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USE OF LACTOSE IN BAKERY PRODUCTS

. EFFECT OF LACTOSE IN SPONGE CAKE TYPE BISCUITS (GENOISE)

1.INTRODUCTION

BRACK and SEIBEL have shown that lactose may replace up to 50 % of sucrose in german pastries formulas .

However , these results are to be completed in order to obtain full replacement of sucrose in sponge cake formulas , which is the result we intend to obtain .In fact , the trials made by BRACK and SEIBEL were not made with a fat free formula and total replacement of sucrose leads to

- great modification of water uptake during the preparation of batter
- changes in gelatinization of starch
- modification of rheological properties of proteins during mixing and baking

Some trials we made previously have shown that the products obtained with full replacement of sucrose without any other changes in formulas are unacceptable because :

- the structure of the "génoise " is too harsh
- the volume is greatly decreased by lactose
- the shape of "génoise" is unaffordable , the batter is not stabilized when the final product is removed from the oven and there is a collapse of the internal structure

The trials we made allowed us to check the functions of lactose use as progressive replacer of sucrose (from 0% to 50%) and to look after :

- the limits of lactose which can be used without any major change in formula
- the changes to be made for formula , preparation of batter and baking in order to be able to replace 50 and 100 % of sucrose

2.EXPERIMENTS

2.1 Formula , baking test

The trials were made following the standart "génoise" baking test (tabl.1)

Tabl.1.1 FORMULA

Flour :	100
sucrose :	100
whole eggs :	100
Sodium bicarbonate:	0,8
ACP :	0,28
Sodium acid pyrophosphate:	0,355

Tabl.1.2 : Mixing,baking

foaming of whole eggs and suger for 14' with an HOBART mixer :
10" at 48rd/min
13'50" at 180 rd/min

mixing with flour :
10' at 48rd/min
5" at 180 rd/min

Baking 6x 80 gr.of batter for 15' at 220°C

2.2 Trials

The experiments were planned by a multifactorial design allowing to test the effect of concentration of lactose and of water content of the batter (central composit planning)
The results we got were treated with response surface methodology

The limits of experimennts werer as follow :
-replacement of sucrose by lactose : from 0%to 50%
-water content of batter : from 30,30%to 39,40%(0 ml to 150 ml water added to the formula)

The baking powders were recalculated on the gross weight basis

3.RESULTS

The equations we obtained after statistical treatment were used to calculate parameters for differents lactose and water content .
Results are given thereafter (tabl 2.1 to 2.5)

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3.1 Density of batters (tabl2.1 ; fig.1)

Lactose increased the density of batters , the intensity of variation depends on the water content .

When no water is added to the batter , the density became too high when lactose replace more than 35 % of sucrose ;the best results regarding density are obtained when:

- sucrose replacement equals 35%and there is no water added to the batter
- sucrose replacement equals 50 % and water added to the batter is 105 ml
- there is no replacement of sucrose and no water added
- there is replacment of sucrose and water added is no more than 60 ml

These results means that :

- lactose may be used to produced batter with more water and allow to increased the weight of batter .
- replacement of lactose must be limited to 35% if there is no change of water content
- some emulsifiers are to be added to the formula to improve density of batters if high quantity of lactose are to be used

3.2 Loss during baking (tabl2.2 ; fig.2)

Results depends on lactose and water content of batter .

With no water added , lactose reduce loss during baking
With high water content , lactose increased water loss

These results may be related to the water uptake by proteins and starch during mixing and baking or to the density of batter after mixing :

- in one hand , a great density reduces water migration during baxing and we already notice that there is a relationship between these two parameters
- in the other hand , a low density increases water migration and the structure is more easily dammaged allowing water to evaporate easily

However , the main results is that lactose could be used to reduced water loss during baking ; this result is to be check in close relationship with density of batter .

3.3 Volume (tabl2.3 ; fig3)

Lactose decreases the volume of "génoise " cakes , this results is unaffordable as soon as sucrose replacement by lactose equals 30-35%

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3.4 Smoothness (tabl.2.5)

Smoothness is measured with an INSTRON universal Testing Machin. The lower the value , the smoother the "génoise"

When no water is added to the formula , lactose improve smoothness of "génoise"

When water is added to the formula, we get opposite results.

