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# Voluntary salt (NaCl) intake in Standardbred horses

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**Summary**

The voluntary salt (NaCl) intake from individual salt blocks was investigated during two different feeding regimes. Eight Standardbred geldings (5–10 years) were fed either two times per day or six times per day for 25 days in a change over design. The salt intake was measured daily by weighing the salt blocks. The horses performed intensive exercise (interval training) or were transported to a track to perform a simulated 2140 m trotting race (11–12.5 m/s) almost every seventh day. The total salt intake in these horses was 19 ± 8 g when fed two times per day and 14±5 g when fed six times per day. There were no increase in salt intake in connection with exercise. The amount of salt ingested did not even cover the estimated maintenance requirement and shows that the voluntary intake of salt from salt blocks is not a reliable route to compensate for salt losses in the exercising horse.

**Keywords:** horses, salt intake, sodium, exercise, salt block

**Die freiwillige Kochsalzaufnahme beim Traber**

Im Zeitraum von April bis Juni 1995 wurde die freiwillige Kochsalzaufnahme mittels eines Salzlecksteines unter verschiedenen Fütterungsbedingungen bei acht Traberwallachen im Alter von 5 bis 10 Jahren untersucht. Der Versuch war als Cross-Over-Design angelegt. Die Tiere wurden über einen Zeitraum von 25 Tagen entweder zweimal (alle 12 Stunden) oder sechsmal (alle 4 Stunden) pro Tag gefüttert. Sie erhielten im Mittel 7 kg Heu und 4 kg Kraftfutter, dem 10% Kochsalz zugesetzt waren. Die Pferde wurden dreimal pro Woche leicht bewegt, alle sieben Tage fand ein intensives Intervalltraining oder ein simuliertes Trabrennen über eine Distanz von 2140 m bei einer Geschwindigkeit von 11–12,5 m/s statt. Die tägliche Salzaufnahme wurde durch Wiegen des Lecksteines gemessen.
Bei einer zweimaligen Fütterung betrug die Salzaufnahme im Mittel 19±8 g pro Tag, bei sechsmaliger Fütterung 14±5 g. Die Salzaufnahme stieg bei Belastung durch Training und Rennen nicht an, die tägliche Salzaufnahme deckte nicht einmal den Erhaltungsbedarf der Pferde. Daraus wird geschlossen, daß die freiwillige Aufnahme von Kochsalz über Salzlecksteine keine zufriedenstellende Möglichkeit ist, um Salzverluste durch Belastung beim Pferd auszugleichen.

Schlüsselwörter: Pferde, Salzaufnahme, Natrium, Belastung, Salzleckstein

## Introduction

Many animals, especially herbivores, have a behavioural drive to seek and ingest salt (sodium chloride) during periods of sodium deficiency. In addition, their voluntary sodium intake seems to be closely matched to their sodium losses *(Denton,* 1982). Sodium is the main osmotic component of the extracellular fluid (ECF) and therefore the most critical electrolyte for blood volume regulation. In the pony about 50% of the total body sodium content is present in bone tissue and the rest in the ECF with 10% in the alimentary tract *(Lindner* et al., 1984). Part of the sodium in the skeleton is exchangeable with the fluid compartments and may also be available to maintain plasma sodium concentration and thereby the volume of ECF. However, in the short term the internal sodium concentration is regulated mainly by fluid shifts. A lowering of the extracellular sodium content will force water out of the ECF and reduce plasma volume. An increase in the extracellular sodium content results in an opposite shift, causing cellular dehydration *(Andersson,* 1978). Sodium balance is hormonally regulated by aldosterone and atrial natriuretic peptide (ANP). Aldosterone is the sodium saving hormone in the body and causes reabsorption and absorption of sodium in the kidney and the alimentary tract. The exact actions of ANP are still uncertain but it has been shown to cause natriuresis (*de Bold*, 1985).
The maintenance requirement of sodium have been calculated by *Meyer* (1987) from the endogenous losses and the utilisation rate in ponies. The calculated maintenance amount in a 500 kg horse is 10 g of sodium per day. In the exercising horse, the sodium in- and output is often unbalanced, due to a low content of sodium in the diet and a large excretion of sodium in the sweat *(Carlson* and *Ocen,* 1979; *Kerr* and *Snow,* 1983). The horse has a considerable capacity of reducing urinary sodium losses both at rest *(Tasker,* 1967) and in connection with exercise *(Jansson* et al., 1995). In spite of that, it is necessary to add sodium to the diet even during resting conditions since the content in the feed is very low. The sodium content of Swedish grass hay is less than 0.6 g/kg DM and of oats less than 0.1 g/kg DM *(LBS,* 1985). One of the most common ways of supplying salt to horses is by a salt block. This might look like an optimal source, giving the horse a free choice. However, the mechanisms behind the appetite for sodium is not yet fully understood and it has been shown that the taste of salt per se can cause a temporary inhibition of salt appetite *(Denton,* 1982).
From practical experience, exercising horses seem to have a low voluntary salt intake from salt blocks. Therefore, the aim of the present study was to investigate if Standarbred horses in training consume enough salt from salt blocks to cover not only their maintenance requirement but also the extra salt losses caused by sweating.

