PROTEINS AND LYSINE CONTENTS OF SOME NORTH-CAMEROON HYBIDS OF SORGHUM GRAINS

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ABSTRACT

Lysine is a primary limiting factor of sorghum and priority must be accorded in nutritional research to the rich lysine varieties rather than to their protein content, since sorghum as staple food has a satisfactory calorico-proteinic ratio.

Total nitrogen and lysine measured by means of microbiological techniques are determined in 69 hybrids being the results of crossings between "Combine-kaffir 60" and local North-Cameroon varieties.

Total protein contents range from 8,8 to 16,8 g for 100 g of grain and these proteins contain from 2,20 g to 3,35 g of lysine for 100 g. Whenever protein content increases in the grain, that of lysine also increases according to a highly significant correlation ($r = 0{,}66$, $\alpha < 0{,}001$); on the contrary, lysine percentage of these proteins decreases ($r = -0{,}52$, $\alpha < 0{,}001$).

Eight varieties contain more than 10 per 100 of proteins rich in lysine (3 g or more per 100 g of proteins).

The African continent remains the principal country for millet and sorghum which grow everywhere except in the moist equatorial region and occupy an important area (about 8 millions hectares in Senagal, Mauritania, Mali, Niger, Upper-Volta, Chad and North-Cameroon (27). North of 10th parallel, they are the principal staple food for the population (9) which consumes more than 85 per 100 of the production (2): 450 g (i-e 1, 550 calories) is the mean daily consumption per capita for the whole of North-Cameroon where the total production ranges from 275,000 to 550,000 tons according to the years for a population estimated at 1,600,000 inhabitants (16).

Table I shows the production during the last few years for some African states.

Table I

Sorghum and millet production in tons (sources F.A.O production yearbook, 1971).

	Mean 1960-61	Mean 1970-71
Upper-Volta	695,000 T	960,000
Mali	880,000	750,000
Niger	1,150,000	1,220,000
Senegal	419,000	528,000
Chad	900,000 (uncertain)	715,000

The small increase in production (10 to 12 p 100 in 10 years) is lower than the mean population increase (25 to 28 p 100 in 10 years) (27): these cereals are a vital staple food and at certain periods constitute the only resource; the importance of millets and sorghum is consequently at once quantitative and qualitative.

Total proteins and aminoacids contents of sorghum depend upon numerous factors : variety, grain size, composition of its different anatomic parts, maturity stage and ecological setting of growing (12, 14, 15 18, 26).

Lysine is the primary limiting factor of sorghum proteins (3, 7, 13, 31) as in all cereals proteins in general : the higher the protein content the more important their lysine shortage (11, 29) According to varieties, to quantity measurements methods and to the authors, the secondary limiting factor is methionine, threonine or tryptophan (10, 13, 20, 21, 22, 23, 24, 32). On the contrary, the excess of leucine would confer on «jowar» sorghum its pellagragenic properties in proteins poor diets : unbalanced of aminoacids would induce a decrease of nicotinic acid in the tissues (17,28); moreover the conversion of tryptophan into niacine seems inhibited by proteins with a high content of leucine (6).

Anatomically the sorghum kernel can be subdivided into three parts: pericarp, germ and endosperm (containing respectively 3 p 100, 12.5 p 100 and 85 p 100 of total proteins of the kernel of FF . 5683 variety (Guinea) (18). Endosperm contains most of the proteins composed of albumin, globulin, prolamine and glutelin, these last two parts being the most important. Where the protein content of endosperm increases, it bears essentially upon prolamines which appear the poorest in lysine (31).

In the plan for improvement of sorghum quality, to-day researches focus mainly on the reduction of the pericarp pigmentation, the expelling of the inner brown ring through genetic means, the increase, of starch availability and the bettering of aminoacids balance (25). Autret et al (4) underline the necessity of not only the improvement of yields of cereals, crops but also the finding of a better proteinic value :

considering sorghum «research should firstly stress the importance of lysine rich varieties since there is a wide operational margin between the 1st and the 2nd limiting factor, a lot more than on high protein content, for it has been seen that these diets have already a satisfactory calorico-proteinic rate».

