly, on the differences on the influences of gliadins, glutenins and insoluble in 0,05 N acetic acid glutenins on the wheat strength.

Table 6 illustrates the correlation coefficients and regression equations for the relationships between :

- Total proteins and gluten protein fractions.

- Gluten protein fractions and wheat strength.

The slopes are significant at $\alpha = 0,05$ and $\alpha = 0,01$ for both hard and soft wheat. The increase in gliadins, glutenins and insoluble in 0,05 N acetic acid glutenins was found to be identical for soft and hard wheat, when raising the total proteins by one unit. The influence of total proteins on gliadins, glutenins and insoluble in 0,05 N acetic acid glutenins for hard wheat can be expressed by means of the slopes 0,52; 0,36 and 0,26 respectively. The rise in gliadins in response to increasing total proteins by one unit was found to be twice as high that of insoluble in 0,05 N acetic acid glutenins. Comparisons made on the influence of these three protein fractions on wheat strength show that insoluble in 0,05 N acetic acid glutenins, arising from hard wheat have the greatest effect. There has been a much more rapid increase in wheat strength when insoluble in 0,05 N acetic acid glutenins rose; than when there was a rise in glutenins. In this context, gliadins appear to have a little influence.

Finally, and in the case of soft wheat, all three protein fractions seem to have the same influence on wheat strength.

CONCLUSION

Positive correlations have been established between total proteins, gliadins, glutenins and insoluble in 0,05 N acetic acid glutenins respectively. It has also been proved that the increase in different protein fractions, when raising the total proteins by one unit, was not dependant on wheat's type. The insoluble in 0,05 N acetic acid glutenins were the least affected by total proteins.

Similarly, positive correlations have also been established between the wheat strength and the contents of gliadins, glutenins and insoluble in 0,05 N acetic acid glutenins. In soft wheat, the three protein fractions appear to have the same influence on wheat strength. In hard wheat, the insoluble in 0,05 N acetic acid glutenins have the highest effect on wheat strength.