### Materials and methods

This study took place at The Swedish Academy of Trotting and Thoroughbred Racing in Örebro, which is responsible for the education of apprentices in Sweden. The observations reported here are part of a study where the effect of different feeding frequencies on fluid balance and digestion were investigated. The horses were fed two different feeding frequencies for 25 days in a change over design, either two times per day (every 12th hour, 05.30 and 17.30) or six times per day (every fourth hour, 05.30, 09.30, 13.30, 17.30, 21.30 and 01.30). Eight Standardbred geldings (5–10 years) were used. They were kept individually in boxes during the experiment. A salt block (99 % NaCl) was placed in each box and salt intake was measured by weighing the salt block every afternoon during 25 days on each feeding regime. The salt block was attached to a plastic holder which was mounted on the box wall. The salt block and the holder were never separated, minimising the risk of salt losses during the weighing. The horses were fed according to the Swedish recommendations of energy and protein supply per 100 kg BW for hard working horses (*LBS*, 1985). The diets corresponded to an intake of 7.4±0.3 kg of grass hay and 4.1±0.2 kg of concentrates per day. There were some differences in the foodstuffs included in the diet to individual horses, since the diets were composed by the apprentice in charge of each horse. The concentrate was predominantly oats but in most horses 1 kg of the oat was substituted by smaller amounts of bran, soya bean meal and/or molassed sugar beet pulp. The contribution of sodium from the feed was negligible. However, depending on the differences in diet composition a mineral feed had to be given with the concentrate to four of the horses to regulate their dietary Ca:P ratio. The contribution of salt from the mineral feed (10% NaCl) to individual horses is shown in Table 1. Water was offered ad libitum from buckets.

Tab. 1: Total daily intake of salt (from a salt block and from a mineral feed) and the amount of salt obtained from the mineral feed in four of the eight horses.

| | | Feeding frequency, Meals per day: 2 times | | 6 times | |
|---|---|---|---|---|---|
| Horse and weight | (kg) | Total salt intake (g/day) | Salt intake from mineral feed (g/day) | Total salt intake (g/day) | Salt intake from mineral feed (g/day) |
| W | 462 | 13 | 7 | 13 | 7 |
| RS | 432 | 9* | – | 10 | – |
| CW | 412 | 10 | 10 | 10 | 10 |
| CD | 430 | 31 | 10 | 19 | 10 |
| MK | 437 | 10 | 7 | 10 | 7 |
| WS | 519 | 5 | – | 3 | – |
| SB | 462 | 5 | – | 4 | – |
| LS | 456 | 72* | – | 45 | – |
| Mean±SE | | 19±8 | | 14±5 | |

* Performed no races during this treatment.

The horses were kept in paddocks for some hours per day and were exercised two to three times per week causing some sweating on the neck and under the tack. The horses performed intensive exercise (interval training) or were transported to a track to perform a simulated 2140 m trotting race (11–12.5 m/s) almost every seventh day. Before the interval training and the races the horses had an intensive „warm up" over 5 km. Once on every feeding regime, the horses were weighted before and after the race. The ambient temperature during these two races were 11°C and 24°C, respectively. The study took place between April and June in 1995 and during this period the average ambient temperature per 24 hours increased from 10 to 16°C.

Data were analysed by Statistical Analysis Systems, GLM procedure (*SAS Institute Inc.*, 1985). All values are presented as means with their standard errors (± SE).

## Results

The average daily salt consumption was 19±8 g (7±3 g sodium) when the horses were fed two times per day and 14±5 g (5±2 g) when they were fed six times per day (Tab. 1). Six of the eight horses had a daily salt intake which corresponded to less than 50 % of the estimated maintenance requirement of sodium and two of these horses consumed only one fifth of the estimated requirement. There were great individual variations in salt intake with two horses licking salt with comparatively good appetite, especially when fed two times per day. Whether the salt block was the only source of salt or if some additional salt was offered by a mineral feed did not influence the total amount of salt intake (Tab. 1). The weight loss after the races were 12±3 kg when fed two times per day and 13±4 kg when fed six times per day, indicating a substantial sweat loss. There was no increase in salt intake in connection with the simulated races (Fig. 1). Due to hoof and joint injuries two of the horses did not perform any races when fed two times per day.

