STUDIES ON SEED GERMINATION AND DORMANCY IN COTTON GENOTYPES (*Gossypium* spp.)[1] /

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Resumen

Se estudió la germinación y dormancia de semillas frescas de algunos genotipos de G. hirsutum, G. herbaceum *y* G. arboreum, *cosechados en tres etapas sucesivas, en relación a sus características y a métodos para romper la dormancia. La germinación inicial fue mayor en* G. herbaceum *seguida por* G. arboreum *y* G. hirsutum. *En* G. herbaceum *la germinación decreció con la etapa de cosecha, mientras que en* G. arboreum *se encontró una tendencia de aumento en la germinación.* G. hirsutum *mostró una baja germinación en semillas de la primer y tercera cosecha. En general, los genotipos de* G. hirsutum *mostraron períodos variables de dormancia, mientras que las otras dos especies no mostraron dormancia en ningún período de cosecha. El cv LRA-5166 (*G. hirsutum*) mostró el período de dormancia más bajo, variando entre 24 y 36 días después de la cosecha. Se observó una relación negativa y significativa entre la germinación inicial y el contenido de vella en la semilla de* G. hirsutum *(r = 0.9603), positiva con el índice de semilla en* G. herbaceum *(r = 0.5277) y negativa con el contenido de humedad inicial de la semilla de* G. arboreum *(r = 0.6128)*

Un tratamiento con calor (45°C) por siete días de las semillas con vella rompió la dormancia del cv. LRA-5166 en forma efectiva. El secado de las semillas al sol por dos días, también aumentó la germinación significativamente

Introduction

Seed dormancy indicates the inability to germinate under favourable conditions. Seeds dormancy in cotton is, however, not a serious problem, since normally, the time gap between harvest and next planting is considerably large. Hence, not much information is available on this aspect in the cultivated cotton genotypes. Nevertheless, to have basic knowledge of germination and dormancy is most important, in order to understand the nature of seed quality and viability later during the storage. In this paper, attempts have been made to obtain information on the initial germination of cotton seeds and factors controlling it, the extent of seed formancy in three cultivated cotton genotypes and methods to break the seed dormancy, if present.

Materials and methods

Experiment I: Initial germination and extent of dormancy period in cultivated cotton genotypes.

A few randomly chosen genotypes from three cultivated species of *Gossypium*, were used for the study. The crop was planted on medium black soil during the wet season of 1981, at the Agricultural Research Station, Dharwad, under rainfed conditions following a recommended package of practices for the region. The details of genotypes with dates of sowing and picking are given in Table 1.

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Table 1. Initial germination percent in cotton genotypes with reference to seed dormancy at different pickings.

Species variety		Pickings				For comparing		
		I	II	III	Mean	Variety (V)	Picks (P)	V x P
1		2	3	4	5	6	7	8
G hirsutum								
1.	DP-338	10	68	46	41 3			
2.	JK-236-2	72	82	82	78 7			
3.	JK-78-162	36	54	58	49 3			
4.	UAS-48-4	24	48	48	40 0			
						C D. at 5%		
5	DP-498	44	72	34	50 0			
6.	DP-342	50	66	28	48.0	9.8	5.7	17 0
7	NA-606	12	62	34	36.0			
8	LRA-5166	20	30	6	18 7			
9	DP-452	80	86	54	73 3			
Mean		38.7	63 1	43.3				
G herbaceum								
1	DB-3-12	96	88	94	92 7			
2	R-51	98	74	72	81 3	C.D at 5%		
3.	SM-6	92	70	78	80 0			
4.	72-245	88	58	80	75 3	6.2	4 8	10 8
5.	Jayadhar	90	62	32	61 3			
Mean		92 8	70 4	71.2	–			
G arboreum								
1	Lohit	52	82	82	72 0			
2	G-27	86	80	92	86 0	C D at 5%		
3	HD-11	90	80	90	86 7	10 7	NS	NS
4.	LD-135	90	88	84	87 3			
5	HD-135	78	84	82	81 3			
Mean		79.2	82 8	86 0				

Note		*G hirsutum*	*G herbaceum*	*G arboreum*
Date of sowing		3 8 1981	5 8 1981	12 8 1981
Date of picking:	I	23.12 1981	16 1.1982	23 1.1982
	II	2 1.1982	31 1.1982	3 2.1982
	III	13 1.1982	15.2 1982	13.2 1982

When cotton seed were picked, they were brought to the laboratory, ginned and immediately kept for germination. Germination tests were carried out at room temperature (28°C ± 2°C) using the standard (between) paper towel technique. Five days were allowed for germination and on sixth day only "normal seedlings" were considered for germination; The period of dormancy was calculated as the time taken for 80 per cent germination. Germination tests were continued until the desired germination was attained.

