

IMPACT OF *BABESIA BOVIS* AND *BABESIA BIGEMINA* ON THE PRODUCTION OF BEEF CATTLE IN URUGUAY

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Uruguay is situated in a marginal area for the development of Boophilus microplus (30° 35° South Lat.) with important areas of enzootic instability for Babesia bovis and B. bigemina.

The livestock products represent 70% of our exports, for which reason it is fundamental to evaluate the losses in the production that these haemoparasites cause as basic information to take future decisions.

In the period 1988-1990, several works were carried out by our laboratory to know the incidence of babesiosis in the reduction of liveweight gains. The results are shown and discussed in the work.

Experiment I: the weight increase of the control group ($x = 0,248$ kg/day), was 23% higher than that of the infected group with Babesia spp (from Uruguay), but significant statistical differences were not found ($P < 0,05$). These animals were kept in boxes and the food was controlled for 76 days.

Experiment II: the incidence of Babesia spp (same strain) was studied for 140 days on Hereford heifers ($n = 14$) on natural pastures. The control group obtained $x = 25,29$ kg of liveweight gain and it was 45% higher than that of the infected group, significant statistical difference were found ($P < 0,05$).

Experiments with attenuated strains III: four studies were carried out inoculating B. bovis and B. bigemina in bovines about one year old, in different growth systems, searching for the limit of application. Significant statistical differences between those groups were not found during the experiment (about 180 days) ($P < 0,05$).

Experiment combining attenuated and pathogenic strains IV: the liveweight gain, in immune and challenged group ($n = 14$) was the same than that of the unchallenged group and did not show significant statistical differences ($P < 0,05$). However the control challenged group had less weight gain and statistical differences were found ($P < 0,05$).

Although this is a preliminary information, it shows that: (a) the incidence of babesiosis on the reduction of weight gains is important; (b) the decrease in weight gain was not observed when attenuated strains were used; when the challenge was done in immunized animals, losses in liveweight gain were not observed.

These results are discussed in order to plan future studies in different real systems of production.

Key words: *Babesia bovis* – *Babesia bigemina* – beef cattle production – Uruguay

Uruguay covers less than 1% of the total area of South America (176.215 km²) and it is situated between parallels latitude 30°-35° South. The larger portion of this land is dedicated to the production of agricultural products (156.818 km²); the livestock breeding sector being the most important, for the country's economy, it represents 70.2% of the total exports (1.6 billion dollars). The herds are represented about 8.1 million beef cattle and 26.0 million sheep (Boletín Estadístico, 1989; D.I.E.A., 1990).

Animal health is an important factor in the economic aspects of livestock production, and it is therefore of national interest to be aware of this problem and to control those diseases whose incidence are negative to the sector.

In 1941 Uruguayan authorities considered the importance of the damage caused by *Boophilus microplus* and babesiosis, and a legal frame was developed for ticks eradication, and the immunization of cattle through the creation of a "Premunition Service" (M.G.A., 1948). These programs had some set backs, but as the subject was an important one and with the support of "840 Animal Health/BID Project" the work has been launched, in 1988 (MAGP, 1988).

Since 1979 the "Premunition Service" has been used non pathogenic live strains of *Babesia bovis* and *B. bigemina* (isolated and "attenuated" at "Miguel C. Rubino" Center). Although there is a risk of these becoming vectors for other diseases, this is the only method available at the present time, and in our experience of more than half a million doses, it has been of a great success (Nari & Solari, 1990).

Decisions to invest in national sanitary programs against these diseases are based primarily on economic estimations, and there is very little information of these aspects at both national and international levels (Sutherst & Kerr 1986; Horn, 1987).

Some assays have been planned in order to arrive at a more accurate estimation of the cost/benefit relation in the sanitary campaign against *B. microplus*. These assays will provide information on the way the disease occurs naturally during its different stages (to be publish).

One of the hypothesis is that a temporary negative effect on the weight gain occurs, and it is compensated later by extra growth. The other one, is that there is no effect of attenuated strain on the weight gain.

Since 1988 "Miguel C. Rubino" Center started a program to quantify economic losses produced by babesiosis. The following aspects were considered: (1) With the same pathogenic strain: (a) Quantify the negative effect on the weight gain. (b) Determine whether this negative effect is related to the acute or the chronic stage of the disease. (c) If the compensatory growth effect is enough to cover those losses. (2) With the strains to be used in immunization process: (a) Analyse the weight gain under different nutritional levels with bovines immunized. (b) Determine how the pathogenic *Babesia spp*, acts related to the weight gain in immunized bovines.

EXPERIMENTAL DESIGN

All the assays were, performed using two or three groups of animals aged 1 to 2 years serologically negative by Immuno Fluorescence Antibody Test (IFAT) (IICA, 1985).

