



ALKOSEL[®]

The Pure Selenium Enriched Yeast Product
The Bioavailable *Selenomethionine*



Lallemand Animal Nutrition



- Selenium and Animal Nutrition

- ALKOSEL[®] - Trial Results

- Selenium's importance in animal nutrition *p3*
- Biochemical role of selenium *p4*
- Selenium, a varied soil distribution across the world *p5*
- Different forms of selenium available *p6*
- ALKOSEL[®] : a monitored manufacturing process *p9*
- Selenium bioavailability, an essential prerequisite *p10*
- ALKOSEL[®] : guaranteed analytical characteristics *P13*
- ALKOSEL[®] : inclusion rates *p14*



Alkosele - Ruminants

- Selenium's Importance in Animal Nutrition -

<i>Se Functions</i>	<i>Main Problems linked with a Selenium + Vitamin E Deficiency</i>
<ul style="list-style-type: none">• <i>Anti-Oxidative</i> Properties• <i>Immune</i> Function• <i>Reproduction</i> Function <p>✓ <u>A critical period</u> : Calving</p> <p>... even with high Vitamin E supplementation</p>	<ul style="list-style-type: none">➤ <u>Immunity</u> :<ul style="list-style-type: none">• Mastitis and somatic milk cell counts➤ <u>Fertility</u> :<ul style="list-style-type: none">• Placenta Retentions• Uterin Infections• Lower spermatic mobility➤ <u>Oxidation</u> :<ul style="list-style-type: none">• Myopathy : white muscle disease (NMD)<ul style="list-style-type: none">• Meat Quality (PSE)• Red blood cell weakness : Haemolytic Anaemias

(Lebreton et al., 1998)



Alkosele - Ruminants

- Biochemical Role of Selenium -

↳ Glutathion Peroxidase (GSH-Px) :

- ✓ Selenodependant enzyme,
- ✓ Essential antioxidant : catalyses the conversion of hydrogen peroxide and organic peroxides to water and alcohols.

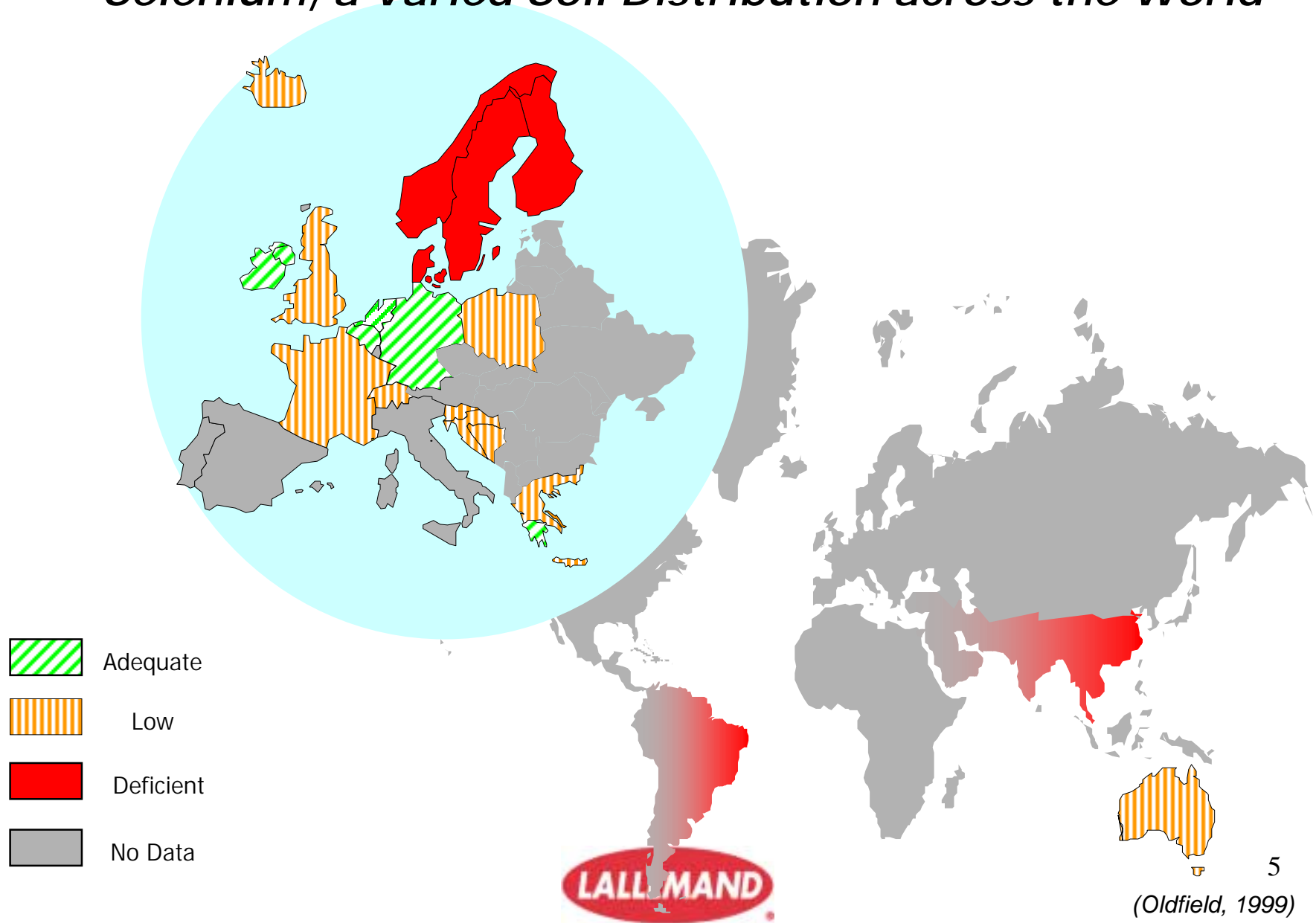
↳ Selenium (GSH-Px) and Vitamin E :

- ✓ Work synergetically to :
 - *Maintain cells integrity,*
 - *Prevent from free radicals formation.*
- ✓ Vitamin E prevents from polyunsaturated fatty acids oxidation whereas Selenium (GSH-Px) metabolises peroxides that are already formed.