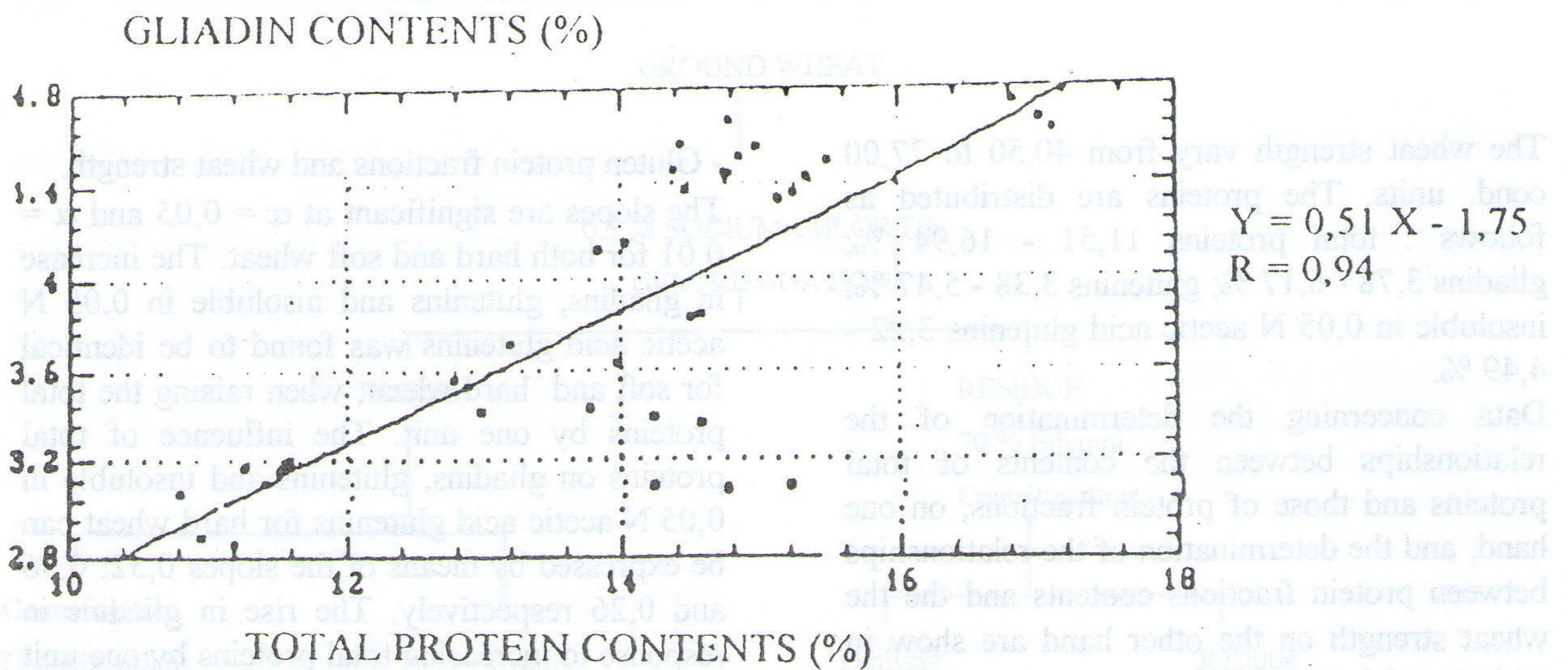


Fig. 2 : Relationship between total protein contents and gliadin contents.

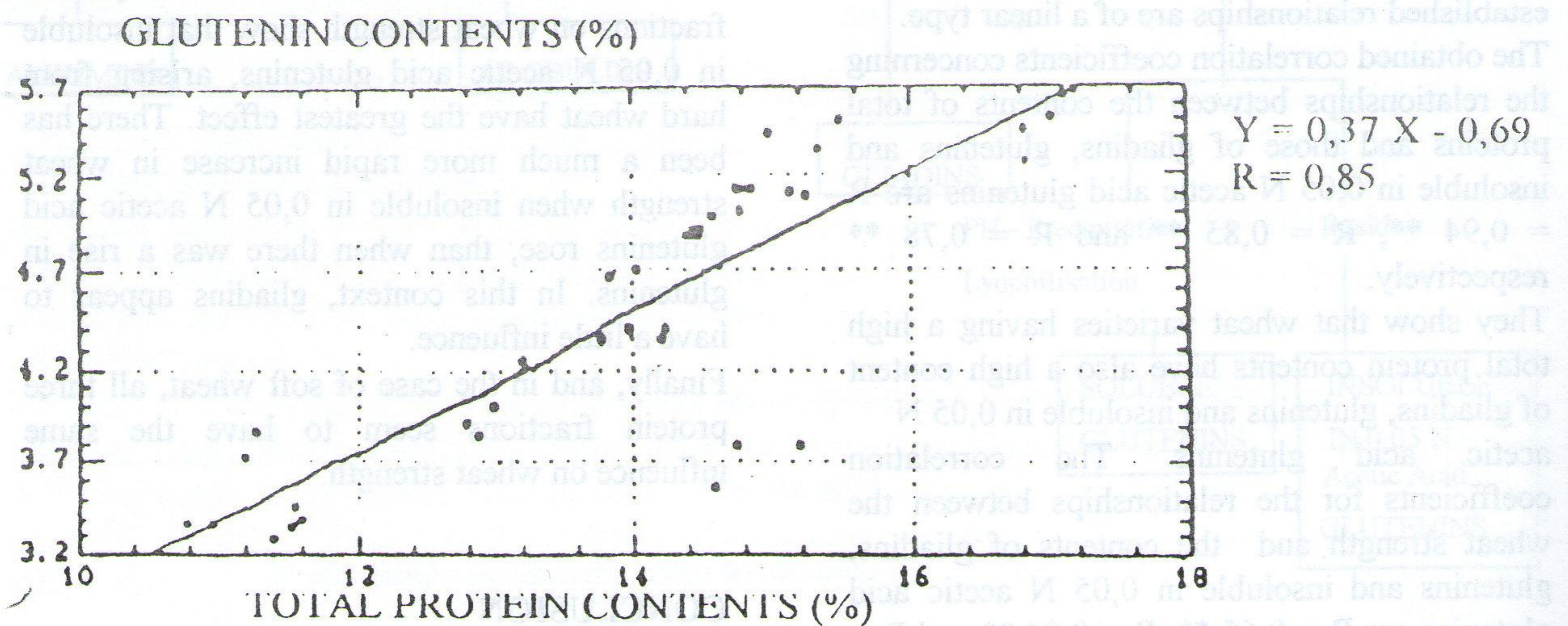


Fig. 3 : relationship between total protein contents and glutenin contents.