The different groups were aleatory distributed, and after analyzing the variance it was determined that they behaved themselves as a single group. The level of the significance of the difference between average weights in each treatment was evaluated by the t "student" method (Snedecor & Cochran, 1967).

All the groups inoculated were controlled by IFAT at the end of the assay and were positive.

Experiment 1

The first study was the observation on liveweight variations in basal maintenance conditions when pathogenic *Babesia spp*. was inoculated.

Material and Methods:

Objective: determination of the productive impact of pathogenic *Babesia spp* on liveweight gain cattle kept in barns with controlled food intake.

Strain: *Babesia spp* isolated from natural outbreak reported in Salto (Uruguay).

Conditions: all animals were kept in barns and the food was given in restricted conditions and individually. Water was supplied ad libitum. The experimental animals were kept under these conditions 14 days before the inoculation.

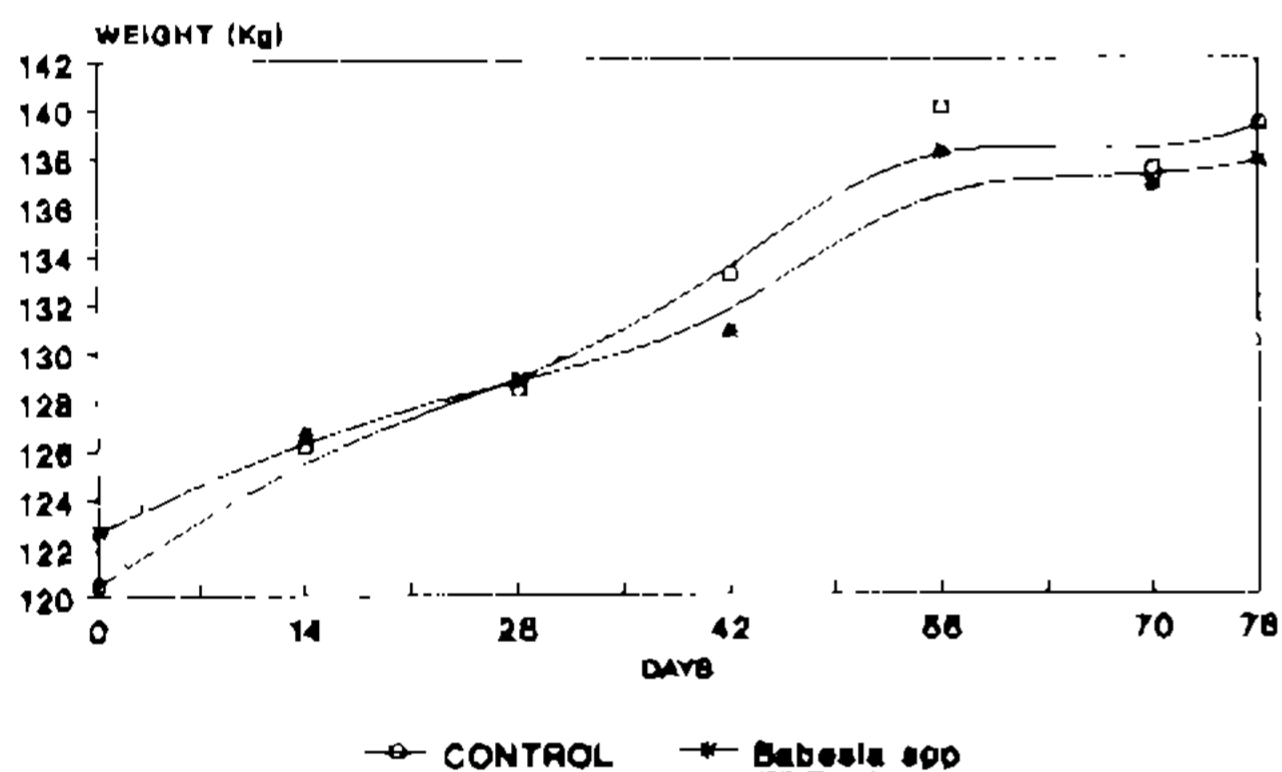
Sampling: cattle was weighted every 14 days.

Group	Age (months)	Bovines (n)	Experimental period (days)	Inoculation (I/M)
Infected	12	6	76	<i>Babesia spp</i> 56 * 10 ⁷ IE
Control	12	7	76	Normal E

E = Erythrocytes

IE = Infected erythrocytes

Analyzing the weights after 76 days the lineal model appeared to be the best; this was confirmed by the high values of $r^2 = 0,93$. The daily weight gain was 0,205 and 0,248 kg in the inoculated and control group respectively. Even though this difference between the groups were not significant ($P < 0,05$), the inoculated groups weights were 3.33% lower than those of the control group, (Table I, Fig. 1).



NOT SIGNIFICANT ($P > 0,05$)

Fig. 1: productive impact of the pathogenic *Babesia spp* on cattle under restricted conditions (period: 76 days).