Alkoseil - Ruminants

- Selenium, a Varied Soil Distribution across the World -



Alkosel - Ruminants

- Different Forms of Selenium Available -

↪ **Inorganic Forms** : Sodium Selenite (Na_2SeO_3)/Selenate (Na_2SeO_4)

- ✓ Low or no difference in the use of either selenite/selenate forms for specific selenoproteins synthesis,
- ✓ Commodity – Low differentiation – Low price – Almost systematic supplementation,
- ✓ Contested bioavailability : selenium surplus is excreted through the urine rather than stored in the tissues.
- ✓ High pulverulence causing inhalation dangers during workers' handlings in factories,
- ✓ Possible pro-oxidative properties of sodium selenite *in vivo*,
... that may result in an additional need of antioxidants for the animals and that may lead to potential oxidation problem during storage of premixes

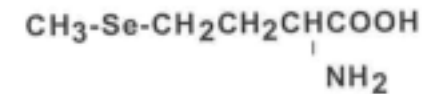
(Spallholz, 1994)



AlkoseL - Ruminants

- Different Forms of Selenium Available -

↪ **Organic Forms** : ALKOSEL® Mineral Enriched Yeast



Selenomethionine

- ✓ Selenium as Selenomethionine,
- ✓ Natural form encountered in crops and forages,
- ✓ No pro-oxidative properties,
- ✓ Higher bioavailability vs inorganic forms,
- ✓ Mammals are not able to distinguish classic methionine form from selenomethionine, which is thus incorporated within body proteins,
- ✓ Only available form of « protected » selenium.

Selenium is an anion, thus it is not possible to obtain a « selenium chelate», as amino acids are also negatively loaded.



Alkosel - General Aspects

- Supplementation Forms -



- **Forms of selenium** used to supplement foods and feeds are primarily the higher oxidation states of selenium while the **selenium present in plants** and of importance in nutrition contain selenium in the reduced state.

Selenium compounds important in nutrition

	Oxidation state	Compound
Most reduced	Se ⁻²	Selenomethionine
	Selenides	Selenocysteine
↓	Se ⁰	Amorphous Se
	Elemental Se	Red Se
		Gray Se
Se ⁺⁴	Selenite	Na ₂ SeO ₃ (selenite)
Most oxidized	Se ⁺⁶	Na ₂ SeO ₄ (selenate)

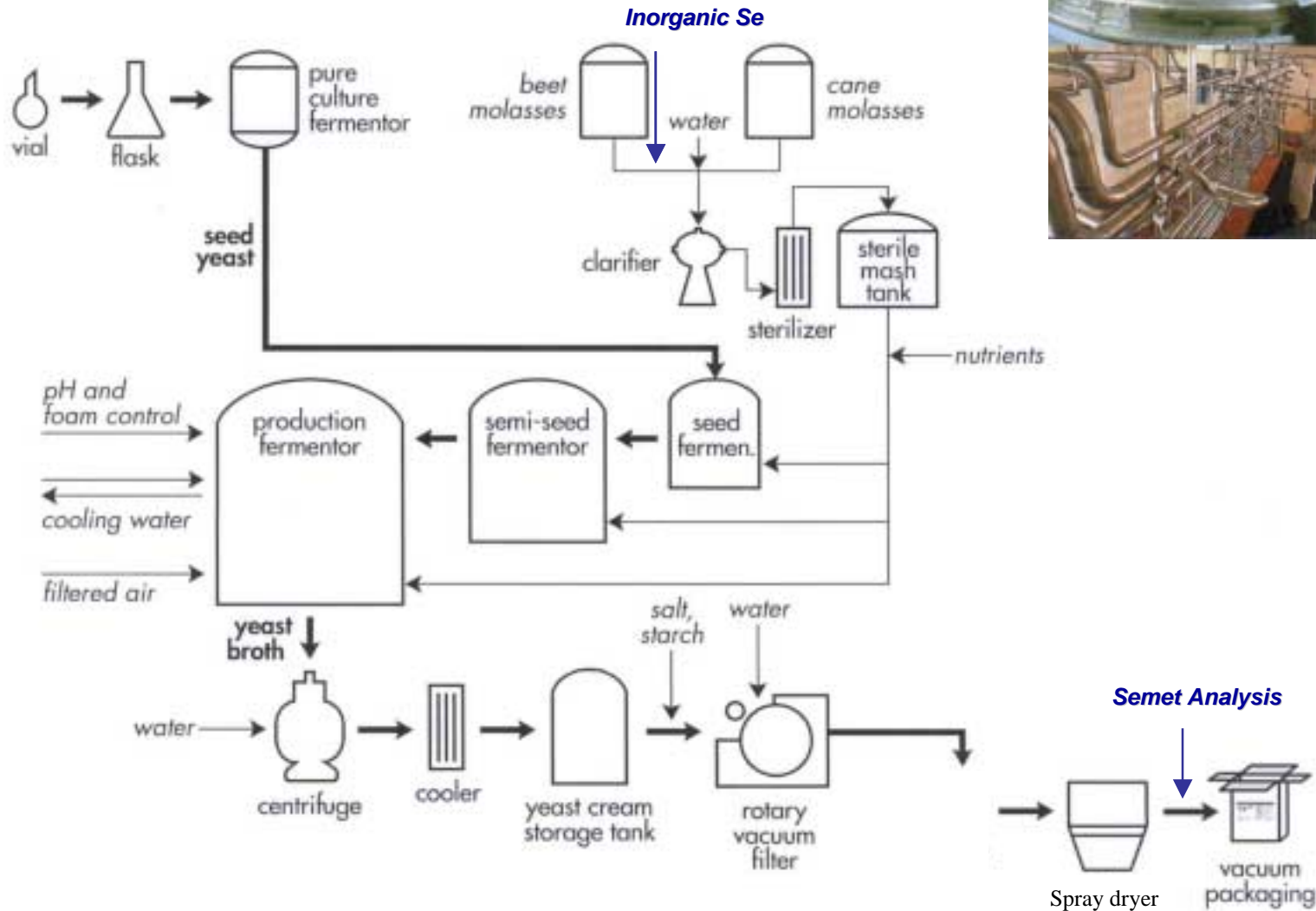
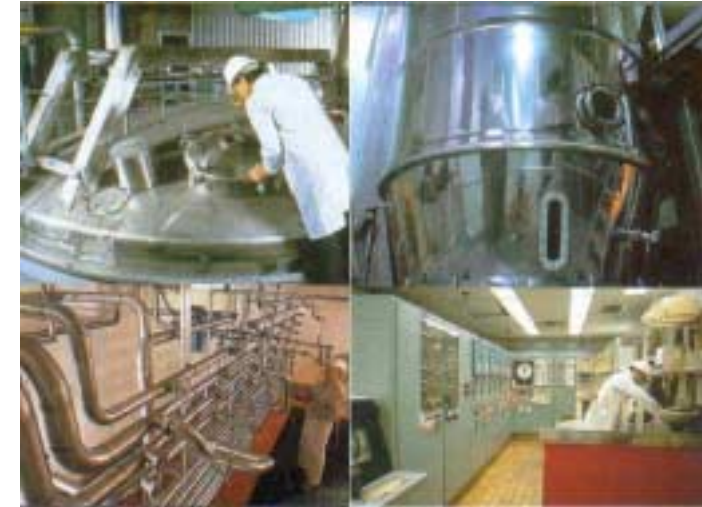
Adapted from Combs and Combs, 1986