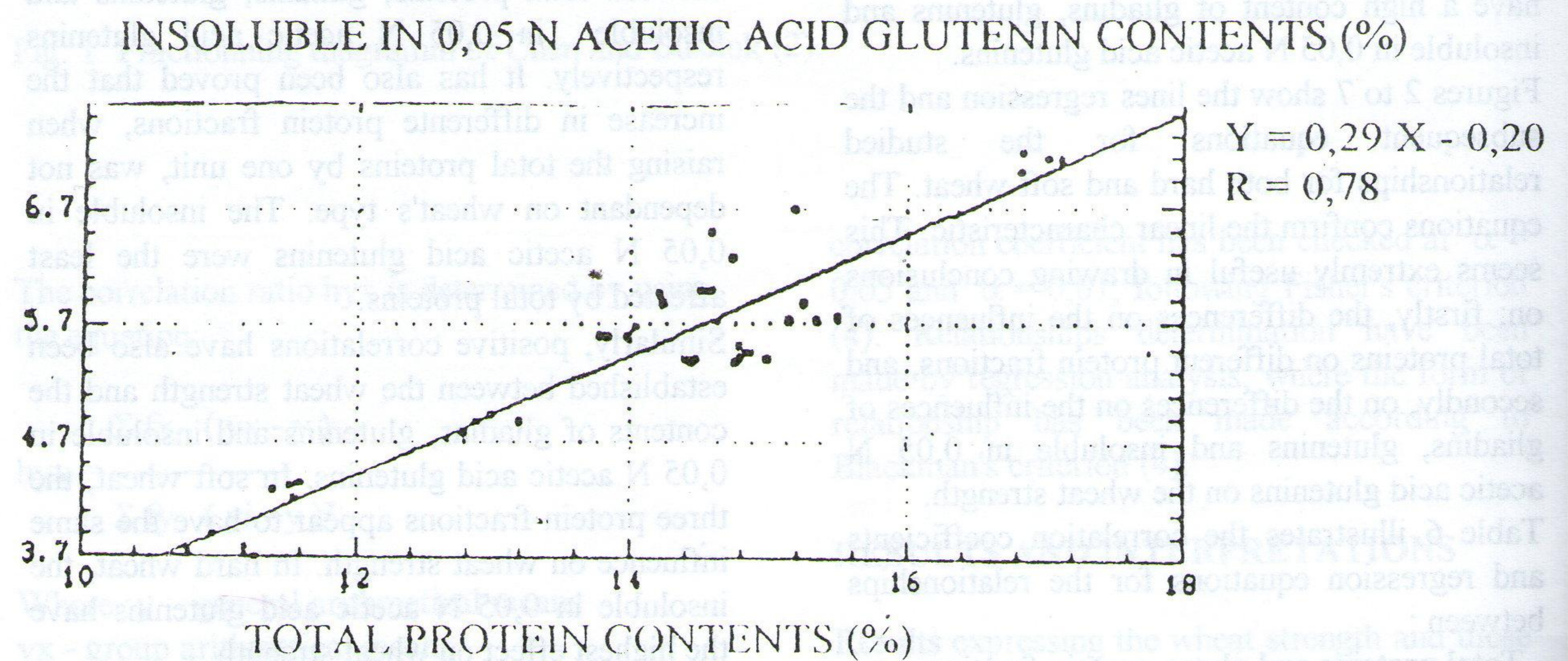


Fig. 4 : relationship between total protein contents and insoluble in 0,05 N acetic acid glutenin contents.

