# Endocrine and metabolic traits in goat kids around weaning

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**ABSTRACT:** Eleven Saanen kids, three days after birth, were divided into two groups: WEAN and MILK. All kids were fed goat milk until the 5th week of age, when the WEAN group began a weaning protocol. MILK group continued to receive goat milk for the entire experimental period, while WEAN group was weaned at 47 days of age. Starting from the 3rd week of age, body weight was recorded and blood samples were taken weekly, before the first meal of the day. Plasma was analysed for glucose, total protein, free aminoacid, insulin, leptin and ghrelin. Weaning did not affect plasma levels of total protein and leptin, but decreased plasma glucose and free aminoacid, and increased ghrelin concentration. Moreover, weaning decreased plasma insulin level more than three times. This result was probably the consequence of the lower concentration of plasma glucose of the WEAN group, but the effect could be enforced by the milk-borne insulin ingested by the MILK kids with the diet. Goat milk contains peptides that can pass across the intestinal epithelium and enter the systemic circulation, suggesting a possible role in accomplishing the immature ability of suckling animals to produce hormones and growth factors.

**Key words:** Weaning, Kids, Insulin, Metabolic traits.

**INTRODUCTION** – Weaning is the stage of life in which mammals change from milk to other sources of nourishment; diet shifts from a mixture of casein, lactose and triglycerides to much more elaborated components. This exchange needs adaptation in digestive activity (Kinouchi *et al*., 2000); for example starch is a new entry and requires the secretion of novel digestive enzymes. Furthermore, the transition to the solid diet is often a crucial moment that can affect growth (Mc Cracken *et al*., 1995), maturation of the reproductive tract (Lawrence *et al*., 2005) and even the quality of the end products (Schoonmaker *et al*., 2002).
For all these reasons, it is worth of interest to evaluate the nutritional and physiological status of weaning kids, in order to prevent or limit those factors that can interfere with the complete expression of the productive potential of farm animals. The knowledge of the endocrine and metabolic asset at the time of weaning could also help to remove those environmental stressors that can alter animal development and welfare.

**MATERIAL AND METHODS** – Three days after birth, eleven Saanen kids were assigned to one of two groups of equal average body weight: WEAN (5 animals) and MILK (6 animals). All kids were fed colostrum until 3 days of age and then goat milk until 4 weeks of age. Starting from the 5th week to the 6th week of age, WEAN group was fed decreasing quantity of milk plus a weaning mixture ad libitum, while MILK group continued to receive goat milk; on day 47 milk was completely withdrawn from WEAN group diet.
Weaning mixture was made of permanent pasture hay and a concentrate which included maize, beet pulp, soybean meal, sunflower seed and mineral/vitamin supplement. Milk and weaning mixture analysis is reported in table 1. During the experimental period, feed intake was recorded every day.
From 21 to 50 days of age, body weight of all kids was recorded and blood samples were taken weekly, before the first meal of the day. Plasma was analysed for glucose and total protein (Giesse Diagnostics Snc – Roma, Italy) and free aminoacid (Goodwin, 1968) with spectrophotometric methods, insulin (Dia Sorin Spa, Saluggia – VC, Italy) and leptin (Multispecies Leptin, Linco Research Inc, St. Charles – MO, USA) by RIA, and ghrelin (Total Ghrelin, Diagnostics System Laboratories Inc., Webster – TX, USA) by ELISA. Data were analyzed by analysis of variance.

Table 1. Analysis of the two experimental diets.

| | Goat Milk | | | Weaning Mixture | |
|---|---|---|---|---|---|
| | as fed | on Dry Matter | | as fed | on Dry Matter |
| Dry Matter (%) | 12.23 | | Dry Matter (%) | 88.81 | |
| Protein (%) | 3.22 | 26.3 | Crude Protein (%) | 15.6 | 17.5 |
| Fat (%) | 3.61 | 29.5 | Ether Extract (%) | 5.36 | 6.04 |
| Lactose (%) | 4.73 | 38.6 | Starch (%) | 16.7 | 18.8 |
| Gross Energy (KJ/g) | 2.72 | 22.2 | Gross Energy (KJ/g) | 16.1 | 18.2 |

**RESULTS AND CONCLUSIONS** – Dry matter intake began to differ in the 6th week of age (P<0.01 in week 7), when WEAN kids progressively began to ingest the weaning mixture (Figure 1). This difference can be explaned by the difficulty of the WEAN group to accept the new diet. On the contrary, no difference has been observed in body weight between the two groups, but the weight of WEAN kids could be overestimated by the presence of feed in the rumen.