- Inorganic selenium is highly oxidised while the **selenoaminoacids** in plants and **Alkosel** are very reduced.
- The **selenides** are more available to ruminants because they avoid reduction to unavailable forms by rumen microbes.
- **Availability of inorganic selenium** is further depressed by low rumen pH on high concentrate diets.



Alkosele - Ruminants

- A Monitored Manufacturing Process -



Alkosele - Ruminants

- Selenium Bioavailability, an Essential Prerequisite -

↳ Bioavailability Measured by:

- *GSH-Px activity in the blood,*

(Pehrson et al., 1989)

- *Se Concentration in the blood,*

(Malbe et al., 1995)

- *Se Concentration in milk and tissues,*

(Pehrson et al., 1994)

Correlation matrix for milk, blood and serum selenium (Se) concentrations and the activity of glutathione peroxidase (GSH-Px) in erythrocytes in 62 cows with milk selenium concentrations ranging between 7 and 33 µg/l.

	Milk Se	Blood Se	Erythrocyte GSH-Px	Serum Se
Milk Se	1.00	0.78	0.70	0.71
Blood Se	0.78	1.00	0.96	0.85
Erythrocyte GSH-Px	0.70	0.96	1.00	0.76
Serum Se	0.71	0.85	0.76	1.00

(Ortman, 1999)



Alkosele - General Aspects

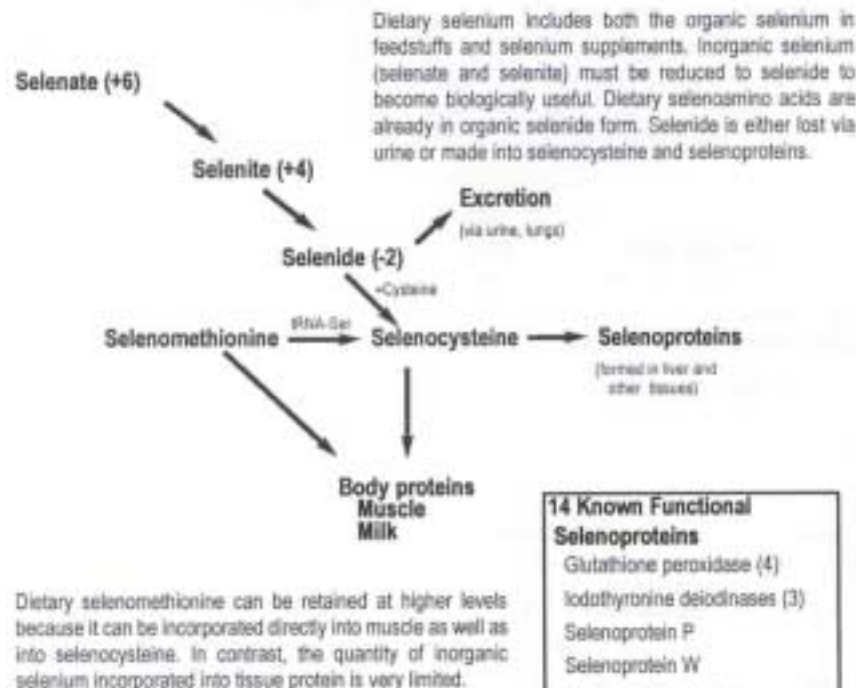
- Bioavailability -



- **Inorganic selenium** is passively absorbed from the small intestine while **selenomethionine** travels in the blood by

Biologically useful selenium forms:

- selenoproteins formed via selenocysteine
- selenoamino acids in body tissues



amino acid transport mechanisms and can either be transported to the liver for incorporation into selenoproteins or directly to other tissues for incorporation into tissue protein.

- **Organic selenium** is uniquely suited to metabolism because selenoamino acids can also be used for protein synthesis in muscle, mammary and other tissues. Tissue selenoamino acids will be recycled during cell turnover.

- Most of the **inorganic selenium** not used in selenoprotein formation is excreted in urine.