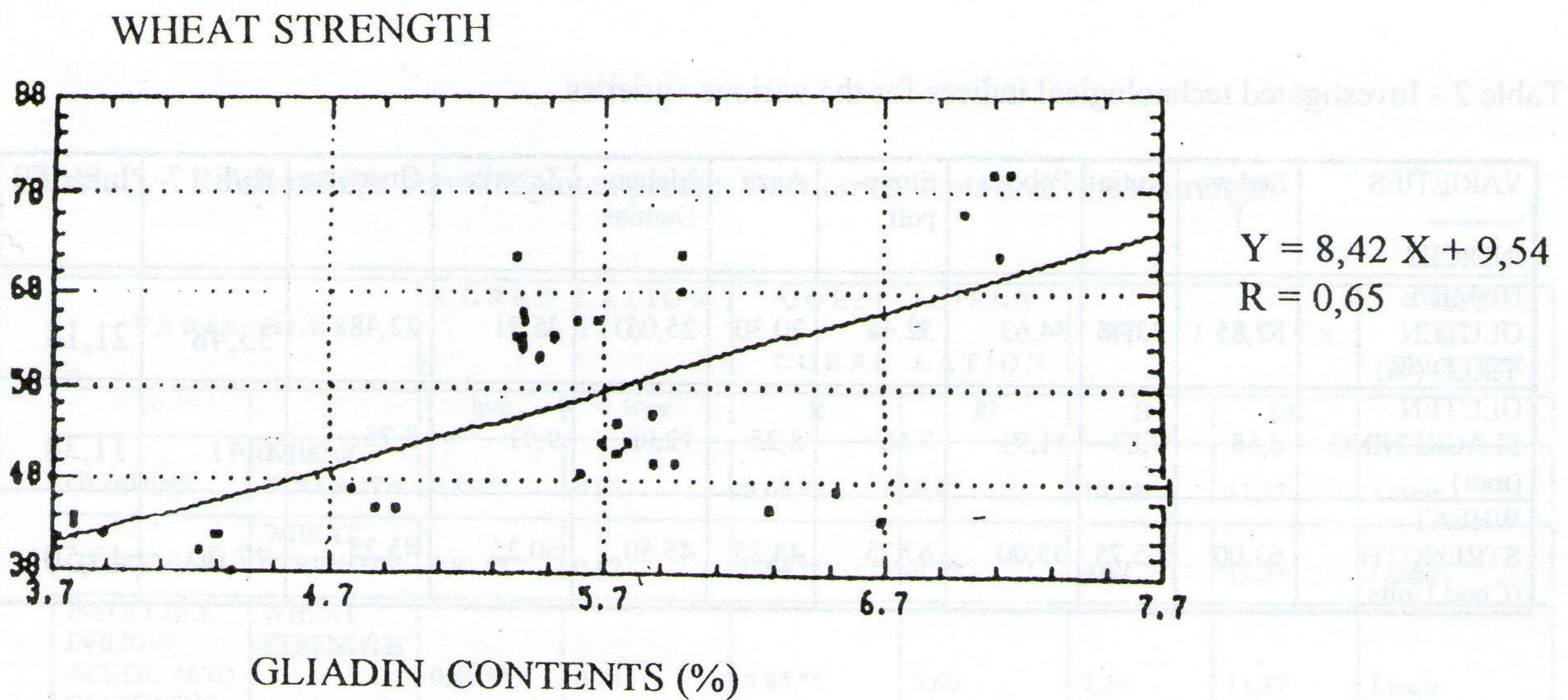


Fig. 5 : Relationship between gliadin contents and wheat strength.