These results are to be related to :
- water uptake by lactose during mixing and baking
- water uptake by proteins during mixing
- water uptake by starch during baking

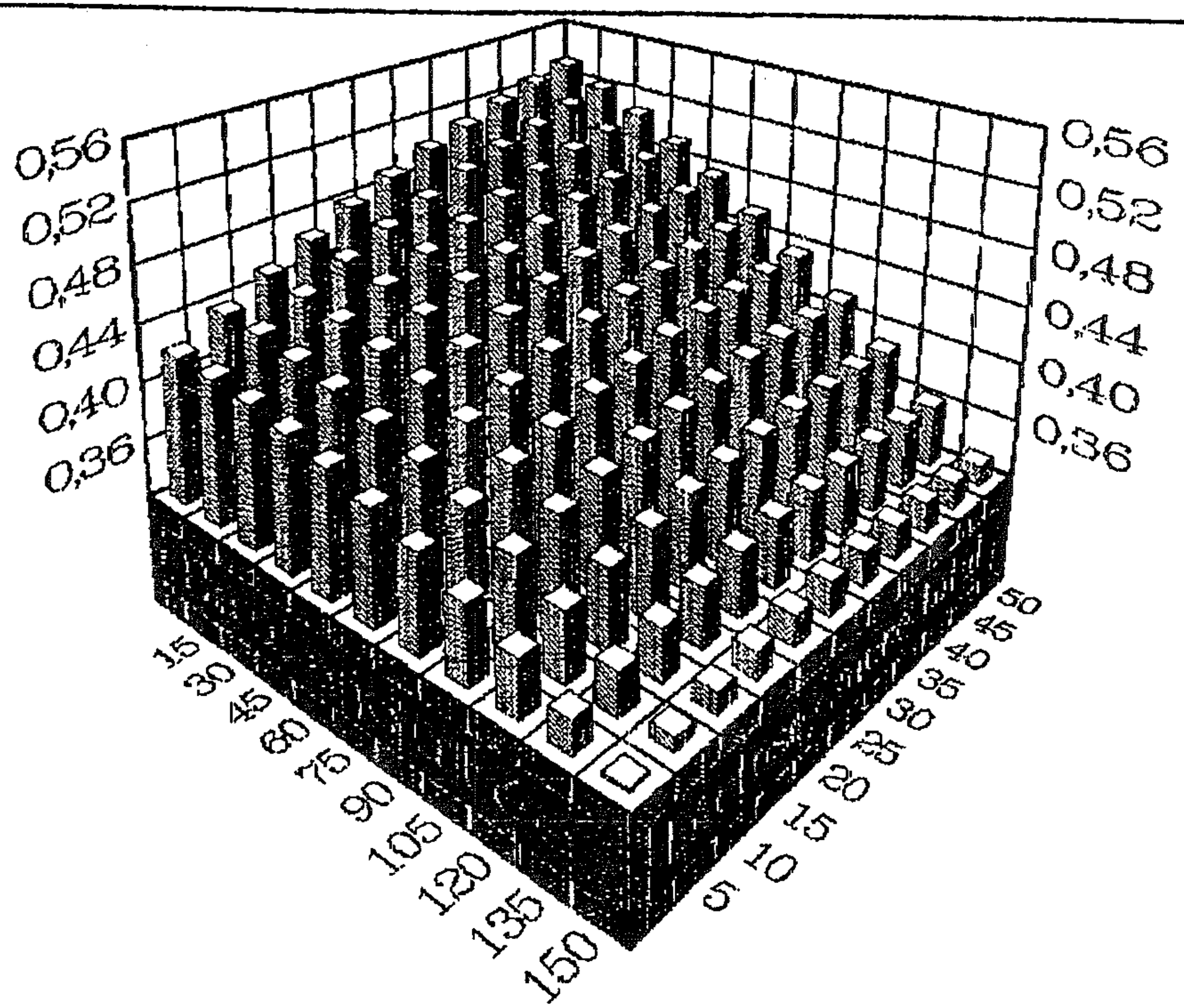
All these phenomenas are cross-linked ,some increase the firmness of final products as is the gelatinization of starch during baking , sugars decrease the firmness through their action on the rate of starch gelatinization and on the water retention reducing the quantity of water which may interact with starch or proteins.