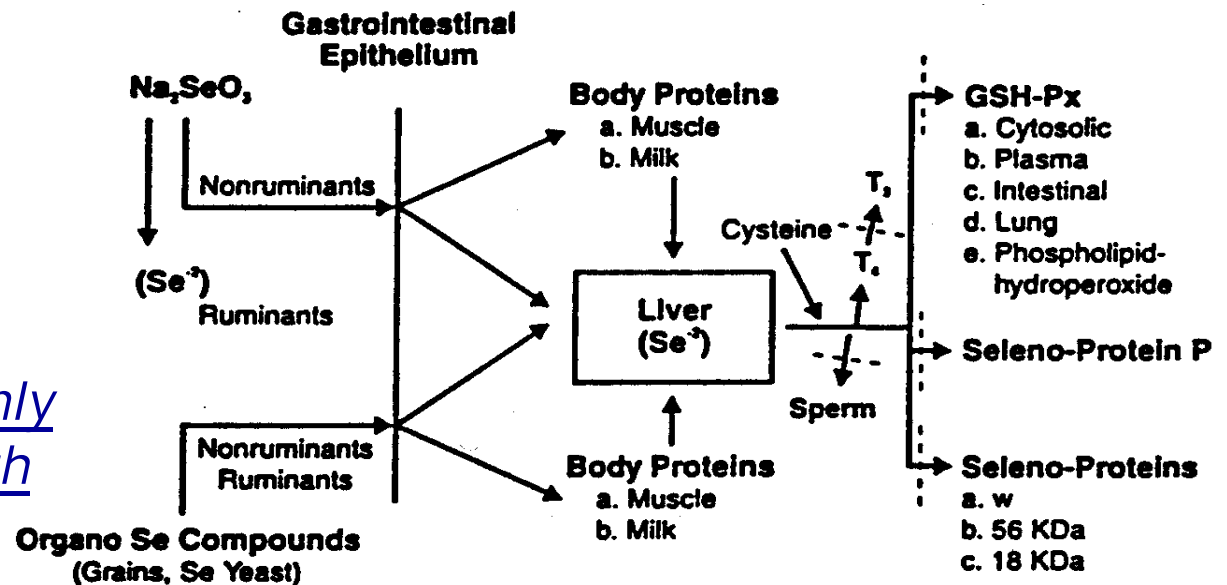


Alkosele - Ruminants

- A Higher Bioavailability of Selenium Yeasts -

In Ruminants :

- Part of *selenite* is transformed by rumen microbes into insoluble compounds which are only poorly absorbed through the intestinal tract.



Utilization of absorbed selenium. Dotted lines refer to where inadequacies will affect formation of the seleno-proteins.

(Nicholson et al., 1991)

- Bioavailability** of inorganic forms is particularly lowered in low pH ruminal conditions (high concentrate diets).

Alkosel - Ruminants

- *Guaranteed Analytical Characteristics* -

↪ Guarantees :

- ✓ Pure selenium enriched yeast product,
- ✓ Total Selenium : 1900-2400 ppm,
- ✓ Guaranteed Selenomethionine content : 2900-3500 ppm,
analysed for each manufacturing batch,
- ✓ Almost 70% of total selenium is from selenomethionine,
- ✓ Nutritional content : B-group vitamins, amino acids, ...

↪ Qualitative Analysis :

- ✓ Total Selenium content,
- ✓ Selenium Bound to the yeast (= Total Se - Soluble Se),
- ✓ Selenomethionine content.



Alkosel - Ruminants

- Inclusion Rates -

✓ *Maximum Se Inclusion Rate in EU : 0,5 ppm (total Se in finished feed)*



	<i>Concentration</i>	<i>Inclusion 0,3 ppm Se</i>	<i>Inclusion 0,4 ppm Se</i>	<i>Inclusion 0,5 ppm Se</i>
<i>Sodium Selenite 1%</i>	<i>10 000 ppm</i>	<i>30 g/ton</i>	<i>40 g/ton</i>	<i>50 g/ton</i>
<i>ALKOSEL®</i>	<i>2 000 ppm</i>	<i>150 g/ton</i>	<i>200 g/ton</i>	<i>250 g/ton</i>



- Selenium and Animal Nutrition

- ALKOSEL[®] - Trial Results

- ALKOSEL[®] - Ruminants : Positioning P16
 - ✓ *Positioning Dairy & Beef* P16
- ALKOSEL[®] - Ruminants : Bioavailability P18
 - ✓ *A higher bioavailability* P18
 - ✓ *A higher Selenium concentration in milk* P20
- ALKOSEL[®] - Ruminants : Milk Quality/Health of Calves P21
 - ✓ *A positive impact on milk quality and health status on calves* P21
 - ✓ *A positive impact on health status of calves* P23
 - ✓ *A positive impact on somatic milk cell counts* P24



AlkoseL - Positioning

- Dairy -



➤ Mastitis & Milk SCC :

- **Herd selenium status** is reflected in bulk tank SCC and incidence of subclinical mastitis. Selenium is needed for adequate activity of GSH-Px in phagocytic cells which fight intramammary infections.
- Infection of the mammary gland signals neutrophils and macrophages to leave the blood and enter the mammary tissue to locate the pathogens. Phagocytosis of the pathogen produce microbiocidal toxic O₂ metabolites.
- The **toxic radicals** are quickly neutralized by antioxidant enzymes including GSH-Px. An accumulation of toxins in the cell owing to selenium deficiency decreases killing ability.





Alkosel - Positioning

- Dairy & Beef -



➤ Reproduction :

- Reproduction ***selenium related problems*** such as retained placenta and other complications are associated with *poor reproductive performance* (CCI (IVV), service per conception,...).
- The aim is to ***improve herd selenium status***, allowing the cow to meet neonatal selenium needs without depleting her own reserves.
- The ***relationship of selenium to male fertility*** involves 3 different factors : antioxidant activity, sperm structure (reduced motility), testicular degeneration.