In addition, moisture content of seed (initial and final), seed index (100 seed weight) and hull to kernel ratio were also evaluated following standard procedures.

Experiment II: Methods to break dormancy in cv. LRA-5166.

The variety LRA-5166 which exhibited seed dormancy for nearly 30 days period in all the three pickings, was chosen for the study. Nine treatments were

imposed including a check (Table 3) The treatments consisted of soaking the seeds for five hours in test solutions followed by washing with distilled water and kept for germination at room temperature using the standard paper towel technique

All the seeds were kept separately in three lots of hundred each The data obtained on germination, was analysed statistically

Results

Experiment I: (a) Initial germination

The initial germination was highest in *G. herbaceum* followed by *G arboreum* and least in *G hirsutum* (Table 1). The germination percent also varied in different species with reference to pickings. Thus, the varieties of *G hirsutum* showed significantly low germination in first (38 7%) and third pickings (43 3%) than in second picking (63 1%) Germination in *G. herbaceum*, was significantly highest in first picking (92.8%) than in either the second (70 4%) or third picking (71 2%). In contrast, the varieties of *G. arboreum* exhibited a tendency for increased germination (79 2, 82 8 and 86.0% in first, second and third pickings, respectively) although the differences were non-significant.

(b) Period of seed dormancy

The data indicated the occurrence of seed dormancy for various periods in the varieties of *G hirsutum* only In the other two species, dormancy was either minimum (*G. herbaceum*) or completely absent (*G arboreum*) Table 2).

In general, in the varieties of *G. hirsutum*, the dormancy period varied with successive pickings: 12 0, 10.7 and 14 0 days in first, second and third pickings, respectively. Among the varieties, JK-236-2 and DP-452 had either negligible period of dormancy, six days in JK-236-2 in the first pick and 12 days in DP-452. The variety LRA-5166 recorded dormancy period for over a period ranging from 24 days (first pick) to 36 days (second pick). The other variety NA 606, also showed dormancy for a lesser period ranging from 12 days (second pick) to 24 days (third pick)

The other varieties had a shorter dormancy period ranging from 6 to 12 days.

(c) Seed characteristics.

The data on fuzziness, seed index, hull to kernel ratio and initial and final seed moisture are given in Table 2.

i) Fuzziness: The data indicated considerable variation in fuzziness among the species studied, which is in the decreasing order: *G. hirsutum* (8 96%), G. *arboreum* (7 10%) and *G. herbaceum* (4 10%). Even within a species, further variation was observed with different pickings Thus, in both *G. hirsutum* and *G. arboreum*, the fuzz content decreased; while in *G. herbaceum*, the fuzz increased with successive pickings

Among the varieties of *G. hirsutum*, cv. LRA-5166, had the highest fuzz content (14 10 to 14 50%), while, cv. JK-236-2 had the lowest (4 37 to 4 60%) The mean data for three successive pickings in *G. herbaceum*, indicated lowest fuzz in R-51 (3 11%) and highest in Sel. 72-245(5 27%). Unlike the other two species, the variation in fuzziness among varieties of *G arboreum* and pickings was considerably less However, HD-133(8 210%), in the first picking, LD-135 the second (7 96%) and in the third picking (8 46%) exhibited relatively higher fuzziness

ii) Seed index (Acid delinted): The mean seed index was in the increasing order of: *G arboreum* (4 74 g), *G. herbaceum* (5 88 g) and *G. hirsutum* (8 19 g). In general, all the three species showed a decreased in seed index with successive pickings. Among the genotypes of *G. hirsutum*, the seed index was relatively higher in DP-338 in the first picking (9 22 g), UAS-48-4 in the second picking (8 98 g) and DP-338 in the third picking (9 82) in comparison to the others.