MATERIAL AND METHODS

Samples of 69 sorghum hybrids come from the IRAT experimental station at Guetale (North-Cameroon) : these hybrids are the results of crossings between «combine-kaffir 60» of American origin and local wet season varieties (DAMOUGARI, DJIGARI, BOULBASSIRI, TCHERGUE, YOLOBRI). These varieties have had the same cultivation conditions.

The availability of very few grams of the F3 and F4 issues per sample restricted our analysis to the measurement of total nitrogen and lysine.

Total nitrogen measurements used the kjeldahl method after sulphuric mineralisation with a selenium catalyst, the conversion coefficient of nitrogen into proteins being 6,25.

Lysine has been measured by microbiological means with the help of «leuconostoc mesenteroides ATCC 8042» (1) after hydrolysis at 120° C for 6 hours in acid medium (HCl, 6N). The values obtained are a little higher than those obtained by chemical methods; hydroxy-lysine should have been added to the medium of «lacto-bacillus» (19,33). In fact, our results though deprived of absolute value directly comparable to those obtained through chemical methods remain nevertheless interesting for they allow a sorting of the samples depending on their lysine content, which was our aim.

Protein contents are conveyed in relation to raw material as well as those of lysine which are related to 100 grams of the total proteins.

RESULTS AND DISCUSSION

Protein and lysine contents of our samples are listed in table I.

Table I

Variations of protein and lysine contents of the sorghum samples.

Hybrids	Protein	Lysine	% Lysine
	g/100 g of raw material	mg/100 g raw material	g of lysine/100 g protein

	Under 10% protein		
CK1 x DA-5	9,0	298	3,32
CK1 x DJ-1	9,3	270	2,88
CK2 x DJ-2	8,9	263	2,95
CK6 x DJ-2	9,2	239	2,60
CK2 x BL-6	9,8	295	3,01
CK1 x YO-46	9,0	279	3,11
CK2 x DJ-8-1	8,8	285	3,25
	Between 10 and 12% protein		
CK1 x DJ-5	10,2	272	2,66
CK4 x DJ-1	11,3	270	2,39
CK5 x DJ-4	11,0	289	2,63
CK5 x DJ-7	10,8	257	2,38
CK2 x BL-12	11,3	295	2,60
CK2 x BL-13	10,2	307	3,00
CK3 x BL-3	10,2	293	2,87
CK4 x BL-3	11,0	299	2,72
CK5 x BL-1	10,8	301	2,79
CK5 x BL-2	11,3	301	2,67
CK5 x BL-4	10,5	263	2,50
CK1 x TC-4	10,3	344	3,35
CK1 x TC-11	11,8	365	3,08
CK2 x TC-2	11,3	300	2,65
CK2 x TC-6	10,0	289	2,88
CK2 x TC-8	10,3	315	3,07
CK x YO-1	10,1	284	2,81
CK x YO-2	11,1	321	2,90
CK x YO-7	11,3	324	2,85
CK x YO-13	11,5	340	2,95
CK1 x YO-14	11,5	361	3,14
CK1 x YO-18	10,8	293	2,71
CK1 x YO-29	10,4	280	2,68
CK1 x YO-40	10,7	325	3,03
CK1 x YO-41	10,5	308	2,94
CK1 x YO-43	11,2	287	2,56
CK1 x YO-45	11,3	296	2,62
CK2 x YO-1	10,9	302	2,77
CK2 x YO-6	12,0	329	2,75
CK2 x YO-7	11,7	309	2,65
CK2 x YO-26	11,2	285	2,54
CK2 x DA-5-1	10,9	282	2,58
CK4 x DJ-11-2	11,2	292	2,62
CK4 x DJ-11-3	11,5	292	2,55
CK4 x DJ-11-7	11,3	291	2,57
	Above 12% protein		
CK5 x DJ-6	12,1	307	2,53
CK6 x DJ-6	13,0	288	2,22