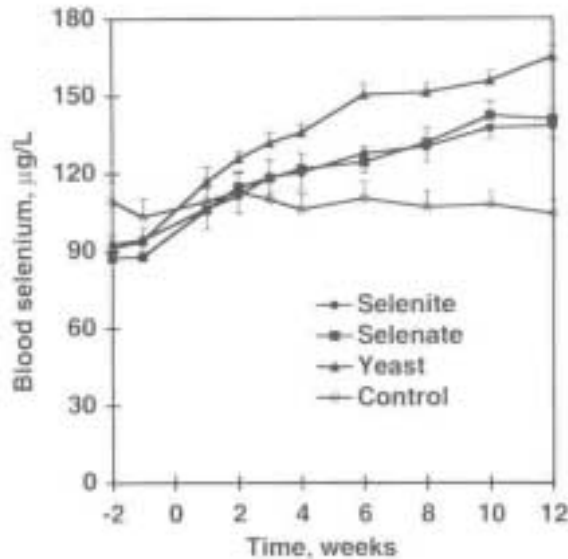
➤ Improving Calf Selenium Status :

- ***Higher selenium status to meet requirements*** bring about selenium related problems : weak or stillborn calves, white muscle disease, lack of resistance to cold, stress at birth.

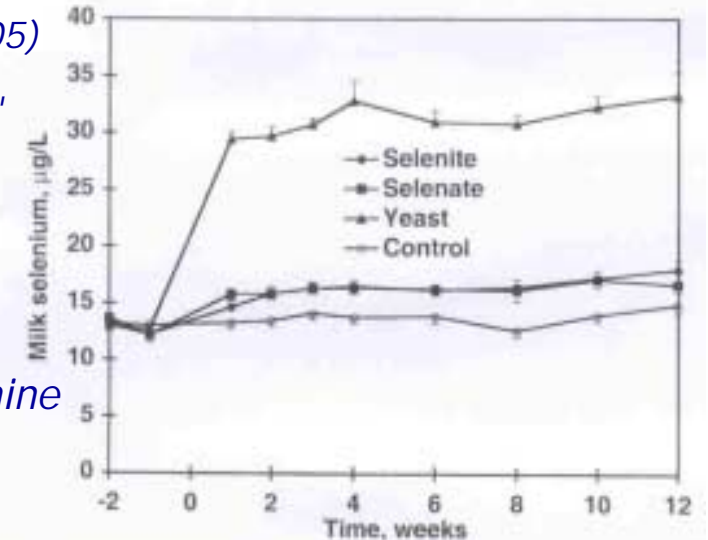


Alkosel - Ruminants

- A Higher Bioavailability -



- Significant difference ($p < 0,05$) in blood selenium concentration,
- Larger difference in the milk (Alkosel: +130%),
- Plateau reached after 1 week due to a possible substitution of methionine by selenomethionine within milk proteins.



Number of animals : 42 dairy cows, production : 9000 L/hd

Treatments : - Selenite : 0,24 - 0,31 ppm (DM)

(Feb-May) - Selenate : 0,24 - 0,31 ppm (DM)

- ALKOSEL : 0,24 - 0,31 ppm (DM)

- Control : 0,10 - 0,12 ppm (DM)

Homogenization : No Se supplementation Sep-Feb

(Se in feed = 0,10-0,12 ppm)

Measures : - Blood samples,

(Week 1,2 before suppl., week 1,2,3,4,6,8,10 et 12 after suppl.)

- Milk samples.

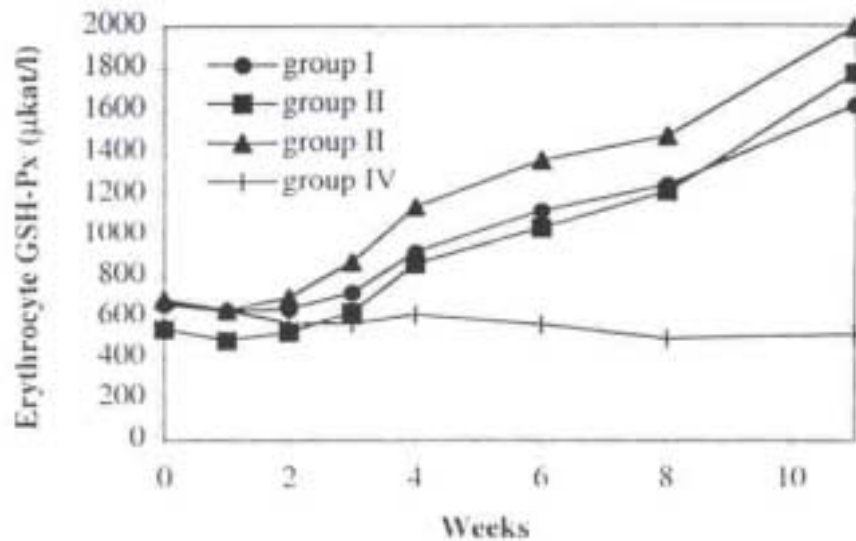
(same frequency)

(Ortman et al., 1996)



AlkoseL - Ruminants

- A Higher Bioavailability -



- GSH-Px activity significantly increased in all supplemented groups.
- The reduced trial duration can partly explain the fact that we did not reach a plateau.
- GSH-Px activity in erythrocytes permit to measure *long-term Selenium status*.

Number of animals : 24 dairy heifers,

Treatments : - I - Selenite : 0,25 ppm (DM)

(Feb-May) - II - Selenate : 0,25 ppm (DM)

- III - ALKOSEL : 0,25 ppm (DM)

- IV - Control : 0,03 ppm (DM)

Homogenization : No Se supplementation Sep-Feb

(Se in feed = 0,03 ppm)

Measures : - Blood samples,

(Week 1,2 before suppl., week 1,2,3,4,6,8 et 11 after suppl.)