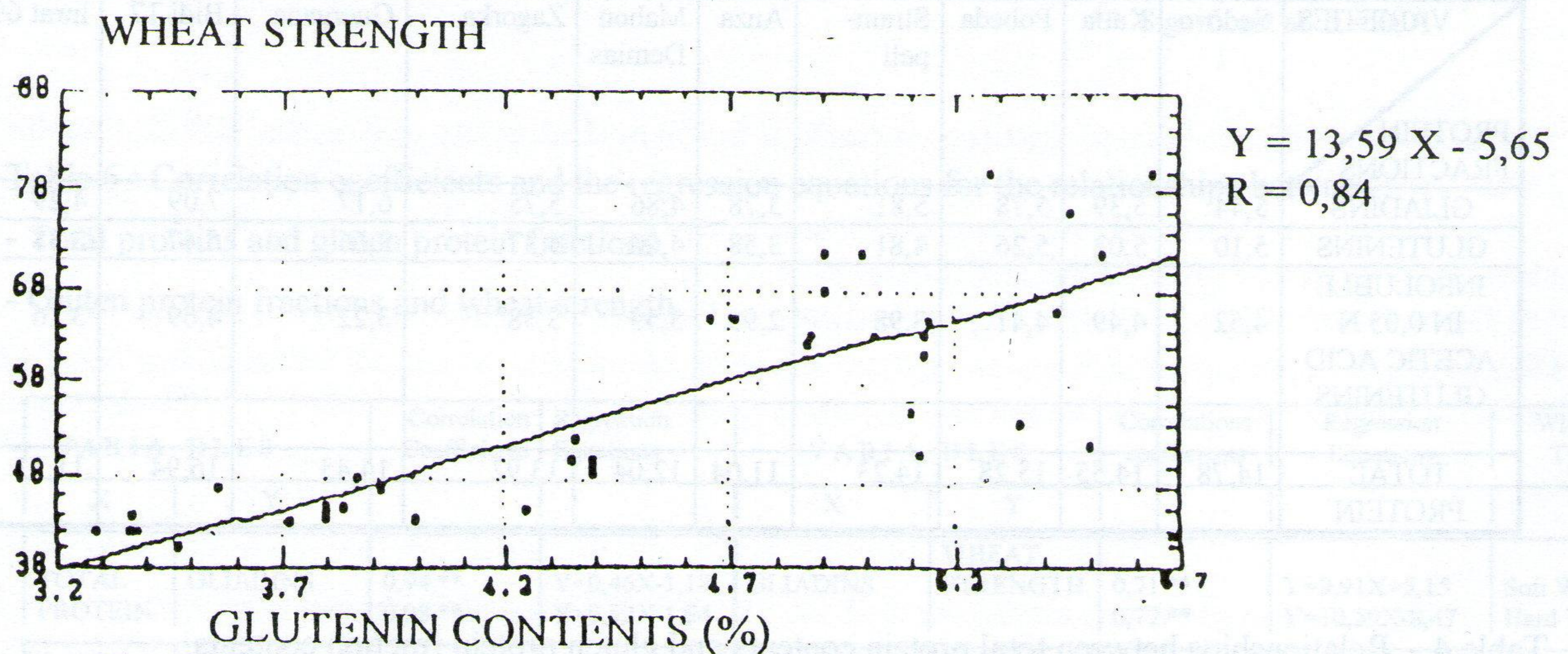


Fig. 6 : Relationship between glutenin contents and wheat strength.