Among the varieties of *G herbaceum*, Jayadhar (6 37 g), Sel. 72-245 (6 28 g), and DB-3-12 (6 23 g) recorded a relatively higher seed index over others in the successive pickings.

The seed index in HD-133 of *G. arboreum* was consistently higher in all the three pickings (5 52, 5 10 and 4 53 g, respectively).

iii) Hull to kernel ratio: In general, *G. herbaceum* (0 78) had higher full to kernel ratio, followed by *G arboreum* (0 63) and least in *G hirsutum* (0 54). In all the species, it however, increased with progressive picking.

Among the varieties of *G. hirsutum*, cv. DP-498, had a higher ratio of 0 57, 0 59 and 0 56 in the first, second and third pickings. The mean data for *G. herbaceum* indicated that hull to kernel ratio was highest in the second picking (0 81), followed by a third picking (0 78) and comparatively lower in the first picking (0 74). The variety SM-6 in the first picking, Sel. 72-245 in the second and third pickings, recorded the highest ratios of 0 75, 0 85 and 0 93 respectively. In *G. arboreum*, the ratio was almost similar in the

Table 2. Dormancy period and some seed characters in the varieties of *Gossypium* spp.

Genotype	Dormancy period (day)			Fuzz content (%)			Seed index (g)			Hull to kernel ratio ratio			Initial seed moisture			Final seeds moisture		
	Picking			Picking			Picking			Picking			Picking			Picking		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
G. hirsutum																		
DP-338	12	12	12	7.64	8.02	7.67	9.22	8.65	8.82	0.51	0.57	0.56	12.50	10.35	10.84	7.46	7.00	7.71
JK-236-2	6	0	0	4.37	4.37	4.60	8.58	7.54	7.74	0.49	0.53	0.52	12.25	11.50	11.60	7.88	–	–
JK-78-162	12	12	12	9.04	7.86	9.25	8.69	8.69	8.37	0.49	0.48	0.53	14.00	10.50	10.00	7.00	7.92	7.30
UAS-78-4	12	6	12	11.05	10.05	9.11	8.92	8.98	8.68	0.57	0.54	0.64	13.30	10.50	8.80	9.18	7.50	7.18
DP-498	12	6	12	12.20	9.31	11.22	7.86	7.09	7.24	0.57	0.59	0.66	13.50	11.00	11.00	8.87	7.92	8.00
DP-342	12	12	12	8.42	6.61	7.45	9.07	8.02	8.20	0.49	0.54	0.57	13.73	11.18	9.25	7.50	8.65	8.25
NA-606	18	12	24	10.19	7.85	6.38	8.29	8.21	8.48	0.55	0.55	0.55	14.71	10.84	10.73	7.88	2.92	7.39
LRA-5166	24	36	30	14.30	14.50	14.10	7.24	7.20	7.30	0.48	0.47	0.48	13.50	12.50	11.00	8.70	8.25	8.00
DP-452	0	0	12	7.98	4.12	8.00	7.44	8.03	6.99	0.47	0.48	0.68	13.24	9.80	9.50	–	–	7.50
Mean	12.0	10.7	14.0	9.47	8.74	8.64	8.36	8.15	8.06	0.51	0.53	0.58	13.42	10.91	10.30	8.06	7.88	7.79
G. herbaceum																		
DB-3-12	0	0	0	4.96	4.84	4.74	5.81	6.23	5.91	0.67	0.78	0.68	9.31	9.50	6.82	–	–	–
R-51	0	6	6	3.08	2.98	3.28	5.88	5.54	5.84	0.74	0.74	0.76	9.00	10.80	13.00	–	7.51	7.00
SM-6	0	6	0	2.42	2.90	4.63	6.05	5.73	6.07	0.99	0.84	0.69	8.70	9.00	9.09	7.43	7.43	–
72-245	0	6	6	2.95	5.66	7.20	5.88	6.28	5.49	0.75	0.85	0.93	7.70	9.06	7.91	–	8.42	7.50
Jayadhar	0	6	6	3.32	3.65	4.95	6.37	5.89	5.02	0.75	0.82	0.86	12.17	9.71	7.36	–	6.79	6.50
Mean	0.0	4.8	3.6	3.35	4.01	4.95	6.00	5.98	5.67	0.74	0.81	0.78	9.34	9.61	8.24	–	7.54	7.00
G. arboreum																		
Lohit	6	0	0	5.88	6.12	6.35	5.11	4.20	3.85	0.61	0.67	0.64	10.78	7.91	7.00	8.46	–	–
C-27	0	0	0	7.68	7.01	6.59	5.45	4.37	4.02	0.67	0.67	0.77	7.00	5.50	4.82	–	–	–
HD-11	0	0	0	6.78	6.57	6.80	5.26	4.83	4.35	0.63	0.61	0.64	6.50	6.00	4.89	–	–	–
LD-135	0	0	0	7.56	7.96	8.46	5.46	4.85	4.24	0.62	0.46	0.63	8.91	5.50	4.51	–	–	–
HD-133	6	0	0	8.21	7.58	6.89	5.52	5.10	4.53	0.59	0.63	0.63	9.86	6.50	4.51	6.00	–	–
Mean	2.4	0.0	0.0	7.22	7.05	7.02	5.36	4.67	4.20	0.62	0.61	0.66	8.61	6.28	5.15	7.23	–	–