CK6 x DJ-7	12,5	275	2,20
CK2 x BL-1	12,1	346	2,86
CK2 x BL-3	13,2	313	2,38
CK2 x BL- 8	13,7	325	2,37
CK4 x BL-1	12,6	318	2,44
CK1 x TC-1	13,1	337	2,58
CK1 x TC-2	12,9	351	2,72
CK1 x TC-6	15,7	382	2,43
CK1 x TC-7	13,8	372	2,69
CK1 x TC-8	12,1	400	3,31
CK2 x TC-1	16,8	410	2,44
CK3 x TC-1	14,5	318	2,20
CK3 x TC-3	12,2	311	2,55
CK x YO-9	13,0	359	2,77
CK x YO-10	13,0	367	2,81
CK1 x YO-15	12,9	373	2,9C
CK1 x YO-22	12,4	344	2,77
CK1 x YO-30	12,6	301	2,39
CK1 x YO-49	12,3	326	3,06
CK2 x YO-5	12,1	324	2,68
CK2 x YO-14	12,6	303	2,41
CK2 x YO-15	14,2	357	2,52
CK2 x YO-18	12,4	304	2,44
CK2 x DJ-4-2	14,5	341	2,36
CK2 x DJ-8-2	12,2	316	2,60

A great variation is to be noticed in the values : they range from 8,8 to 16,8 g/100 g grains for protein and from 0,239 to 0,410 g/100 g for lysine. Here only the variety is responsible for the observed dispersion, other contributing factor remaining constant.

We grouped the samples into 3 categories : 10% have a protein content lower than 10%, 51%, between 10 and 12% and 39% have a protein content higher than 12%. Generally, these samples of sorghum hybrids are relatively well endowed with proteins as is revealed from the frequency distribution (figure 1).

Lysine values range from 2,60 to 3,32 g for 100 g protein with an average of 3,01 g for the samples having a protein content of less than 10%, whereas the samples showing a protein content higher than 12% have values ranging from 2,20 to 3,31, averaging 2,58 g. In the intermediary groups, values are situated between 2,38 and 3,35 with an average of 2,76 g. Figure 2 shows the histogram of lysine contents for 100 g of proteins : 13% of the samples have a lysine content between 2,20 and 2,40 g, 52% between 2,40 and 2,80 and 35 p. 100 above 2,80.

In absolute terms, an increase in the protein content is linked to an increase of the lysine content of the grain; the relationship between these two parameters is very clear (fig.3). A positive and highly significant correlation has been found ($r = 0,66$, $\alpha < 0,001$). The richest samples in protein have been noticed and are stated here: CK2 x BL-8, CK1 x TC-6, CK1 x TC-7, CK2 x TC-1, CK3 x TC-1, CK2 x YO-15, CK2 x DJ-4-2. These hybrids which contain between 318 and 410 mg of lysine for each 100 g of grain, show proteins more unbalanced in lysine since they hold on an average 2,43 g for every 100 g proteins (from 2,20 to 2,69 g) more than samples poorer in proteins (average of 3,01 only for those holding less than 10%). When the protein content increases, the lysine content of these proteins decreases. There is a highly significant negative correlation linking these two attributes ($r = -0,52$ $\alpha < 0,001$ which is illustrated in fig.4).

CONCLUSIONS

Many studies have brought to light the positive relationship existing between an increase in the weight and the percentage of lysine in sorghum-based diets (8-28-30-31) : in reality, the nutritive value of the protein from a low-graded proteins sorghum is higher than that of a high-graded sorghum, as has been shown in growth experiences for the Rat and the Chicken; sorghum poor in proteins is better balanced in aminoacids and particularly for lysine than a protein rich sorghum. Thus, in the hybrids group containing less than 10% of protein, 57% of the samples have a lysine content higher than 3 g; in the group containing 10 to 12 p. 100 of proteins there is only 18 p 100 and in the richest group only 4 p 100.

Considering these results from a nutritional point of view it would seem worthwhile to promote the best balanced varieties. Thus, some varieties fit the selection criterium defined essentially by the lysine rate of proteins : CK2 x BL-13, CK1 x TC-4, CK1 x TC-8, CK1 x TC-11, CK2 x TC-8, CK1 x YO-14, CK1 x YO-40, CK1 x YO-49 (containing more than 10% of proteins with a lysine content higher than 3 g); then follow CK2 x BL-1, CK3 x BL-3, CK2 x TC-6, CK x YO-2, CK x YO-13, CK1 x YO-41, and CK1 x YO-15, contain more than 10 p 100 of proteins of which the lysine content ranges from 2,86 to 2,95.