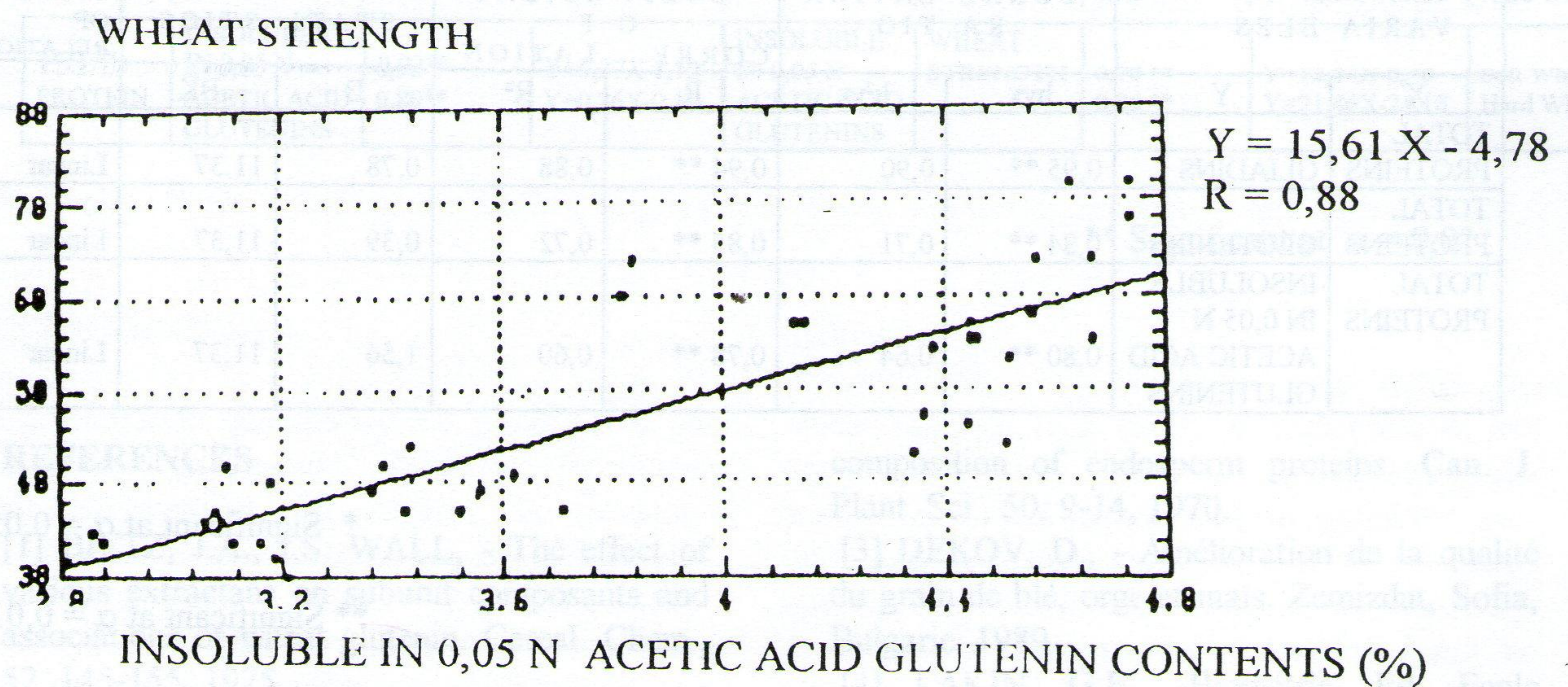


Fig. 7 : Relationship between insoluble in 0,05 N acetic acid glutenin contents and wheat strength..

Table 2 - Investigated technological indices for the various varieties.

VARIETIES	Sadovo 1	Katia	Pobeda	Stram- peli	Anza	Mahon Demias	Zagorka	Guergana	Bidi 17	Inrat 69
INDICES										
HUMIDE GLUTEN YIELD (%)	32,85	33,46	34,63	32,46	20,30	25,06	25,71	22,48	33,48	21,18
GLUTEN SLACKENING (mm)	8,58	7,83	11,91	7,66	8,25	12,08	9,91	9,75	6,41	11,38
WHEAT STRENGTH (Cond.Units)	63,00	65,75	53,00	67,75	44,25	45,50	50,25	45,25	77,00	40,50

Table 3 - Quantity of the main protein fractions for the various varieties.

VARIETIES	PROTEIN CONTENTS % d. m.									
	Sadovo 1	Katia	Pobeda	Stram- peli	Anza	Mahon Demias	Zagorka	Guergana	Bidi 17	Inrat 69
PROTEIN FRACTIONS										
GLIADINS	5,44	5,39	5,78	5,81	3,78	4,86	5,75	6,17	7,09	4,29
GLUTENINS	5,10	5,02	5,26	4,81	3,58	4,00	4,37	3,66	5,47	3,38
INSOLUBLE IN 0,05 N ACETIC ACID GLUTENINS	4,52	4,49	4,41	3,98	2,99	3,55	3,38	3,22	4,69	3,16
TOTAL PROTEIN	14,78	14,55	15,28	14,23	11,04	12,04	13,92	14,45	16,94	11,51

Table 4 - Relationships between total protein contents and gluten protein fraction contents.

VARIABLES		CORRELATION RATIO		COEFFICIENT OF CORRELATION		STATISTICS		TYPE OF RELATION
X	Y	hyx	h²yx	R	R²	B	BK	
TOTAL PROTEINS	GLIADINS	0,95 **	0,90	0,94 **	0,88	0,78	11,37	Linear
TOTAL PROTEINS	GLUTENINS	0,84 **	0,71	0,85 **	0,72	0,39	11,37	Linear
TOTAL PROTEINS	INSOLUBLE IN 0,05 N ACETIC ACID GLUTENINS	0,80 **	0,64	0,78 **	0,60	1,56	11,37	Linear

* Significant at $\alpha = 0,05$

** Significant at $\alpha = 0,01$

Table 5 - Relationships between gluten protein fraction contents and wheat strength.