Table 3. Germination per cent as influenced by various physico-chemical treatments in the freshly harvested seeds of LRA-5166.

Sl. no.	Treatments	Germination (%)	Difference over control (%)
1	Fuzzy (Control	37.3	..
2	Fuzzy – Sundried	72.0	+ 34.7
3	Fuzzy – 45°C, 3 days	66.7	+ 29.4
4	Fuzzy – 45°C, 7 days	81.3	+ 44.0
5	Acid delinted	57.3	+ 20.0
6	Delinted + water soaked	54.7	+ 17.4
7	Delinted + GA_3 20 ppm	56.0	+ 19.3
8	Delinted + etherel 50 ppm	49.3	+ 12.0
9	Delinted + water soaked-dried	59.3	+ 22.0
For comparing treatments:		S. Em±	5.0
		C.D. at 5%	10.6

first two pickings (0.61 and 0.62) which increased to 0.66 in the third picking. Among the varieties, G-27 showed consistently higher ratio of 0.67, 0.67 and 0.77 in the successive pickings.

iv) Initial seed moisture: The mean initial seed moisture was the highest in *G. hirsutum* (11.54%) followed by *G. herbaceum* (9.06%) and least in *G. arboreum* (6.68%). With reference to the time of picking, there was a reduction in initial seed moisture in all the species. In *G. hirsutum*, the initial seed moisture decreased from 13.42 percent in the first picking to 10.30 percent in the third picking. Among the genotypes, DP-342 (14.7%) followed by JK-78-162 (14.0%) in the first picking, LRA-5166 in the second picking (12.50%) and JK-236-2 in the third picking (11.60%) had relatively higher moisture contents.

The mean initial seed moisture in *G. herbaceum*, was slightly more in the second picking (9.60%) than in first picking (9.34%), but decreased in the third picking (8.24%). Relatively, higher moisture content was seen in Jayadhar (12.17%) in the first picking, R-51 in the second (10.80%) and the third pickings (13.00%). However, there was no consistency in the decrease in seed moisture among the varieties with successive pickings.

In *G. arboreum*, the variation in seed moisture with successive pickings was considerable, reducing from 8.61% in the first picking to 5.15% in the third picking. In all the pickings, Lohit maintained relatively higher content (10.78, 7.91 and 7.00% , respectively).

v) Final seed moisture: The data on final seed moisture was also collected to verify whether the expected decreased seed moisture is related to enhanced germination. The data indicated a decrease in seed moisture to around 7–8 percent irrespective of initial seed moisture to attain 80 percent germination in all the three species studied.

Experiment II: Methods to break seed dormance in cv. LRA-5166.

Among the eight treatments tried in comparison to the untreated control, fuzzy seeds subjected to a temperature of 45°C for seven days showed a significant increase in the germination to 81.3 percent that is 44.0 per cent more than the seeds stored at room temperature. Even sun drying for two consecutive days, showed a 34.7 percent increased germination over the control. Although other treatments gave significantly higher germination, they were not on par with the above two treatments (Table 3).