(Ortman et al., 1996)

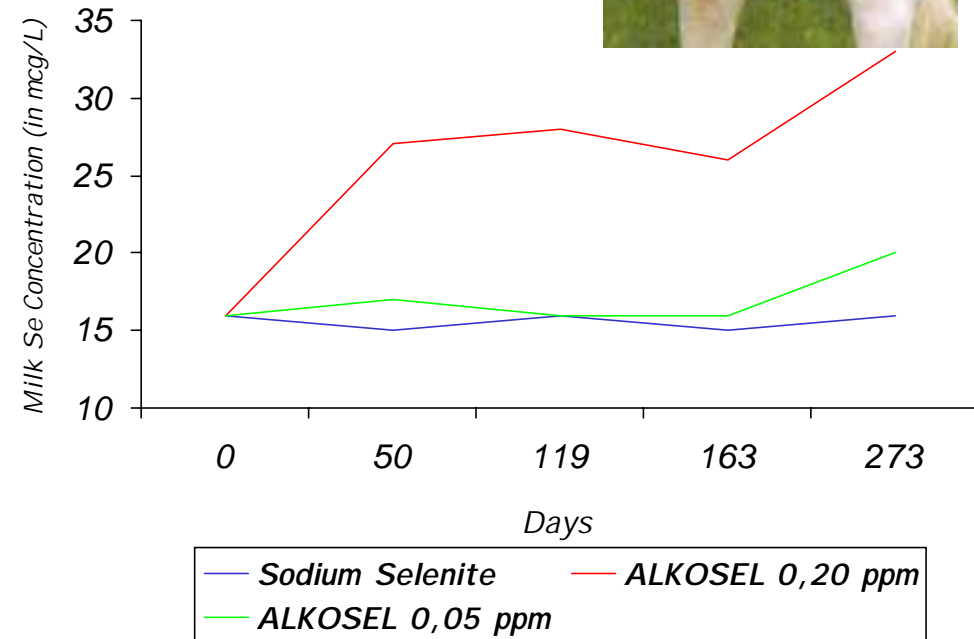


Alkosel - Ruminants

- An Improved Selenium Concentration in the Milk -



- Milk Se level is clearly superior in the **Alkosel** group and even for a *low dose* of 0,05 ppm.
- Aspila (1991) mentioned that *milk for human consumption should at least contain 20 µg of Se per Kg of milk*. Such a concentration is easily obtained by using an organic selenium source.



Number of animals : 24 dairy cows,

Treatments : Se in basic diet = 0,15 ppm (DM)

- (Nov-Sep)
- Selenite : 0,20 ppm ie 0,35 ppm total
 - ALKOSEL : 0,20 ppm ie 0,35 ppm total
 - ALKOSEL : 0,05 ppm ie 0,20 ppm total

Homogeneization : No Se supplementation

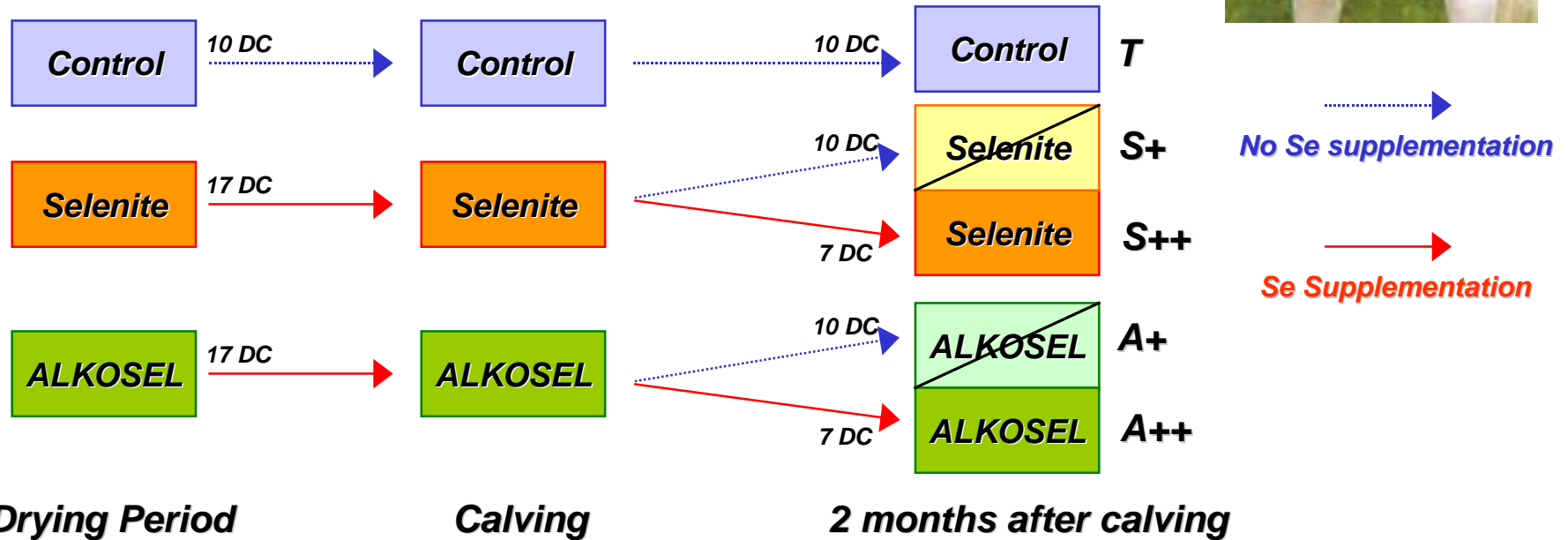
Measures : - Blood samples,
(d0, d50, d119, d163 and d273)
- Milk samples
(same frequency)

(Pehrson., 1994)



Alkoseel - Ruminants

- Milk Quality / Health of Calves -



Number of animals : 44 dairy cows,

Treatments : - Control : 0 Se

(Nov-May) - Selenite : 0,20 - 0,23 ppm (DM)

- ALKOSEL : 0,08 - 0,105 ppm (DM)

For each treatment, DC are separated into 2 groups after calving

Homoqeneization : No Se supplementation

Measures : - Blood samples,
(calving, 2 months after calving)