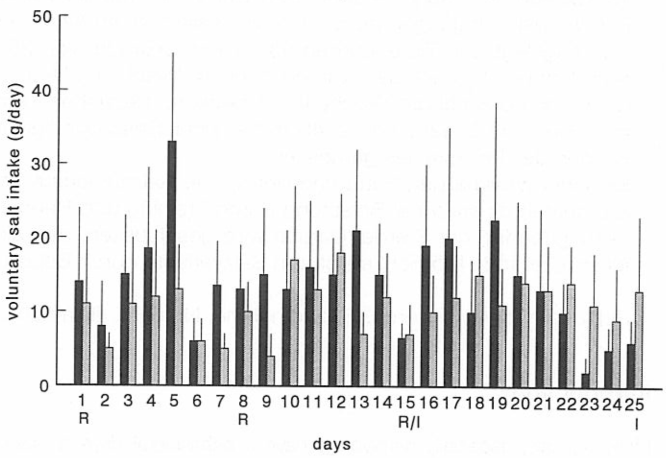


Fig. 1: Daily salt intake from a salt block (mean±SE) in eight Standardbred horses when fed either two times per day (black bars) or six times per day (striped bars). Days where the horses performed interval training or a simulated trotting race are marked with I and R, respectively.

## Discussion

Our study shows that exercising horses do not compensate for their salt losses by increased salt intake, at least not when offered salt from salt blocks. On average, the intakes corresponded to 55–75% of the maintenance requirement of 10 g sodium (26 g salt) calculated by *Meyer* (1987). In a study by *Tasker* (1967) the daily endogenous sodium losses was measured to 3 g for horses with a body weight of 450 kg. With these low endogenous losses reported by *Tasker* (1967) the average salt intake in the present study was enough to meet the maintenance requirement, but not to compensate for the losses during exercise. However, there was no apparent increase in salt intake in connection with exercise. The low salt intake could be due to a lack of an efficient salt appetite in exercising horses. On the other hand, the taste of salt have been shown to reduce salt appetite in both rats and sheep (*Nachman* and *Valentino*, 1966; *Denton*, 1982). According to *Denton* (1982), taste aversion may be an important factor for reduced sodium intake in sheep when ingesting solutions with high sodium concentration (900 mmol/l). Therefore, we suggest that licking concentrated salt suppressed salt appetite in the horses studied here before their physiological need was reached. Another explanation may be that the time it would take to ingest the salt needed from a salt block, is so long that the horses give up. If the latter is true, feeding loose salt could be an interesting strategy to increase the voluntary salt intake in athletic horses.

In this study the weight loss was not divided into sweat, faecal and respiratory water losses. The sweat production causes the main weight loss but the respiratory water loss have been estimated to account for about 10% of the total fluid loss during exercise *(Hodgson* et al., 1993). In an experimental study with Standardbred trotters, using a similar exercise programme as in the present study, the fluid loss was 8.0±0.5 kg and the sodium loss about 30 g *(Jansson* et al., 1995). The horses in that study were offered 38 g of salt (15 g sodium) with the feed every day. This resulted in a drop in plasma sodium concentration on the first day of recovery and a total urinary sodium retention for two days post exercise. However, when the horses were loaded with saline (90 g NaCl in total) before the exercise, these changes did not occur. From that study it could be calculated that to avoid a lowering of plasma sodium concentration and maintain a positive urinary sodium excretion, at least 75 g of salt should have been consumed on exercise days. A similar effect on sodium balance after supplementation with NaCl prior to exercise has also been reported by *Coenen* et al. (1995). Comparing the salt intake in the earlier study *(Jansson* et al., 1995) with the intakes in the present study it is likely that many of the horses here may have been sodium deficient since only one horse consumed more than 38 g of salt per day. In a study by *Lindner* et al. (1983) where Shetland ponies had a daily sodium intake less than 5 mg/kg body weight, clinical signs like restlessness, licking, decreased cutaneous turgor, swallowing problems and reduced food and water intake were seen when exercise had been performed regularly for 20 days. In addition, the post exercise plasma volume was decreased, but there were no significant differences in heart rate and body temperature during exercise. The sodium intake in these Shetland ponies corresponded to a salt intake of 6.5 g in a 500 kg horse and indicates that the two horses with the lowest salt intake in the present study must have been sodium deficient. These two individuals had depressed feed appetite and were thin and bony but seemed not to have any problems with exercise performance. Sodium deficiency can lead to hypovolemia and cellular hypervolemia *(Andersson,* 1978). The deteriorating effect of decreased circulatory volume on work capacity has been investigated in humans *(Saltin,* 1964), but to our knowledge it is not known in detail what circulatory adjustments a reduced plasma volume will cause in the horse.