Discussion

Initial germination, seed dormancy and seed characteristics in cotton.

Of the three cultivated species, only the varieties of *G. hirsutum*, showed considerable variation for period of dormancy; while in other species, it was either negligible or absent. The occurrence of seed dormancy in cotton, particularly in *G. hirsutum*, has also been previously reported (2, 3, 4, 7, 9). Christidis (4) was of the opinion that cotton seeds probably need several days of rest, depending upon the date of maturity and variety.

Reasons for differences in the initial seed germination in successive pickings among the species and varieties within the same species may be attributable to certain seed characteristics, be different for each species. Correlations worked out between initial germination and seed characters amply indicated this possibility (Table 4). One of the reasons for the extended period of seed dormancy in *G. hirsutum* may be ascribed to fuzziness as there was a significant negative relationship between initial germination and fuzz content ($r = -0.9603$). As far back as 1935, Simpson (9) and recently Bhagavandas (3) have shown that sulphuric acid treatment to freshly harvested seeds increased the germination percentage. Bailey (1) suspected that wax and lignin in conjunction with fuzz might play a part in restricting the

Table 4. Simple correlations between initial germination and seed characters (correlation co-efficient = r).

Species	Seed germination vs.			
	Initial moisture content	Fuzz content	Seed index	Hull to kernel ratio
G. hirsutum	-0.0597	-0.9603**	0.1817	-0.3682
G. herbaceum	0.0611	-0.2133	0.5277*	-0.3931
G. arboreum	-0.6128*	0.3702	0.1458	0.1479
Levels of significance			5% P	1% P
G. hirsutum (25 df)			0.381*	0.487**
G. herbaceum and *G. arboreum* (13 df)			0.514*	0.641**

absorption of moisture by seeds. Further, it has been observed that delayed germination due to fuzz on cotton seeds may exert a secondary inhibition (3). In *G. herbaceum*, the initial seed germination (although high) was positively related with seed index (r = 0.5277). The seed index in this species generally decreased, with progressive pickings, indicating a possibly poor development of embryo. It is reported that poor and delayed germination in seeds of certain varieties of cotton was due to poor embryo development (2). Further, it was also observed that embryo was not dormant but only weak. Regarding *G. arboreum*, in which no dormancy was observed, the initial seed moisture was correlated negatively with seed moisture (r = -0.6178). Paddy seeds having both high and low moisture content germinated late.

Those having low moisture content germinated late and also showed high germination (8). The final seed moisture data from the present studies have also amply proved this observation.

In none of the species did hull to kernel ratio have any relationship with initial germination, although considerable variation was observed among the species and among the pickings within a variety. Kempanna *et al.* (5) investigating the causes for poor germination in four cultivated species of cotton found that the germination in *G. arboreum* was not influenced by impermeable seed coat. According to them, germination in *G. hirsutum* was controlled by factors of an unknown physiological nature. However, the present studies clearly indicated that fuzziness in *G. hirsutum*, seed weight in *G. herbaceum* and seed moisture in *G. arboreum* influence initial seed germination.

Methods to break seed dormancy in cv. LRA-5166.

The data indicated that either sun-drying or heat treatment successfully breaks the seed dormancy in cv. LRA-5166. Similar results were also reported in paddy seeds by heat treatment (6, 8). High temperatures (40-50°C) breaks the seed dormancy in cotton by making the seed coat permeable (2). It may also possibly destroy certain growth inhibitors accumulated in the seed during its development. By removing fuzz by acid delinting, the germination increased only to a small extent, thereby indicating that fuzz forms only a part of the impediment affecting good germination. Probably some internal factor(s) may be responsible. However, it was also observed that none of the growth regulators used, which are reported to break dormancy, enhanced the germination to the extent of heat treatment. Thus, it may be surmised that heat treatment, not only enhanced the permeability of seeds, but also destroyed some interfering substances.