The authors thank Mr. ECKEBIL, J.P. (IRAT-GUETALE) for having placed at their disposal the hybrid specimens of *Sorghum*.

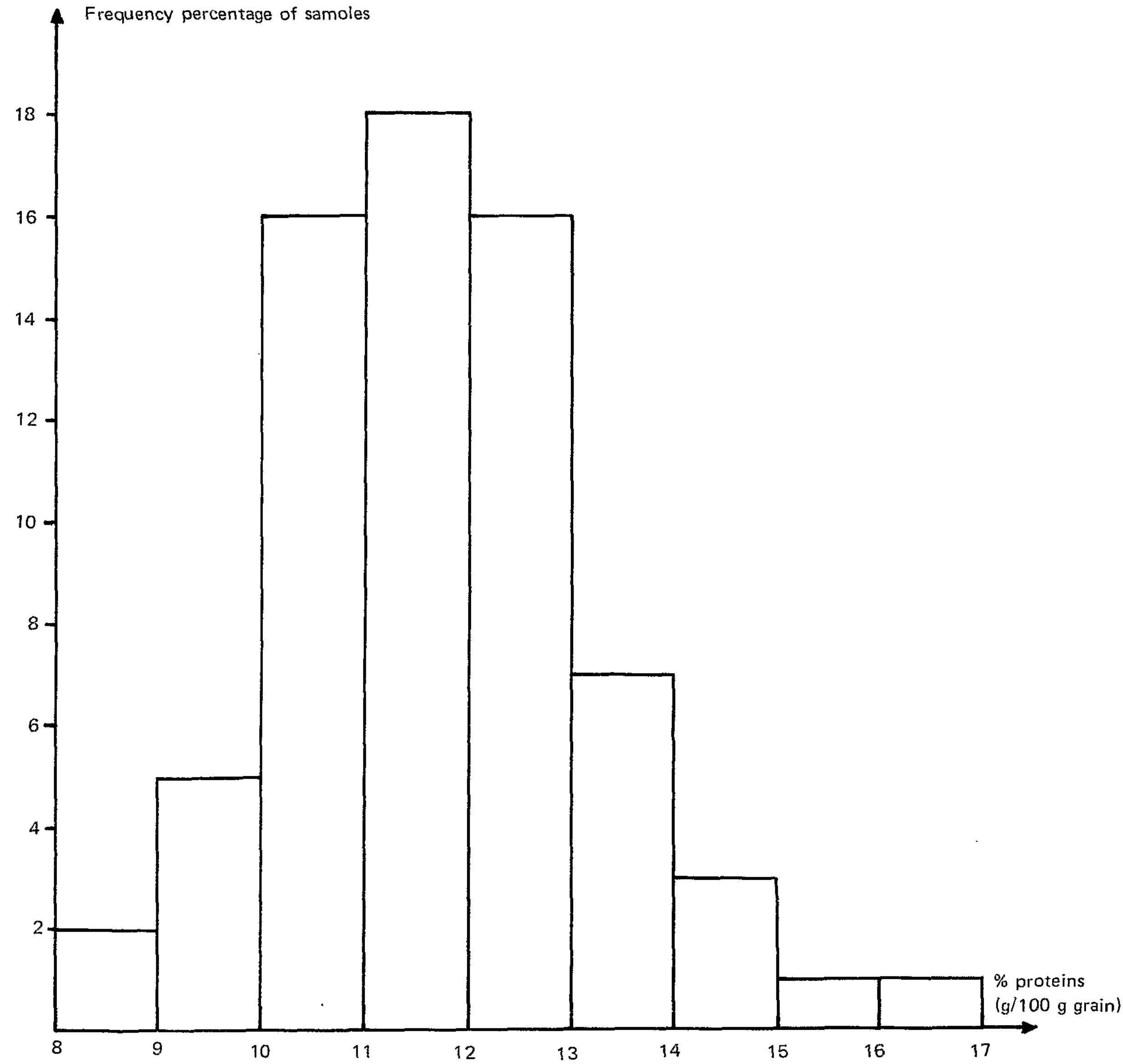

Figure 1 HISTOGRAM OF PROTEINS CONTENT IN THE 69 SORGHO HYBRIDS.