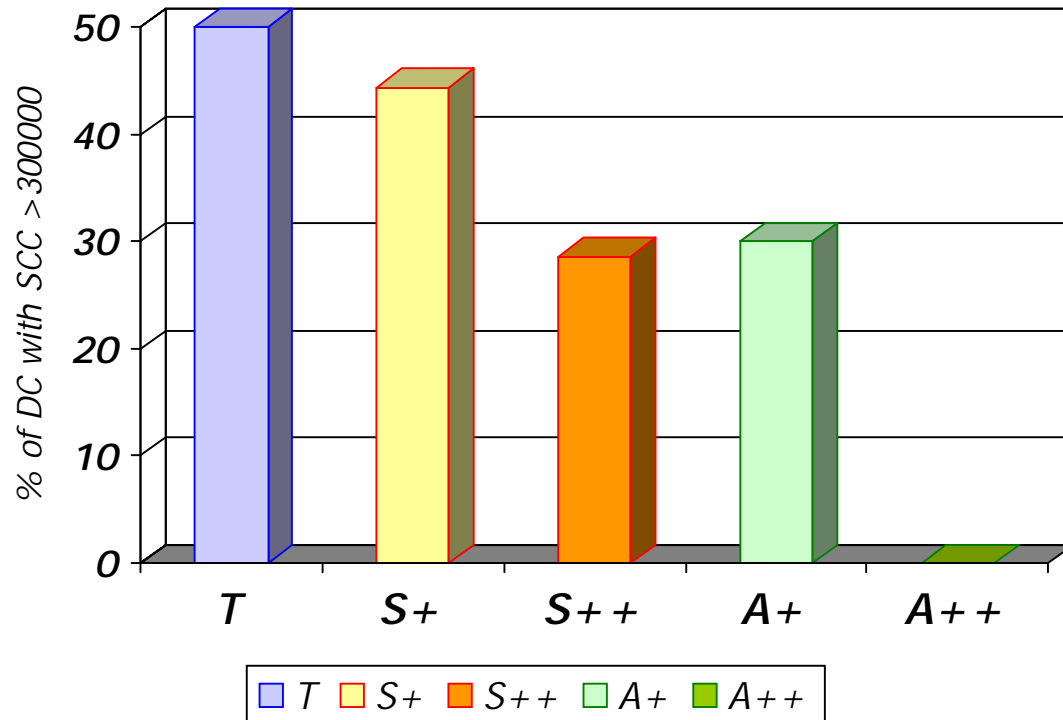
- Evaluation of health status
(vigor, weight, myopathies, diahreas at birth, d20, d40)

- Evaluation lactation parameters
(production, mastitis)



AlkoseL - Ruminants

- A Positive Impact on Somatic Milk Cell Counts -



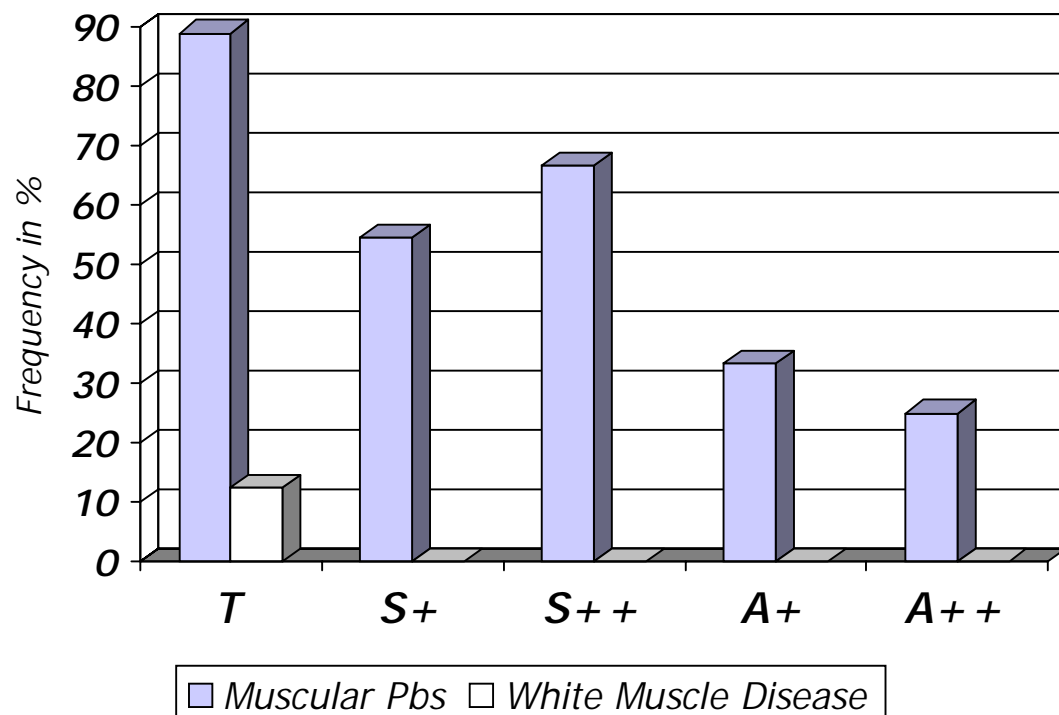
- This trial showed a *significant influence* of **selenium** supplementation on somatic milk cell counts.
- In the **AlkoseL** group during all the trial period, *no animal* had a somatic cell count >300 000.

+ : Se supplementation from drying period to calving
++ : Se supplementation from drying to 2 months after calving



Alkosel - Ruminants

- A Positive Impact on Health Status of Calves -



- A Se supplementation markedly decreases risks of white muscle disease break out and gravity of subclinical muscular affections.