Summary

Germination of freshly harvested seeds at three successive pickings, and the extent of dormancy in a few genotypes of *G. hirsutum*, *G. herbaceum* and *G. arboreum*, in relation to some seed characters and also methods to break the seed dormancy, were studied. The initial germination was highest in *G. herbaceum* followed by *G. arboreum* and least in *G. hirsutum*. In *G. herbaceum*, the initial seed germination declined with successive pickings; while in *G. arboreum*, there was a tendency for enhanced germination. *G. hirsutum* showed significantly low germination in the first and third pickings. In general, the genotypes of *G. hirsutum* showed varying periods of seed dormancy, while the other two species remained non-dormant, in all the pickings. Cv. LRA-5166 (*G. hirsutum*) showed a relatively longer period of dormancy ranging from 24 to 36 days after harvest. A significant negative relation between initial germination and fuzz content in *G. hirsutum* (r = -0.9603), positive correlation with seed index in *G. herbaceum* (r = 0.5277) and negative relation with initial seed moisture in *G. arboreum* (r = -0.6128) were observed.

Heat treatment of fuzzy seeds (45°C) for seven days broke the dormancy effectively in the dormant variety LRA-5166. Sundrying for two consecutive days also increased germination significantly.

Literature cited

1. BAILEY, A. E. "Cotton seed and cotton seed products". Interscience Publishers, Inc. New York. 1948.

2. BALASUBRAMANIAM, R. and MUDALIAR, V. R. A physiological study of delayed germination in cotton. Madras Agricultural Journal 21:147-162. 1933.

3. BHAGAVANDASS, M. Preliminary investigations on the dormancy of cotton seeds. Madras Agricultural Journal 56:97-99. 1969.

4. CHRISTIDIS, B. G. Dormancy in cotton seed. Agronomy Journal 47:400-403. 1955.

5. KEMPANNA, C., PARAMESHWAR, N. S. and KHALLAK, A. Variations in seed germination of four *Gossypium* species. Mysore Journal Agricultural Science 1:71-80. 1967.

6. MISRO, B. and MISRA, P. K. Certain consideration on seed dormancy. Oryza 61:18-22. 1969.

7. PATIL, M. S. Seed dormancy and viability in some varieties of cotton. Current Research 5:1-2. 1976.

8. SIKDER, H. P. Dormancy of rice seeds in relation to different moisture contents of grains and dates of harvests. Journal Agricultural Science Cambridge 81:159-163. 1973.

9. SIMPSON, D. M. Dormancy and maturity of cotton seed. Journal Agricultural Research 50:429-434. 1935.

Notas y comentarios

Premio Nobel de Medicina y Biología de 1984

César Milstein, un argentino del Laboratorio de Biología Molecular de Cambridge, Inglaterra, Nils Jerne, un danés nacido en Londres, del Instituto de Inmunología de Basilea, y el intermediario entre los dos, George Köhler, de Alemania Occidental, fueron los escogidos para recibir el Premio Nobel de Biología y Medicina de 1984, por haber inventado los anticuerpos monoclonales, y haber abierto, con esta investigación, las puertas de la ingeniería genética.

Como muchos otros importantes logros científicos, el primer aviso se encuentra en una carta al editor que dirigieron Milstein y Köhler (quien trabajaba con Milstein en Cambridge) a la revista **Nature**, y publicada el 7 de agosto de 1975, en la que describían un método para producir grandes cantidades, muy puras y muy precisas, de anticuerpos, esas armas con que el sistema inmunológico del cuerpo lucha contra las enfermedades.

Los anticuerpos son muy útiles, no sólo para combatir enfermedades sino en otras esferas de la biomedicina. El problema reside en que el sistema de la inmunidad produce anticuerpos a toda clase de antígenos, lo que quiere decir que es muy difícil obtener anticuerpos puros. Una proteína simple puede tener varios puntos antigénicos y un solo patógeno puede llevar consigo muchas proteínas superficiales diferentes. El cuerpo responde con un coctel de anticuerpos mezclados; el purificar una sola especie de anticuerpo lleva al investigador contra los límites de los métodos fisicoquímicos.

Aquí entran los anticuerpos monoclonales. Estos son hechos por un cultivo de células genéticamente idénticas, o sea, un clon. Debido a que un solo linfocito produce un solo anticuerpo, un cultivo monoclonal secreta un producto puro. Pero las células normales del organismo tienen una vida muy limitada, consiguiéndose sólo unas siete u ocho divisiones antes de que ellas mueran. Un cultivo derivado de un solo linfocito sería de una vida demasiado corta para ser útil.