In complex formulas as is "génoise" , we are unable , at the present time , to determine the relative reaction of these phenomenas which depends on :
- initial water content
- water uptake by differents raw materials
- mixing
- baking

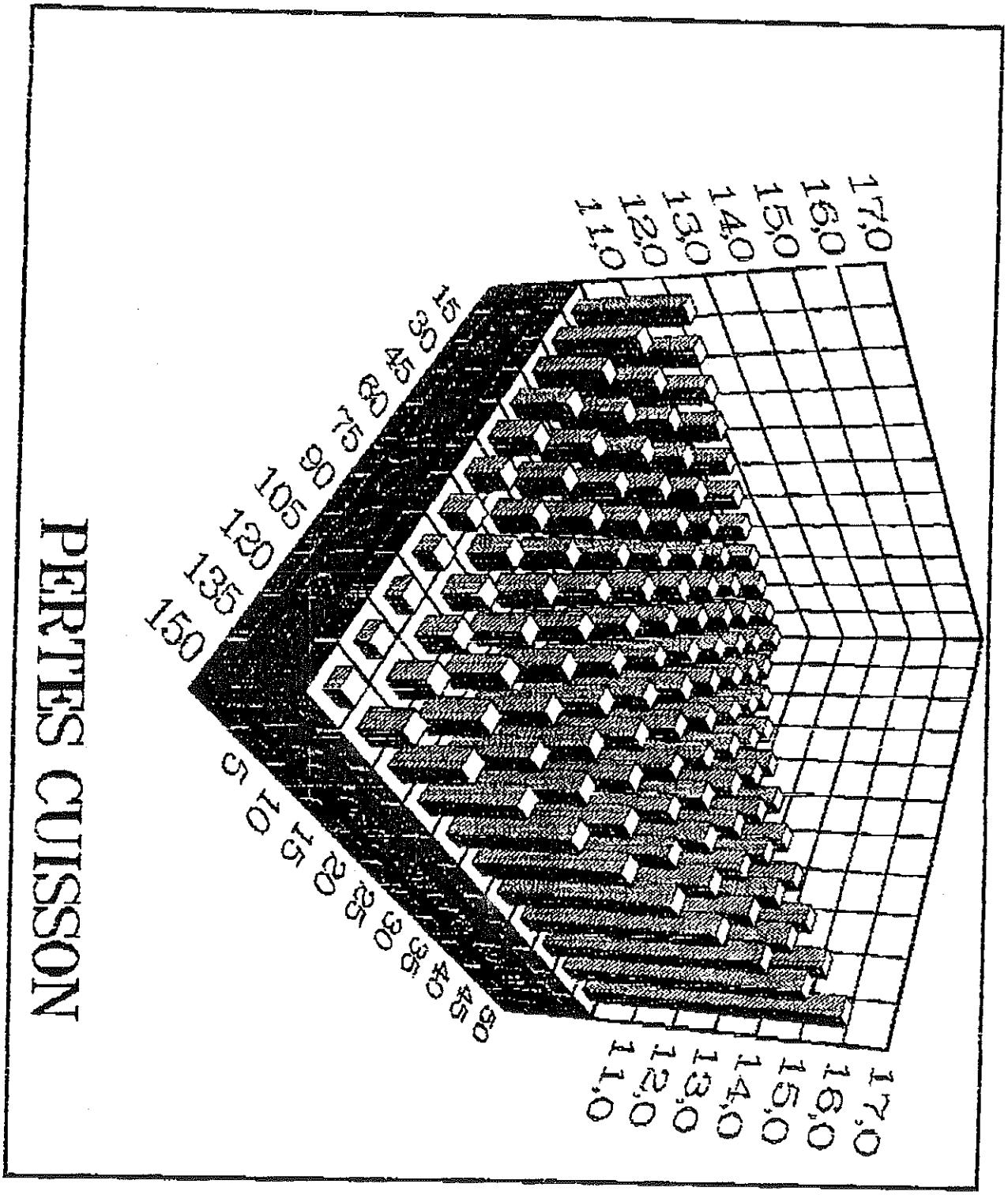
4.CONCLUSION

Lactose may be used in "génoise" formula to
- improve density of batter
- reduce loss during baking
- improve freshness

However , these results depend on the precise formula and on methods of mixing ; the next trials will be made to determine :
- how to change formula to increase lactose content without loss of quality
- which change are to be made with mixing and baking
- the opportunity to use emulsifiers