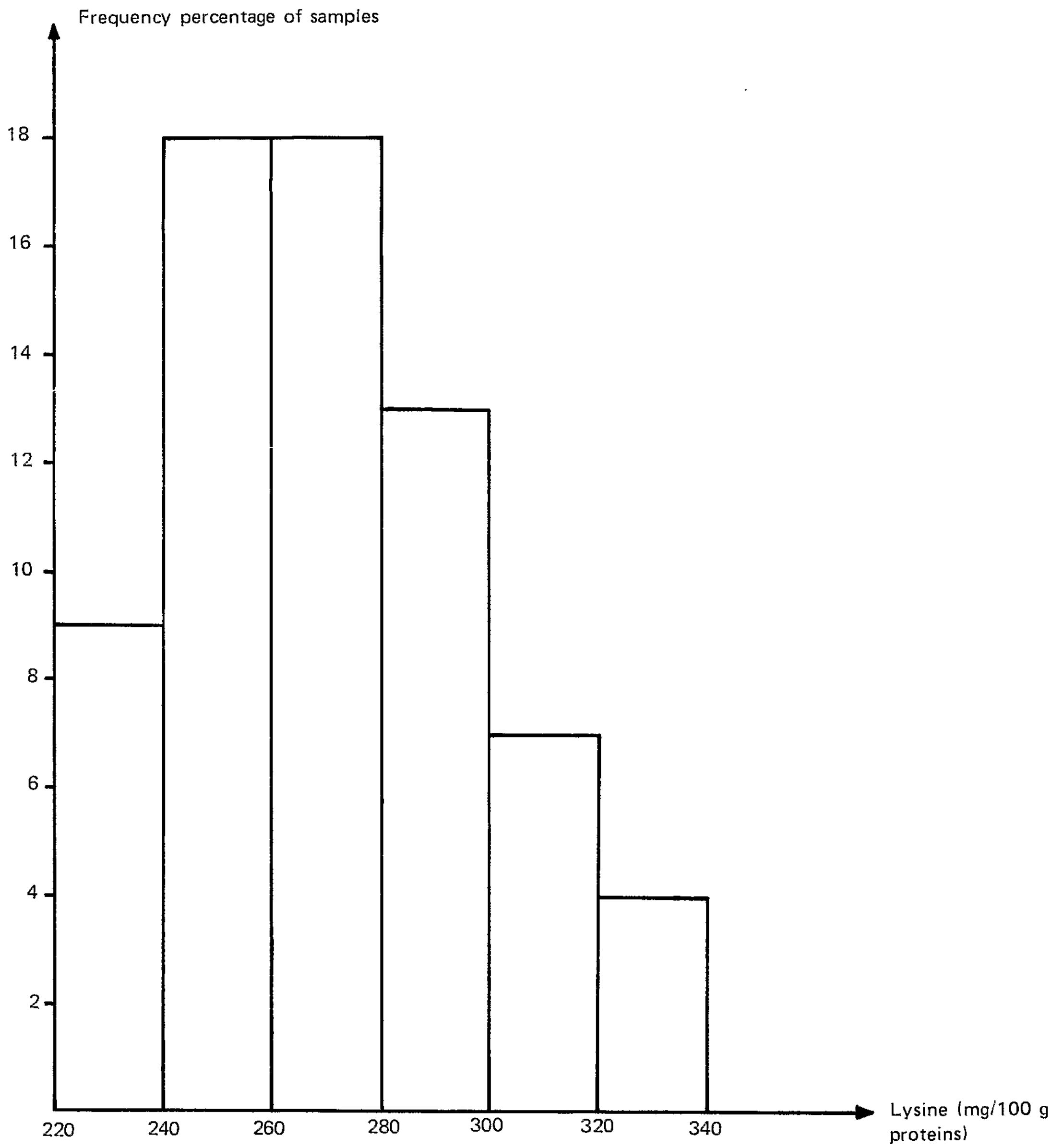

Figure 2 HISTOGRAM OF LYSINE CONTENT IN THE 69 SORGHO HYBRIDS