In the short term there will be no compensation for the extracellular sodium losses within the body *(Jansson* et al., 1995). However, in the long term these losses must be prevented to avoid circulatory disturbances. In a study on sodium depletion in ponies it was shown that the greatest relative reduction of sodium content was in the ingesta, the blood and the muscle tissue. However, the skeleton had the largest absolute loss *(Lindner* et al., 1984). It can not be considered acceptable that the athletic horse has to mobilise sodium from the muscle tissue or the skeleton in order to compensate for salt losses.

It is interesting to note that two of the horses which showed a comparatively good salt appetite consumed almost the double amount of salt when they were fed only two times per day. In addition, one of these horses was not performing any races during this period. In a study by *Schryver* et al. (1987), twelve unexercised horses consumed more than 50 g salt per day from a salt block even though their diet contained more salt than their maintenance requirement. This shows that horses can have an overconsumption as well as a minimised intake when salt is offered from salt blocks.

In conclusion: Exercising horses do not regulate their salt intake, at least not when offered salt from salt blocks. Therefore, it is recommended to include salt in the diet.

**References**


*Andersson, B.* (1978): Regulation of water intake. Physiological Reviews 58, p. 582–603

*de Bold* (1985): Atrial natriuretic factor: a hormone produced by the heart. Science 230, p. 767–770

*Carlson, G. P.* and *Ocen, P. O.* (1979): Composition of equine sweat following exercise in high environmental temperatures and in response to intravenous epinephrine administration. J. Equine Med. Surg. 3, p. 27–32

*Coenen, M., Meyer, H.* and *Steinbrenner, B.* (1995): Effects of NaCl supplementation before exercise on metabolism of water and electrolytes. Equine Vet. J. Suppl 18, p. 270–273

*Denton, D.* (1982): The hunger for salt. Springer-Verlag Berlin Heidelberg, first ed.

*Hodgson, D. R., McCutcheon, L. J., Byrd, S. K., Brown, W. S., Bayly, W. M., Brengelmann, G. L.* and *Gollnick, P. D.* (1993): Dissipation of metabolic heat in the horse during exercise. J. Appl. Physiol. 74, p. 1161–1170

*Jansson, A., Nyman, S., Morgan, K., Palmgren-Karlsson, C., Dahlborn, K.* and *Lindholm, A.* (1995): The effect of ambient temperature and saline loading on changes in plasma and urine electrolytes ($Na^+$, $K^+$) following exercise. Equine Vet. J., Suppl 20, p. 147–152.

*Kerr, M. G.* and *Snow, D. H.* (1983): Composition of sweat of the horse during prolonged epinephrine infusion, heat exposure and exercise. Am. J. Vet. Res. 44, p 1571–1577

*LBS* (1985): Hästens foder. (Feeding horses.) Lantbruksstyrelsens rapport. (Report from the Swedish ministry of agriculture) 5

*Lindner, A., Schmidt, M.* and *Meyer, H.* (1983): Investigations on sodium metabolism in exercised Shetland ponies fed a diet marginal in sodium. Equine Exercise Physiology. Eds: *Snow, D. H., Persson, S. G. B.* and *Rose, R. J.* Granta Editions, Cambridge, p. 310–317

*Lindner, A., Schmidt, M., Meyer, H.* and *Teleb, H. M.* (1984): Veränderungen des intestinalen sowie intermediären Wasser- und Elektrolytstoffwechsels bei Pferden mit chronischen Natriummangel. Z. Tierphysiol. Tierernährung. u. Futtermittelkde. 52, p. 155–170

*Meyer, H.* (1987): Nutrition of the equine athlete. Equine Exercise Physiology. Ed: *Gillespie, J. R.* and *Robinson*, N. E. ICEEP Publications Davis, California, p. 644–673

*Nachman, M.* and *Valentino, D. A.* (1966): The role of taste and post-ingestional factors in the satiation of sodium appetite in rats. J. Comp. Physiol. Psychol. 62, p. 280–283

*Saltin, B.* (1964): Circulatory response to submaximal and maximal exercise after thermal dehydration. J. Appl. Physiol. 19, p. 1125–1132

*SAS Institute Inc.* (1985): Sas User's Guide: Statistics. SAS Institute Inc., Cary, NC, USA

*Schryver, H. F., Parker, M. T., Daniluk, P. D., Pagan, K. I., Williams, J. Soderholm, L. V.* and *Hintz, H. F.* (1987): Salt consumption and the effect of salt on mineral metabolism in the horse. Cornell Vet. 77, p. 122–131.

*Tasker, J. B.* (1967): Fluid and electrolyte studies in the horse. III Intake and and output of water, sodium, and potassium in normal horses. Cornell Vet. 57, p. 649–657



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