DENSITE PATE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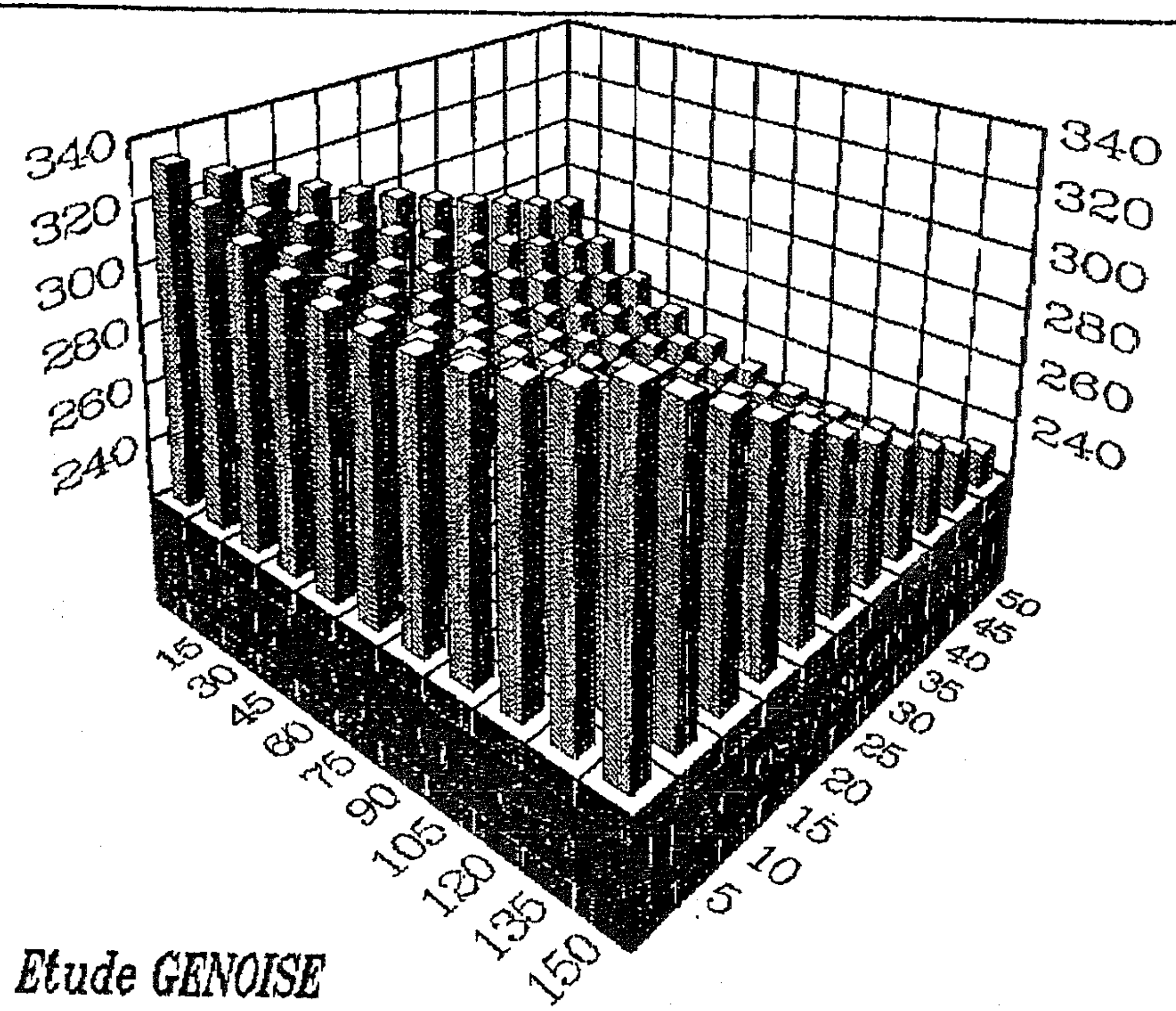
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Etude GENOISE