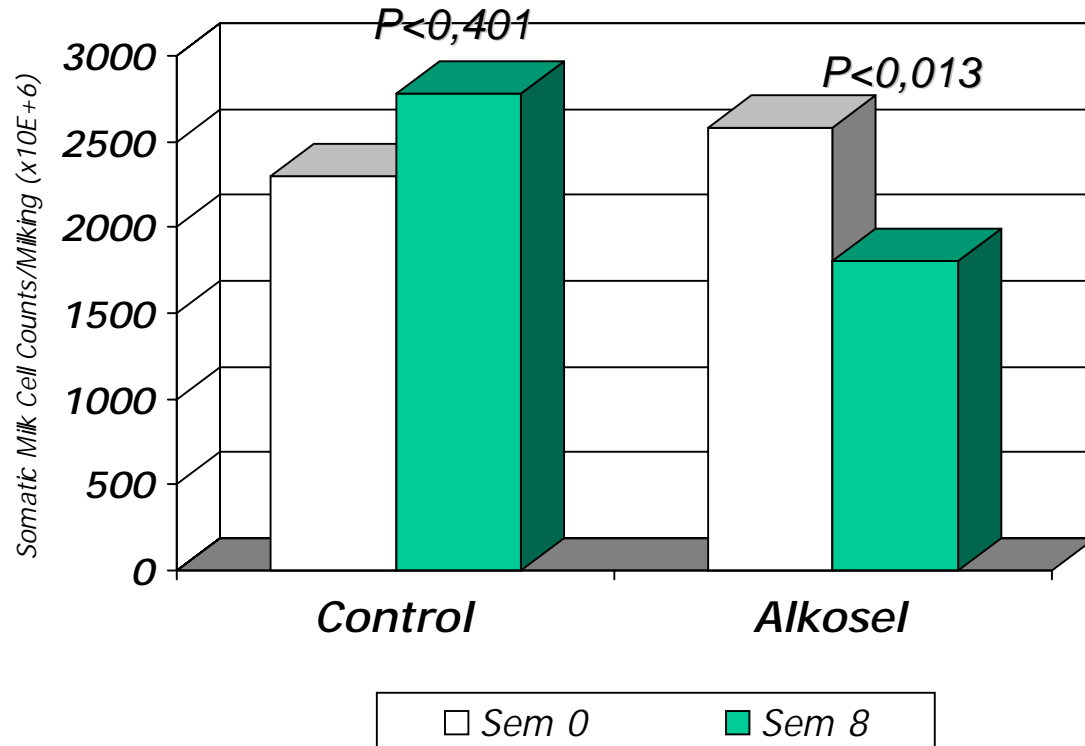
+ : Se supplementation from drying period to calving

++ : Se supplementation from drying to 2 months after calving



Alkosel - Ruminants

- A Positive Impact on Somatic Milk Cell Counts -



- This trial showed a significant influence of selenium supplementation on somatic milk cell counts.
- Corrected effects according to individual milk production (difference in milk production during the end of lactation phase).

Number of animals : 100 mid lactating DC (calving March-April)

Measures : - Milk and Blood Analyses,
(week0, week1, week2, week4, week8, week14, week18, week26)

Treatments : - Control : 0 Se

(Oct-March) - ALKOSEL : 0,20 ppm (DM)

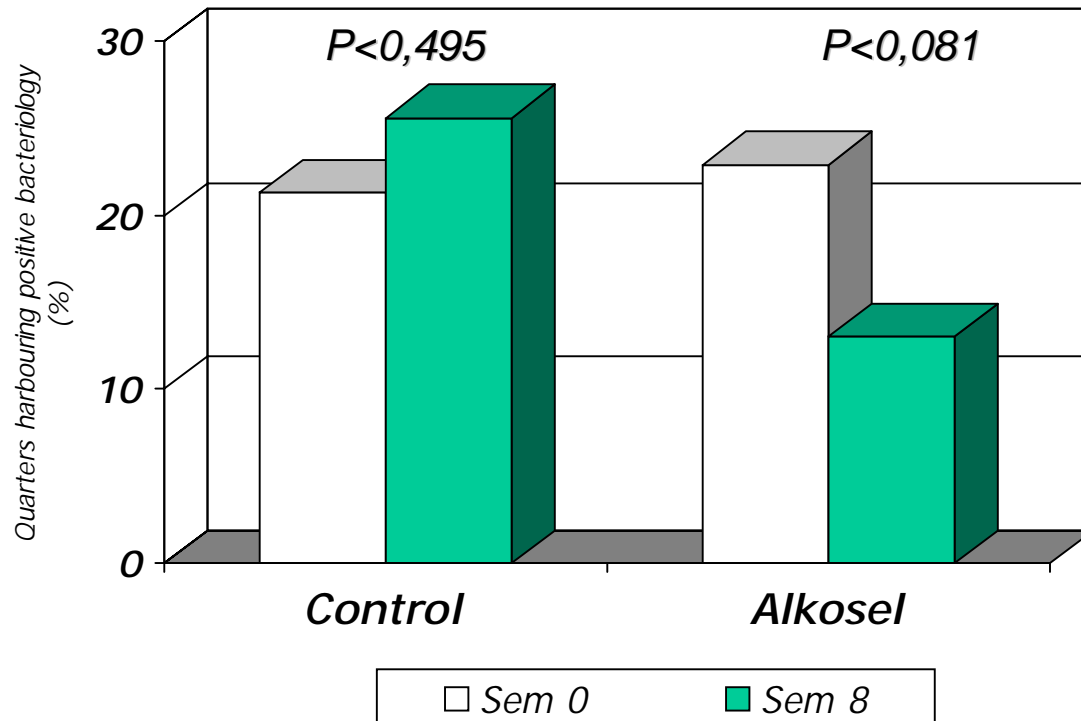
- Milk Quality Parameters
(neutrophil functions, somatic milk cell counts, bacteriology, ...)

(Malbe et al., 1995)



Alkosel - Ruminants

- A Positive Impact on Somatic Milk Cell Counts -



- At the beginning of the trial, 21% of quarters were infected. *Staphylococcus aureus* was isolated on 29% of positive quarters and *Streptococci* on 75% of cases.
- This trial showed a significant influence of selenium supplementation on bacteriology.

Number of animals : 100 mid lactating DC (calving March-April)

Measures : - Milk and Blood Analyses,
(week0, week1, week2, week4, week8, week14, week18, week26)

Treatments : - Control : 0 Se

(Oct-March) - ALKOSEL : 0,20 ppm (DM)

- Milk Quality Parameters
(neutrophil functions, somatic milk cell counts, bacteriology, ...)

(Malbe et al., 1995)