VARIA BLES		CORRE LATION RA TIO		COEFF ICIENT O F CORRE LATION		STATI STICS		TYPE OF RELATION
X	Y	hyx	h²yx	R	R²	B	BK	
GLIADINS	WHEAT STRENGTH	0,83 **	0,68	0,65 **	0,42	10,14	11,37	Linear
GLUTENINS	WHEAT STRENGTH	0,91 **	0,82	0,84 **	0,70	4,68	11,37	Linear
INSOLUBLE IN 0,05 N ACETIC ACID GLUTENINS	WHEAT STRENGTH	0,86 **	0,74	0,83 **	0,60	2,34	11,37	Linear

** Significant at $\alpha = 0,01$

Table 6 : Correlation coefficients and the regression equations for the relationships between :

- Total proteins and gluten protein fractions.
- Gluten protein fractions and wheat strength.

VARIA BLES		Correlation Coefficients	Regression Equations	VARIA BLES		Correlations coefficients	Regression Equations	Wheat's Type
X	Y			X	Y			
TOTAL PROTEIN	GLIADINS	0,94 **	Y=0,46X-1,18	GLIADINS	WHEAT STRENGTH	0,71 **	Y=9,91X+5,15	Soft Wheat Hard Wheat
		0,98 **	Y=0,52X-1,64			0,77 **	Y=10,59X-8,47	
TOTAL PROTEIN	GLUTENINS	0,96 **	Y=0,43X-1,32	GLUTENINS	WHEAT STRENGTH	0,72 **	Y=10,93X+5,78	Soft Wheat Hard Wheat
		0,88 **	Y=0,36X-0,89			0,95 **	Y=16,94X-18,59	
TOTAL PROTEIN	INSOLUBLE IN 0,05 N ACETIC ACID GLUTENINS	0,93**	Y=0,37X-1,12	INSOLUBLE IN 0,05 N ACETIC ACID GLUTENINS	WHEAT STRENGTH	0,70 **	Y=12,04X-8,40	Soft Wheat Hard Wheat
		0,80**	Y=0,26X-0,10			0,96 **	Y=21,46X-24,18	

** Significant at $\alpha = 0,01$

REFERENCES

[1] BIETZ, J.A., J.S. WALL, - The effect of various extractans on subunit composants and associations of wheat glutenin. Cereal. Chém., 52, 145-155, 1975.

[2] CHEN, C.H., W. BUSHUK, - Nature of proteins in Triticale and its parental species. I- Solubility characteristics and amino-acid

composition of endosperm proteins. Can. J. Plant. Sci., 50, 9-14, 1970.

[3] DEKOV, D., - Amélioration de la qualité du grain de blé, orge et maïs. Zemizdat, Sofia, Bulgarie, 1989.

[4] LAKIN, G.F., -Biométrie. Ed. Ecole Supérieure, Moscou, 1990.

[5] MAC RITCHIE, F., - Differences in Baking quality between flours. J. Fd. Technol., 3, 187-194, 1978.

[6] PAYNE, P.I., - Genetics of wheat storage proteins and their effect of allelic variation on bread-making quality. Ann. Rev. Plant Physiol., 38, 141-153, 1987.

[7] PRESTON, K.R., N. WOODBURY, V. BENDELOW, - The effects of gliadin fractions of varying molecular weight on the mixing properties of a synthetic dough system. Cereal Chemistry, 52, 427-430, 1975.

[8] R. D'OVIDIO, D.O. ANDERSON, - PCR analysis to distinguish between alleles of a member of a multigene family, correlated with wheat bread-making quality. Theor. Appl. genet., 88, 759-763, 1994.

[9] SADOUKI, H. - Electrophorèse des protéines de blé tendre et ses relations avec la qualité boulangère. Thèse Magister, INA, Alger, 1985.

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