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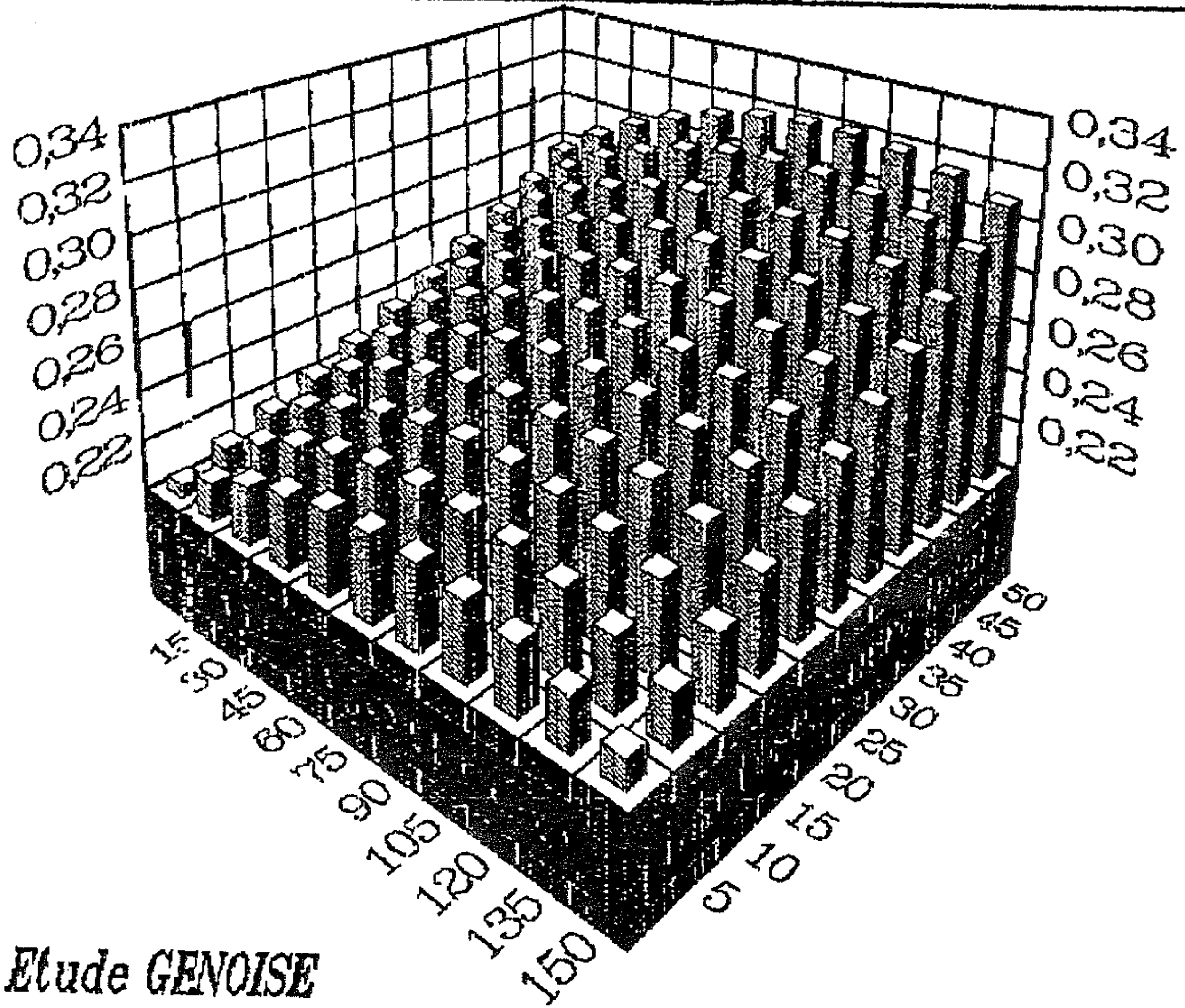

Etude GENOISE

DENSITE GENOISES

Tableau n°2.1 : Masses volumiques des pâtes (g/ cm3)