These results show the babesiosis effect during the acute period of the disease on bovine under basal feeding condition.

Since the behaviours of weights at the end of the experiment, show a more emphatic difference trend, a new longer field assay was necessary.

Experiment 2

It was performed in a natural environment similar to what happens in most of the country (winter and late fall grass and normal ratio animals per surface).

Material and Methods:

Objective: determination of the productive impact of a pathogenic *Babesia spp* on liveweight gain of Hereford heifers in natural grassland, during the clinical and chronic period.

Strain: *Babesia spp* isolated from a natural outbreak reported in Salto (Uruguay).

Conditions: all animals were in natural pastures, at the ratio 1,8 bovine/ha.

Sampling: cattle was weighted every 28 days.

Group	Age (months)	Bovines (n)	Experimental period (days)	Inoculation (I/M)
Infected	20	14	140	<i>Babesia spp</i> 20 * 10 ⁵ IE
Control	20	14	140	Normal E

E = Erythrocytes

IE = Infected erythrocytes

Daily increase of weight was 0,181 kg for the control group, and 0,098 kg for the challenged group. (Table II). During the experimental period, the whole increase for the control groups was 25,29 kg – 45% higher than the infected group (13,71 kg). The percentage

TABLE I

Results of experiment 1 – Incidence of pathogenic *Babesia spp*. On weight gain in controlled conditions

Group	Initial weight (X ± SD – kg)	Final weight (X ± SD – kg)	Increase (X ± SD – kg)	Increase (% of IW)	Daily gain (kg)
<i>Babesia spp</i>	122,67 ± 22,41	137,80 ± 28,41	14,80 ±	12,33	0,205
Control	120,43 ± 15,06	139,29 ± 14,98	18,86 ±	15,66	0,248

Period: 76 days; each group/7 bovines.

SD: Standard desviation;

IW = initial weight. Not significant ($P < 0,05$).

TABLE II

Results of experiment 2 – Incidente of *Babesia* spp on liveweight gain in field conditions

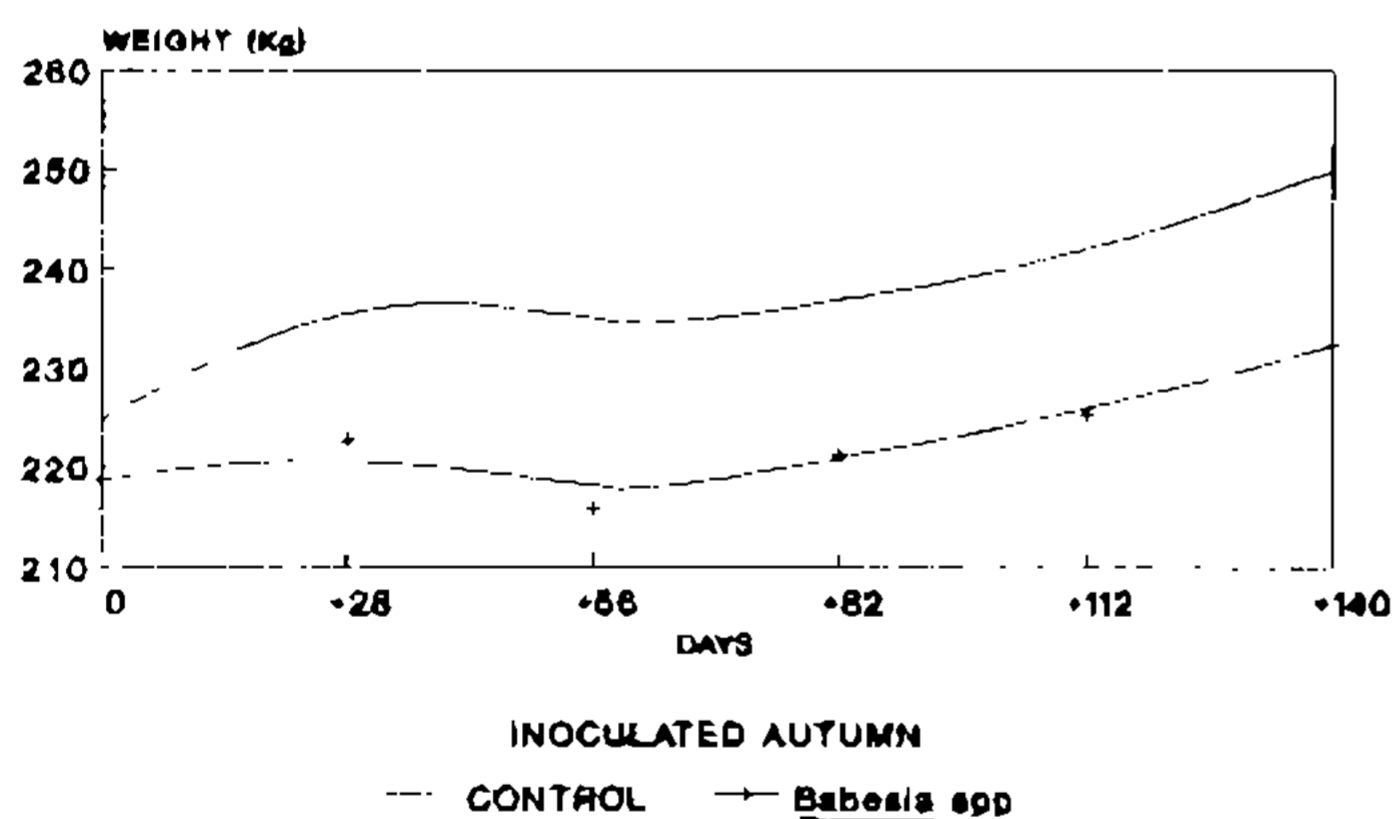
Group	Initial weight (X ± SD – kg)	Final weight (X ± SD – kg)	Increase (X ± SD – kg)	Increase (% of IW)	Daily gain (kg)
<i>Babesia</i> spp	218,71 ± 30,25	232,42 ±	13,71 ± 8,69	6,20	0,098
Control	224,71 ± 17,68	250,00 ±	25,29 ± 12,92	11,20	0,181