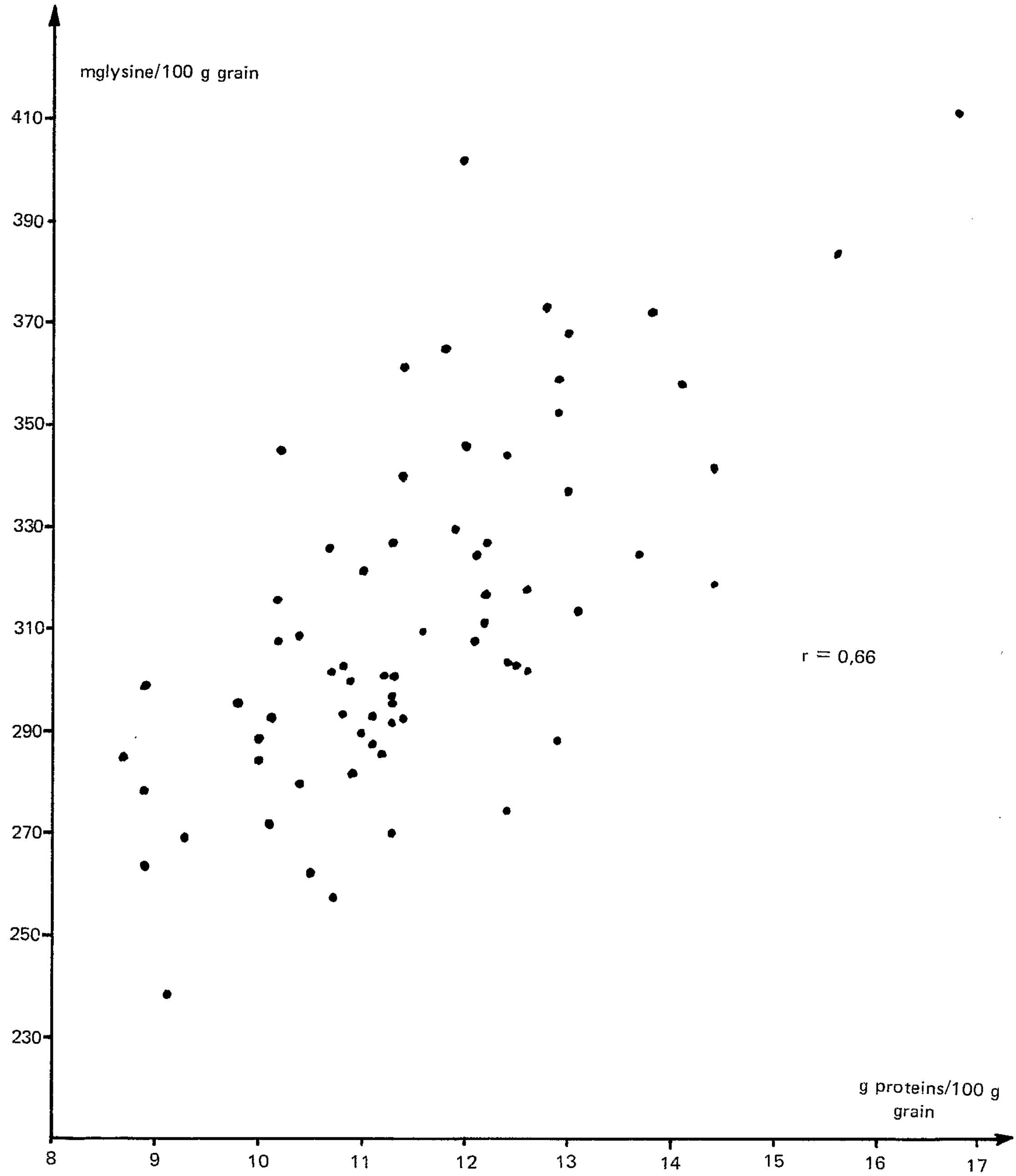

Figure 3 LYSINE CONTENT CORRELATED WITH PROTEINS CONTENT.