	0	5	10	15	20	25	30	35	40	45	50
0	0,42	0,44	0,45	0,47	0,48	0,49	0,50	0,51	0,52	0,53	0,53
15	0,42	0,44	0,45	0,46	0,47	0,48	0,49	0,50	0,51	0,52	0,52
30	0,42	0,43	0,44	0,46	0,47	0,48	0,48	0,49	0,50	0,50	0,51
45	0,41	0,42	0,44	0,45	0,46	0,47	0,47	0,48	0,49	0,49	0,49
60	0,40	0,42	0,43	0,44	0,45	0,45	0,46	0,47	0,47	0,47	0,48
75	0,40	0,41	0,42	0,43	0,43	0,44	0,45	0,45	0,45	0,46	0,46
90	0,38	0,39	0,40	0,41	0,42	0,42	0,43	0,43	0,43	0,44	0,44
105	0,37	0,38	0,39	0,40	0,40	0,41	0,41	0,41	0,41	0,41	0,41
120	0,36	0,37	0,37	0,38	0,38	0,39	0,39	0,39	0,39	0,39	0,39
135	0,34	0,35	0,35	0,36	0,36	0,37	0,37	0,37	0,37	0,36	0,36
150	0,32	0,33	0,33	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,33

Tableau n°2.2 : Pertes à la cuisson (%)

	0	5	10	15	20	25	30	35	40	45	50
0	12,65	12,52	12,38	12,24	12,11	11,97	11,83	11,70	11,56	11,42	11,29
15	11,99	11,92	11,86	11,79	11,73	11,66	11,59	11,53	11,46	11,40	11,33
30	11,61	11,61	11,62	11,62	11,63	11,63	11,64	11,65	11,65	11,66	11,66
45	11,27	11,34	11,42	11,50	11,57	11,65	11,73	11,80	11,88	11,96	12,03
60	10,98	11,13	11,27	11,42	11,57	11,72	11,87	12,01	12,16	12,31	12,46
75	10,74	10,96	11,18	11,40	11,62	11,84	12,06	12,28	12,50	12,71	12,93
90	10,56	10,85	11,14	11,43	11,72	12,01	12,30	12,59	12,88	13,17	13,46
105	10,42	10,78	11,14	11,51	11,87	12,23	12,59	12,95	13,31	13,68	14,04
120	10,34	10,77	11,20	11,64	12,07	12,50	12,93	13,37	13,80	14,23	14,67
135	10,30	10,81	11,31	11,82	12,32	12,82	13,33	13,83	14,34	14,84	15,35
150	10,32	10,90	11,47	12,05	12,62	13,20	13,77	14,35	14,93	15,50	16,08

Tableau n°2.3 : Volume (cm3)

	0	5	10	15	20	25	30	35	40	45	50
0	334	326	318	311	304	297	291	285	279	274	269
15	325	317	309	302	294	287	281	274	268	263	257
30	319	310	302	294	287	279	272	266	259	253	247
45	314	305	296	288	280	273	265	258	252	245	239
60	311	301	293	284	276	268	260	253	246	239	233
75	309	300	291	282	273	265	257	249	242	235	228
90	309	300	290	281	272	264	255	247	240	233	226
105	311	301	292	282	273	264	256	247	239	232	224
120	315	305	295	285	275	266	257	249	241	233	225
135	320	310	299	289	280	270	261	252	243	235	227
150	328	317	306	296	285	276	266	257	248	240	231

Tableau n°2.5 : Résistance à la compression des génoises (MPa)

	0	5	10	15	20	25	30	35	40	45	50
0	38,2	37,6	37,0	36,6	36,2	35,9	35,6	35,5	35,4	35,3	35,4
15	35,0	34,7	34,4	34,3	34,2	34,1	34,2	34,3	34,5	34,8	35,1
30	31,8	31,8	31,9	32,0	32,2	32,5	32,9	33,3	33,8	34,4	35,0
45	28,7	29,0	29,4	29,8	30,3	30,9	31,6	32,3	33,1	34,0	34,9
60	25,7	26,3	27,0	27,7	28,5	29,4	30,4	31,4	32,5	33,7	35,0
75	22,8	23,7	24,7	25,7	26,8	28,0	29,3	30,6	32,0	33,5	35,0
90	20,0	21,2	22,4	23,8	25,2	26,7	28,2	29,9	31,6	33,4	35,2
105	17,2	18,7	20,3	21,9	23,6	25,4	27,3	29,2	31,2	33,3	35,4
120	14,5	16,3	18,2	20,1	22,1	24,2	26,4	28,6	30,9	33,3	35,8
135	11,9	14,0	16,1	18,4	20,7	23,1	25,6	28,1	30,7	33,4	36,2
150	9,3	11,7	14,2	16,8	19,4	22,1	24,8	27,7	30,6	33,6	36,6