Period: 140 days; each group/14 bovines.

SD = Standard deviation; IW = Initial weight.

Significant (P < 0,05).

of weight gain compared with the initial weight was 6.2 and 11.2 in the inoculated and control groups. This 5% difference is considered statistically significant (P < 0,05). The availability of grass was at first poor but it was better in Spring, nevertheless the great difference between the groups did not change during the assay. These results show the negative effect of babesiosis in the growth of affected cattle (Fig. 2). This partially confirms the above hypothesis since the compensatory effect in the inoculated group was not shown.



SIGNIFICANT (P<0,05)

Fig. 2: productive impact of the pathogenic *Babesia* spp on cattle liveweight gain (period: 140 days).

Experiment 3

The next point is related with the effect of the strains used in premunition on the growth of the animals. To this purpose the effect of the standard inoculations. (*B. bovis* or *B. bovis* + *B. bigemina*) was measured in normal and in improved feeding conditions.

Material and Methods:

Objective: determination of the productive impact on cattle (8-9 months old), immunized with attenuated alive vaccine, on natural and improved (Solari et al., 1989) pastures.

Strain: *B. bovis*; Attenuated (1986). *B. bigemina*; Attenuated (1980).

Preparation of the vaccine: as Callow (1977) describes .

Condition: A) Hereford calves on natural pastures (ratio at 1,7/ha). B) Hereford calves on improved pastures.

Sampling: cattle was weighted every 28 days.

A) Conditions: natural pastures (Ratio 1,7 Calves/ha)

Group	Age (months)	Bovines (n)	Experi- mental period (days)	Ino- culation (I/M)
Infected	8-9	15	156	<i>B. bovis</i> 1 * 10 ⁷ IE
Infected	8-9	15	156	<i>B. bovis</i> 1 * 10 ⁷ IE <i>B. bigemina</i> 2 * 10 ⁵ IE
Control	8-9	15	156	Normal E

B) Conditions: improved pastures

Group	Age (months)	Bovines (n)	Experi- mental period (days)	Ino- culation (I/M)
Infected	9	20	154	<i>B. bovis</i> 1 * 10 ⁷ IE
Infected	9	20	154	<i>B. bovis</i> 1 * 10 ⁷ IE <i>B. bigemina</i> 2 * 10 ⁵ IE
Control	9	20	154	Normal E

E = Erythrocytes

IE = Infected erythrocytes

TABLE III

Results of experiment 3 – A) Incidence of alive attenuated vaccine on the weight gain in *natural pastures*

Group	Initial weight (X ± SD – kg)	Final weight (X ± SD – kg)	Increase (X ± SD – kg)	Increase (% of IW)	Daily gain (kg)
<i>B. bovis</i>	111,33 ± 7,88	152,80 ± 8,07	41,47 ± 7,49	37,25	0,266
<i>B. bovis</i> + <i>B. bigemina</i>	113,67 ± 12,76	155,80 ± 12,76	41,80 ± 10,04	36,77	0,268
Control	115,07 ± 16,48	155,47 ± 15,55	47,07 ± 8,15	35,69	0,263

Period: 156 days; each group/15 bovines.