La hazaña de Milstein y Köhler fue fusionar células de un tumor canceroso, que son inmortales, con una

célula normal que producía un anticuerpo específico. Crearon así una línea celular inmortal que secretaba un anticuerpo puro. Estas células se llaman hibridomas.

Pronto se dieron cuenta de las implicaciones de su descubrimiento. Los anticuerpos monoclonales podrían ser utilizados para fabricar el interferón más puro. Pueden distinguir un tipo de célula de otro; un tipo de leucemia de otro. Y lo mejor de ellos es su confiabilidad; presentan siempre las mismas propiedades porque todas las células del clon son idénticas.

El gobierno británico declinó patentar el descubrimiento por lo que Milstein y Köhler decidieron redactar la comunicación que publicó **Nature**. Esto ha sido criticado en algunas revistas científicas, entre ellas **New Scientist**, que editorialmente señaló que algunos premios Nobel recibidos por científicos de instituciones británicas han sido explotados comercialmente por compañías de otros países (otro ejemplo es la penicilina). Pero, en realidad, es sólo en los últimos años en que las universidades y organismos estatales están patentando los avances que obtienen en la electrónica y la biotecnología. A partir de las investigaciones dirigidas por Milstein, la industria ha venido desarrollando usos comerciales a los anticuerpos monoclonales, principalmente 1) en procesos industriales, como en la producción de interferones, esas sustancias antivíricas y anticancerosas elaboradas por el cuerpo; 2) en diagnosis, como anticuerpos para tipificar tejidos, lo que es necesario para trasplantes; y 3) en terapia, como drogas citotóxicas que son llevadas por anticuerpos específicos a células cancerosas, dejando intactas las otras células. Y hay muchos ejemplos más.

Milstein, quien tiene 57 años, se graduó en química en la Universidad de Buenos Aires, en 1957. En 1958, estudió para su doctorado en el departamento de bioquímica de la Universidad de Cambridge. Trabajó por primera vez en el Consejo de Investigación Médica en 1960, y regresó a la Argentina en 1961. Por dos años fue jefe del Instituto Nacional de Microbiología en Buenos Aires, pero renunció y regresó a Inglaterra cuando cuatro miembros de su personal fueron despedidos por pertenecer a un sindicato.

Köhler, quien tiene 38 años, aparte de sus dos años con Milstein, ha realizado su labor en el Instituto de Inmunología de Basilea, Suiza, que fue fundado por Jerne. Se espera que asuma la dirección del nuevo Instituto Max Plank de Inmunología en Freiburg, Alemania Occidental.

Jerne, quien dice que para el trabajo teórico que él realiza, sólo necesita un pedazo de papel, fue incluido en el premio en razón de que sus teorías sobre la diversidad de los anticuerpos marcaron una nueva dirección en la ciencia de la inmunología. Cuando los químicos descubrieron que la conformación de las moléculas de proteína era determinada solamente por la secuencia de los aminoácidos que la componen, cayó en descrédito la teoría anterior, la hipótesis de instrucción, que sostenía que los anticuerpos eran como cadenas desdobladas que, en contacto con el antígeno, se envolvían sobre este antígeno para formar un anticuerpo a la medida. Jerne propuso entonces, en 1955, la teoría de la selección clonal de la formación de anticuerpos. Esta idea fue la base subsecuente de la inmunología. Esto llevó al trabajo de Gustav Nossal, en Australia, que mostró que cada linfocito producía sólo una clase de anticuerpo, un concepto que hizo posible la técnica de Milstein y Köhler para producir hibridomas. Su siguiente idea, dice Jerne, fue que la mutación somática para darle a los linfocitos su vasto repertorio de anticuerpos. Jerne es danés, aunque nacido en Londres. Hizo su trabajo doctoral en Copenhague y trabajó seis años en el Instituto Serum. Mientras dirigía el Instituto Paul Erlich, en Frankfurt, le fue propuesto, por la firma suiza Hoffman-La Roche, que iniciase el Instituto de Inmunología de Basilea. Adalberto Gorbitz.