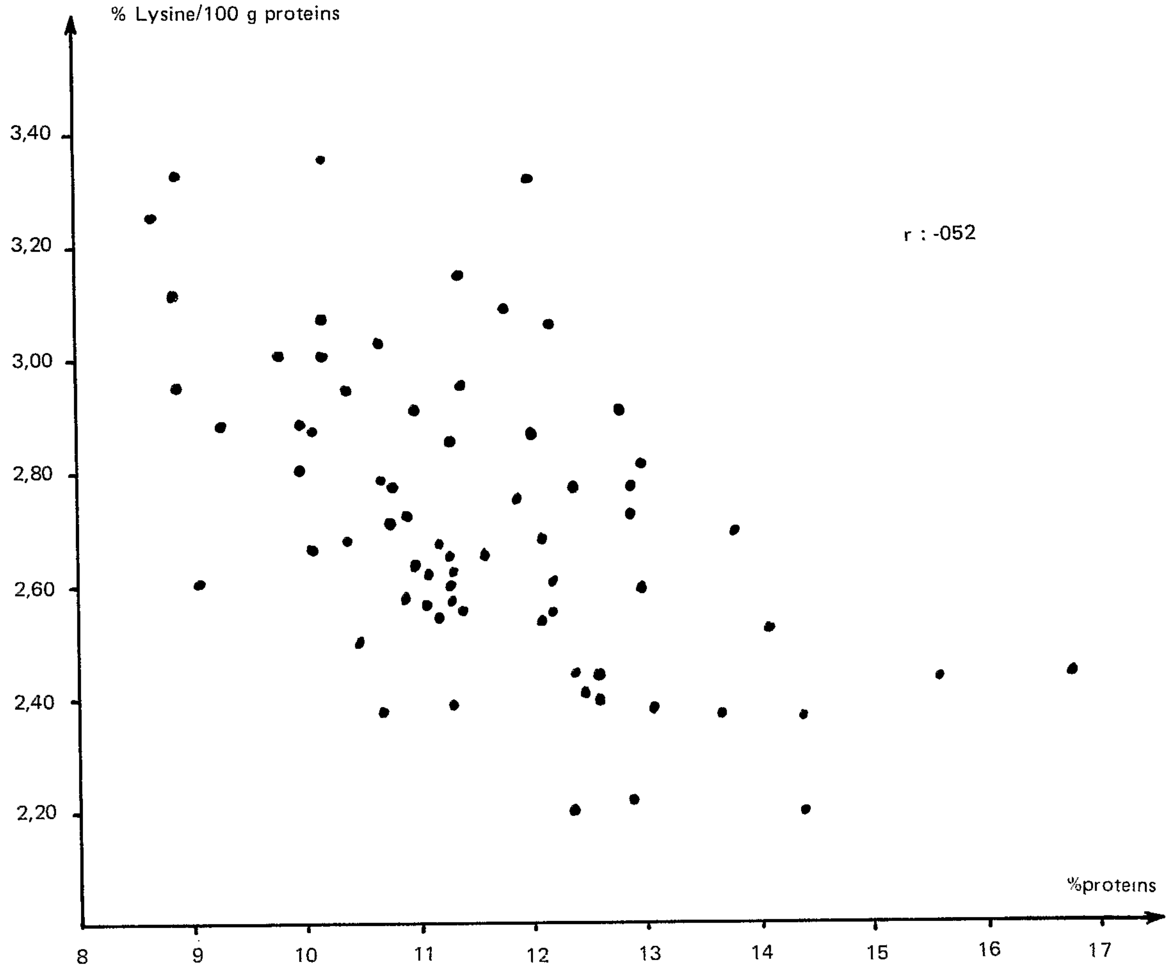

Figure 4 LYSINE CONTENT OF PROTEINS CORRELATED WITH PROTEINS CONTENT.

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PUBLICATION DE L'OFFICE NATIONAL DE LA RECHERCHE SCIENTIFIQUE ET TECHNIQUE DU CAMEROUN

PUBLICATION OF THE NATIONAL OFFICE FOR SCIENTIFIC AND TECHNICAL RESEARCH OF CAMEROON

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Volume 2, No 3 - Août 1979