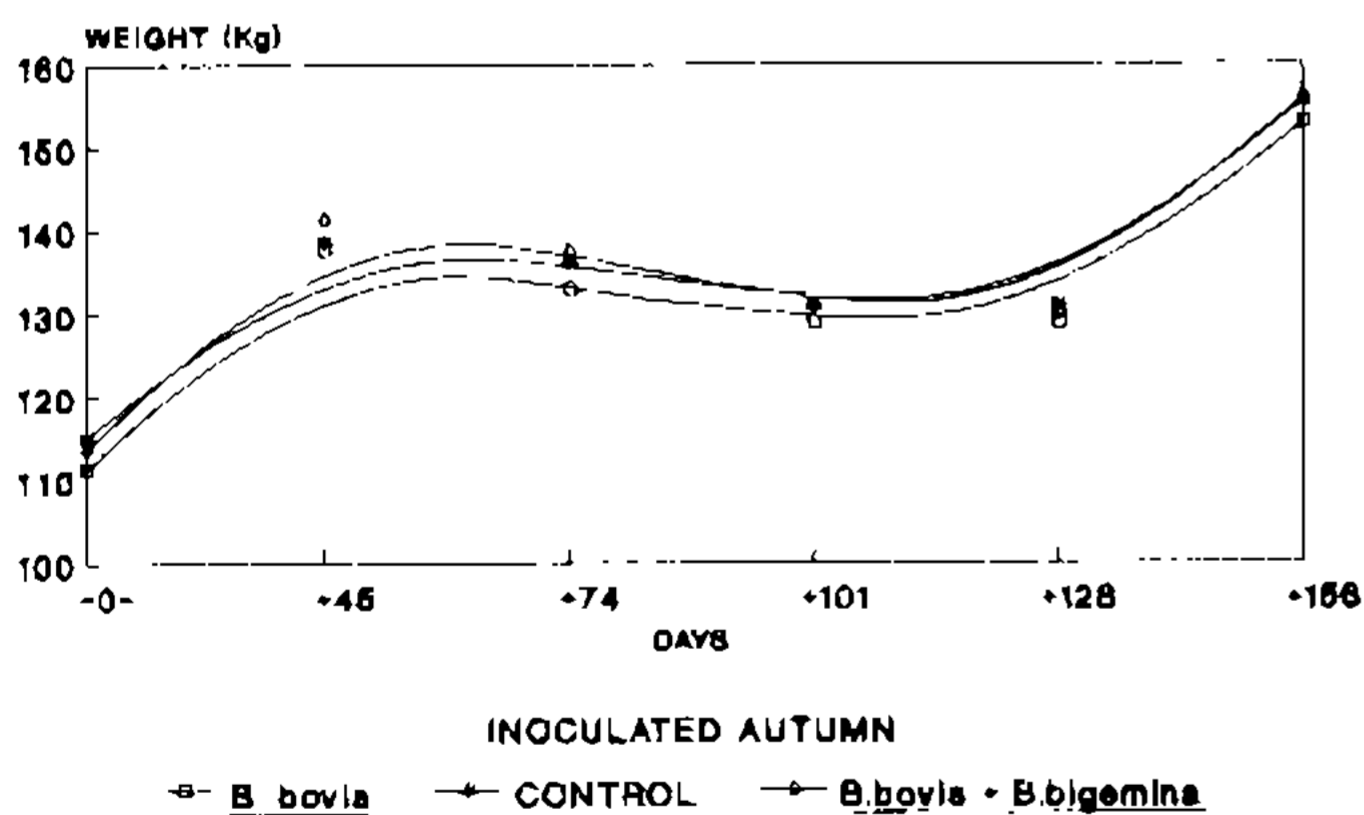
B) Incidence of alive attenuated vaccine on the weight gain in *improved pastures*

Group	Initial weight (X ± SD – kg)	Final weight (X ± SD – kg)	Increase (X ± SD – kg)	Increase (% of IW)	Daily gain (kg)
<i>B. bovis</i>	182,45 ± 40,94	281,90 ± 42,26	99,45 ± 13,75	54,51	0,646
<i>B. bovis</i> + <i>B. bigemina</i>	170,55 ± 26,72	262,85 ± 31,67	92,30 ± 16,83	54,12	0,599
Control	180,89 ± 39,21	283,53 ± 41,71	102,63 ± 12,01	56,74	0,666

Period: 154 days; each group/20 bovines.

SD - Standard deviation; IW = Initial weight

Not significant (P < 0,05).