Plasma level of total protein was not affected, but the weaning protocol decreased significantly overall means of plasma glucose (6.55 vs. 6.90 mmol/l, P<0.05) and free aminoacid (4.89 vs. 5.27 mmol/l, P<0.001, WEAN and MILK group, respectively). Even greater differences in plasma metabolites were observed on week 7 of the experimental period (Figure 2). These results could be the consequence of the higher availability of nutrients of the milk diet.

Figure 1. Dry matter intake.

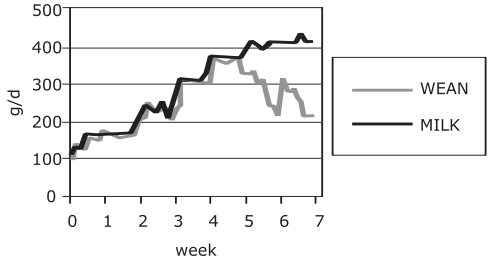



Figure 2. Plasma levels of metabolites on week 7.

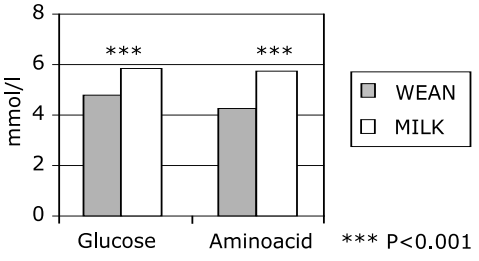
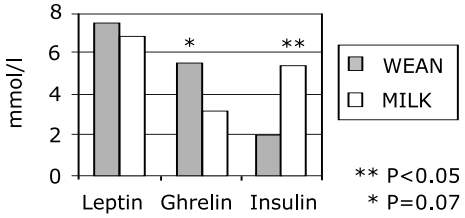



Figure 3. Plasma levels of hormones on week 7.




Plasma level of leptin was not different between groups (Figure 3). Leptin is a metabolism modifier that plays a crucial role in coordinating food intake, energy expenditure and nutrient utilization (Houseknecht *et al*., 1998). For this reason, we expected a decrease in plasma leptin level in WEAN group at the time of weaning, in accordance with the decrease of dry matter intake. However, also Tokuda et al., in a recent experiment on lambs (2003), have not observed differences in plasma leptin concentration between pre- and post-weaning.

Otherwise, weaning on week 7 increased (P=0.07) plasma level of ghrelin (219 vs 123 pmol/l in WEAN and MILK group, respectively) (Figure 3). Ghrelin is a hormone that can affect feeding behaviour as stimulator of

food intake (Kojima *et al.*, 2005) and, in normal conditions, its level increases during fasting (Toshinai *et al.*, 2001); therefore this result could be the consequence of the reduced dry matter intake of the WEAN group at weaning time. Finally, weaning on week 7 decreased more than three times plasma insulin level (Figure 3). This difference is probably due to the lower concentration of plasma glucose in WEAN group (Figure 2), but the effect could be enforced by the intake of milk-borne insulin by means of the diet in MILK kids.

Insulin is naturally present in goat milk and its amount, in mid lactation, is about 272 ± 25 pmol/l (Magistrelli *et al.*, 2005). At the end of the experiment, on week 7 of life, MILK kids assumed about 1000 pmol of insulin per head, daily, and this ingestion could be responsible - together with the major glucose concentration - for the higher level of this hormone in the plasma of sucklings. Moreover, in suckling rat it has been demonstrated that insulin added to milk replacer increased plasma level of insulin (Kinouchi *et al.*, 1998).

Milk-borne peptides can pass across the gastro-intestinal mucosa (Gonnella *et al.*, 1987) and enter the systemic circulation via a receptor-mediated process (Xu et al., 2000; Blum *et al.*, 2002). This transfer suggests a possible role for milk bioactive molecules in accomplishing the immature ability of the suckling animals to produce hormones and growth factors. In particular, a high level of plasma insulin, just before weaning, seems to act as a stimulatory factor of pancreatic amylase gene expression (Kinouchi *et al.*, 1998).

In conclusion, weaning can affect plasma glucose, aminoacid, ghrelin and insulin level. The effect on plasma insulin could be the consequence of the interruption of milk-borne insulin ingestion. Anyway, further studies are needed in order to clarify the possible effect of milk peptides on the development of young animals, around weaning.

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