# Dairy Goat Co-operative (N.Z.) Ltd

PO Box 1398, Hamilton, New Zealand
Telephone 07 839 2919 Fax 07 839 2920 Website www.dgc.co.nz

## POLYAMINES

Polyamines are low molecular weight polycations. They are structurally flexible and due to their positive charge, they can interact and form ion pairs with negatively charged ions.

Polyamines are produced by living cells from unicellular and multicellular organisms. They are synthesised from two amino acids (L-ornithine and L-methionine). They include putrescine, spermidine and spermine. Putrescine is a precursor to spermidine and spermine.

Being produced by cells, polyamines are found in plants, animals and as a consequence in foods. Dietary polyamines can contribute to the polyamine body pool.

### 1. Polyamines in human milk

Human milk and other mammalian milks contain high levels of polyamines (mainly spermine and spermidine, much less putrescine). Polyamines form a part of the non protein nitrogen fraction of milk. In human milk, polyamine concentrations increase during the first weeks and reach a maximum after one to two weeks, after which the levels decline. [1]

Studies have shown important individual variabilities in polyamine concentrations. Many factors can influence the composition of milk including genetic factors, nutritional status, amount of dietary polyamine intake, environmental factors, bacterial contamination, etc. [1]

Cow's milk appears to have lower polyamine contents compared to human milk. One reason for this is the high rate of polyamine degradation from enzyme activities (diamine oxidase and polyamine oxidase). [1]

### 2. Absorption of exogenous polyamines and possible importance

In a study carried out by Bardocz et al (1995), the uptake of exogenous polyamines appeared to be linearly dependent on the total input.

After 1hour intragastric intubation, the proportions of polyamines shown in the following table were found in the small intestinal tissue or were absorbed into the body of rats.

| | In the small intestinal tissue | Into the body |
|---|---|---|
| Putrescine | 4 – 12 % | 35 – 43 % |
| Spermidine | 8 – 13 % | 34 – 44 % |
| Spermine | 4 – 10 % | 23 – 31 % |

Two thirds of the putrescine absorbed was converted into non polyamine compounds and only 11-15% was recovered as putrescine. In contrast, most of the spermidine (79-82%) and spermine (72-74%) remained in the form given.

After absorption it was observed that the distribution of polyamines was not even, and was likely to reflect their metabolic activity.

Although cells are able to synthesise polyamines, it is possible that polyamines from the diet may be important in supplementing endogenous levels in times of rapid growth and development. In particular situations, an exogenous supply may be necessary. However, this area is not well yet understood.

## 3. Polyamine roles and functions

Polyamines are important constituents of all mammalian cells. Some of the roles and functions of polyamines are listed below:

1- They are essentially involved in **cell growth** and **differentiation**. They are involved in the regulation and stimulation of DNA, RNA and protein synthesis. They are also mediators of the action of hormones and growth factors. [5]

2- Polyamines interact with different components of the cell membrane, modulating the membrane functions and decreasing its fluidity. In addition, it can modulate various intra cellular messengers [1]. More recently it has been suggested that polyamines, especially spermine, may be a natural antioxidant protecting cells from oxidative damage [6].

3- It is also thought that polyamines may play a role in **the prevention or reduction of sensitisation to food allergens**. [3]

Two main aspects have been further investigated. They include the effects of polyamines on the gastrointestinal and the immune systems.

Effect on growth and maturation of the gastrointestinal mucosa [4]

Polyamines exert various direct and indirect trophic effects and play an important role in relation to the growth and maturation of the gastrointestinal mucosa.

For rapid dividing tissues such as the intestinal epithelium, exogenous sources of polyamines supplied by food or the microbial flora are potentially important.

Oral administration of exogenous spermine or spermidine has been shown to induce a marked acceleration of mucosal maturation and proliferation in young rats. These results prove the effect of dietary polyamines on intestinal growth and development. However, doses used were high in comparison to natural levels found in rat milk.

Similarly, the oral administration of 1g of yeast (*Saccharomyces boulardii*) to human volunteers showed an increase in microvillus enzyme activities after 5 days. This dosage corresponds to a daily oral intake of 6.7 umol of polyamines.

It is suggested that the daily intake for infants from human milk of 3.5 umol (700ml per day with an average of 500 nmol/100ml of polyamines) could be potentially biologically active. However further studies are warranted to determine the activity of milk polyamines on the intestinal growth and epithelial permeability of infants.

Role in preventing or reducing sensitisation to food allergens [3]

The appearance of food allergy is linked to factors such as genetic predisposition, intestinal permeability and maturity of the immunological system.

Based on information from animal and human studies, it is thought polyamines may play a role in preventing or reducing sensitisation to food allergens by influencing the intestinal permeability and the intestinal immune system.

It has been shown for example that oral spermine and spermidine can induce maturation of the intestine, modify histological aspects of the epithelium and intestinal permeability to macromolecules.

A human epidemiological study also identified that allergy incidence in children was:

- high if the mean spermine level in milk was less than 2 nmol/ml
- close to zero if the mean spermine level was > 13 nmol/ml

## KEY POINTS

1. Polyamines are present in human milk.
2. Polyamines are important for cell growth and differentiation. They can affect the growth and maturation of the intestinal mucosa. They may also play a role in preventing or reducing sensitisation to food allergens.
3. Polyamines from the diet may be important in supplementing endogenous levels. However, further research is required to investigate the role and dose effects of polyamines from foods and the potential benefits in increasing their levels in IFs to mimic those of breast milk.

**References:**

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