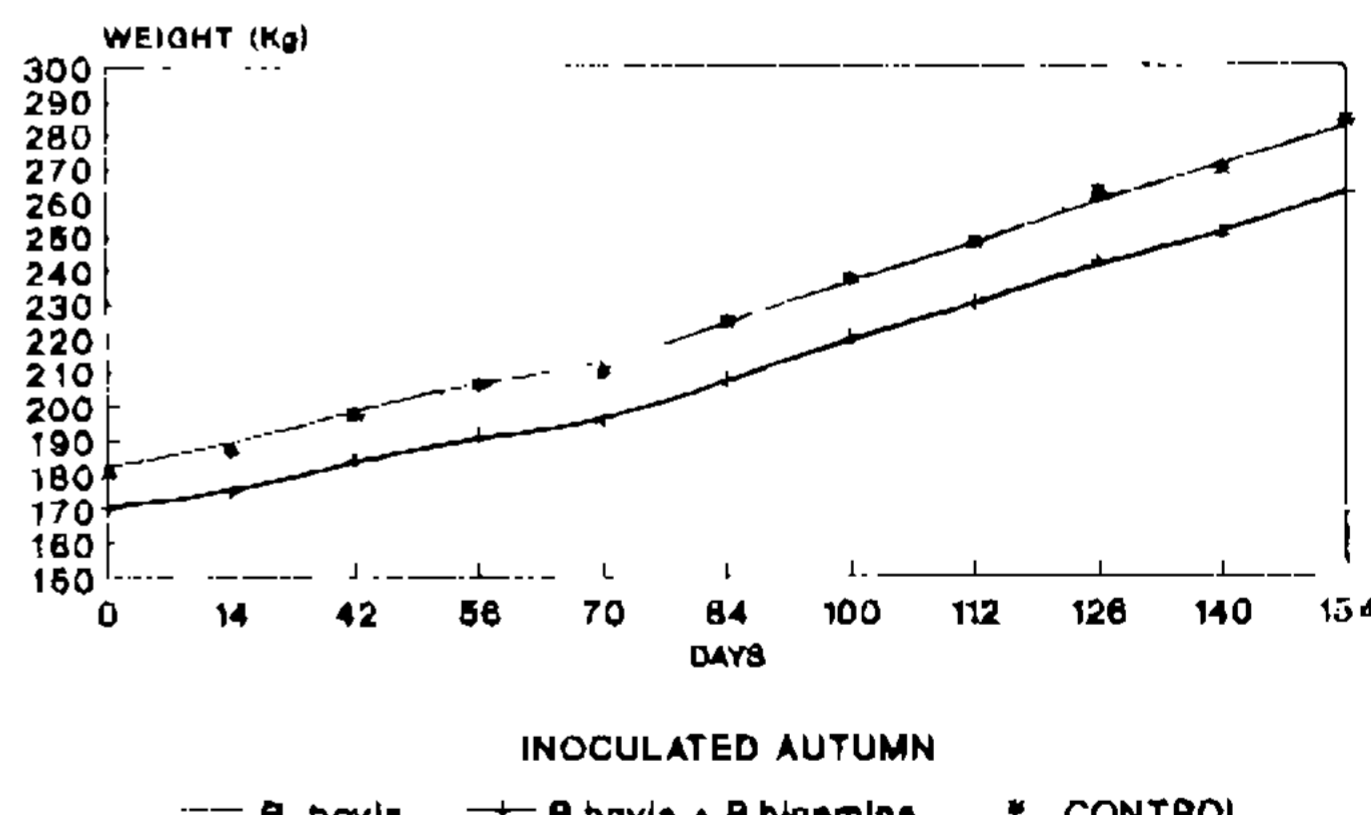
NOT SIGNIFICANT (P<0,05)

Fig. 3: livesweight gain on immunized hereford calves on natural pasture (period: 154 days).

Although there were variable performances amongst the different feeding levels, there were no differences between the inoculated and the control groups (Table III, Figs. 3, 4).

The second step on this study was what would happen with the immunized cattle when challenged with pathogenic strains.

Experiment 4



NOT SIGNIFICANT (P<0,05)

Fig. 4: livesweight gain on premunized hereford calves on improved pasture (period: 154 days).

Material and methods:

Objective: determination of the productive impact on cattle immunized with an attenuated alive vaccine challenged with a pathogenic *Babesia* spp.

Strain: *B. bovis*; Attenuated (1986). *B. bigemina*; Attenuated (1980). *Babesia* spp; from Salto, Uruguay.

Preparation of the vaccine: as Callow (1977) describes.

Challenge: all animals were inoculated with the same pathogenic field strain. One of the groups was vaccinated one year before challenged.

Condition: the cattle was in the same natural pastures at ratio 1,8 heifers/ha.

Sampling: cattle was weighted every 28 days.

Group	Age (months)	Bovines (n)	Experimental period (days)	Inoculation (I/M)
Infected	18	13	199	<i>Babesia</i> spp 22 * 10 ⁵ IE
Immunized and challenge	18	14	199	<i>Babesia</i> spp 22 * 10 ⁵ IE
Control	18	14	199	Normal E

E = Erythrocytes
IE = Infected erythrocytes

Animals aged 18 to 20 months were chosen in view that immunization is usually performed at the age 8-9 months.

Significant differences ($p < 0.05$) have been found amongst the groups after a 199 days period, the immunized animals gained 3.55% more weight than the controls (Table IV, Figs 5,6).

TABLE IV

Results of experiment 4 – Productive impact on heifers immunized and challenge with pathogenic *Babesia* spp in natural pastures

Group	Initial weight (X ± SD - kg)	Final weight (X ± SD - kg)	Increase (X ± SD - kg)	Increase % of IW)	Daily gain (kg)
Control	201,43 ± 16,19	274,71 ± 17,16	73,29 ± 10,94	36,38	0,368
<i>Babesia</i> spp Control	198,57 ± 28,20	254,64 ± 27,72	56,07 ± 13,49	28,24	0,280 (a)
Challenged <i>Babesia</i> spp Immunized	207,62 ± 15,41	263,62 ± 22,37	66,00 ± 13,35	31,79	0,330

Period: 199 days; each group/14 bovines.
SD = Standard deviation; IW = Initial weight.
a: Significant (P > 0.05).

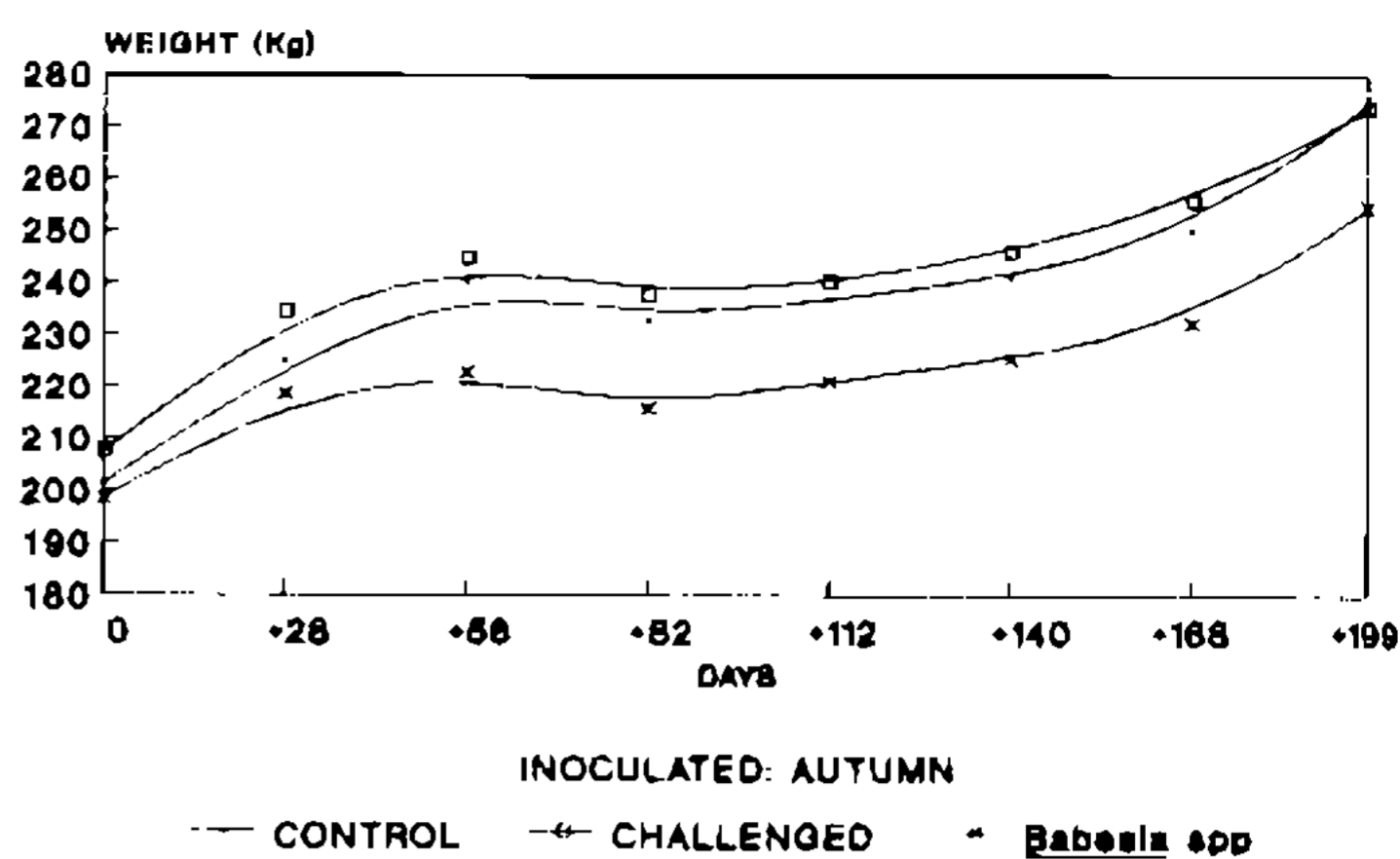
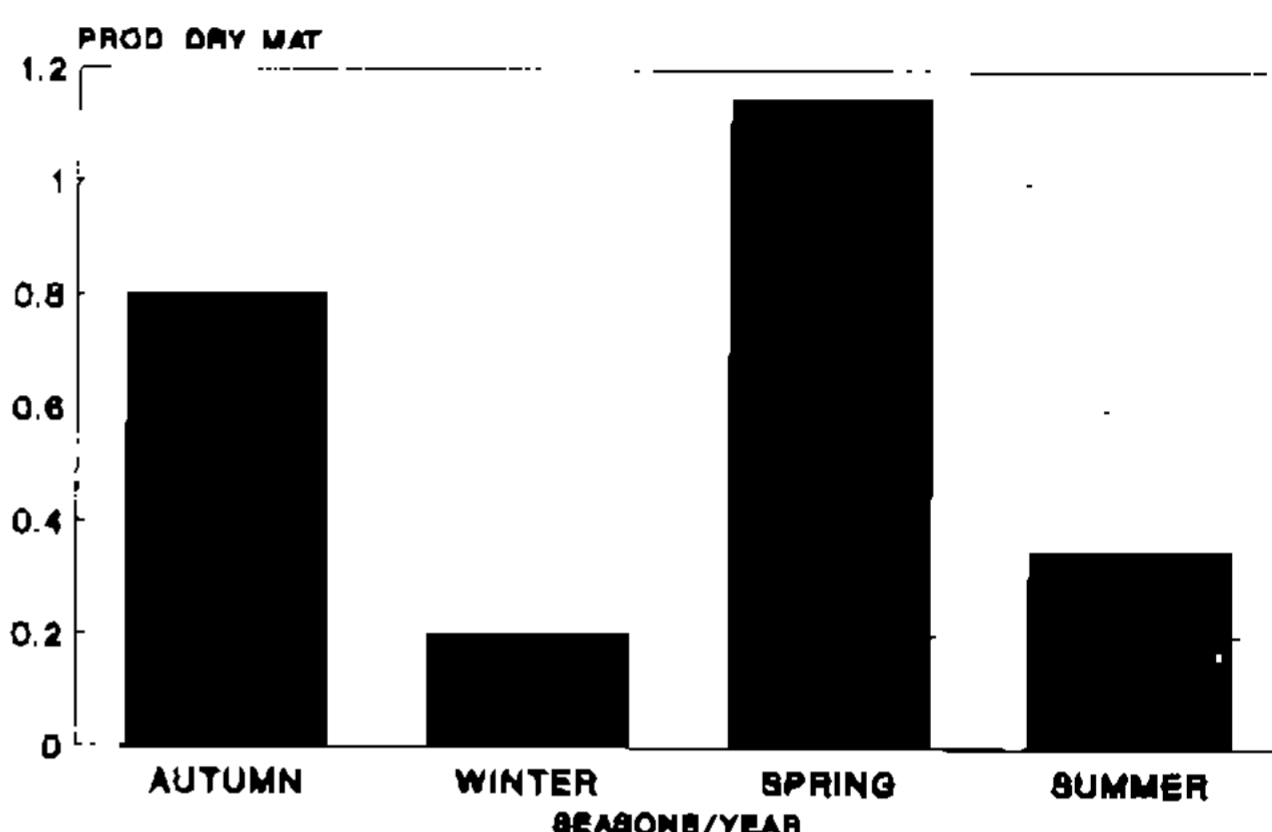


Fig. 5: productive impact on cattle immunized and challenged with pathogenic strain (period: 199 days).



FROM: CIAAB-MGAP; URUGUAY

Fig. 6: natural pastures in the different season eastern zone (total/year 2.5 ton/ha).

Looking at the weights in the wintertime, the difference is more notorious in the non immunized group.

COMMENTS

The general considerations of the conditions in which the assays have been performed are

based on epidemiological information and beef cattle production system (Nari & Solari, 1990; Cardozo et al. 1990): (a) It has been known for the last then years that 90% of the outbreaks have been caused by *B. bovis* and that they are sparsely distributed all over the country. (b) Serological results from farms show that there is a relatively high dispersion to the north of parallel 32,2° South Lat., (61,2-90,4%) with a low average prevalence (19,9-27,0%). (c) The seasonal incidence is evident; the outbreaks occur principally during autumn, (April-June), within the maximum infection challenged of *B. microplus* (F₃ generation). (d) The warm weather enables the area to produce beef with a variable availability of grass throughout the year (Fig. 6). (e) Births occur principally from September to November.

If these results are confirmed in different circumstances, with different strains and different quantity of doses, the current epidemiological treatment of the bovines in chronic stages could be reviewed in order to minimize losses.

CONCLUSIONS

(1) There is a negative effect of babesiosis on the livestock production.

(2) The weight gain decreased 3.33; 3.55 and 5% in 76, 199 and 140 days respectively, representing from 23 to 45% less in the increase comparable with the control weight gain group.

(3) There is no incidence of attenuated strain on weight gain.

(4) Significant differences were found between the immunized and the challenge control groups.

(5) It is necessary to complete these assays due to their importance as indicators in the evaluation of sanitary campaign against ticks.

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