



NUTRIFAX

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Water and Electrolyte Balance in the Performance Horse



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“You can lead a horse to water but you can’t make him drink” is a saying that has been used for years to portray the stubbornness of the horse. But in the heavily sweating horse this has nothing to do with stubbornness, but rather the water and electrolyte balance of the horse. This Nutrifax discusses the importance and balance of water and electrolytes in the performance horse, as well as deficiency prevention.

Why is Water so Important?

Although it is often overlooked in horse nutrition, water should be considered the first limiting nutrient as a horse will die of thirst before starvation. The horse’s body is composed of approximately 65% water. So, a 500 kg horse is approximately 339 litres of water! Water is required for many different body functions, such as blood circulation, muscle function, digestion, cleansing the body of waste and toxins, skin elasticity and cooling the body. Water is distributed into the intercellular (inside the body’s cells) and the extracellular (fluid surrounding the cells) compartments of the body. The extracellular fluid includes blood plasma, interstitial fluid (fluid that flows in the microscopic areas between cells) and fluid in the digestive system. Two-thirds of the total body water is contained in the extracellular compartment. The large intestine acts as a water reservoir and can hold approximately 60 litres of fluid, which is utilized during endurance type exercise.

Water consumption is affected by several factors, such as ambient temperature, body condition, exercise, feed quality, health, stage of lactation and dry matter intake. It is also affected by water loss from the body, such as through feces, urine, respiratory gases and sweat.

Water intake is proportional to dry matter intake, but the composition and digestibility of the diet can also have an effect. Horses generally consume 37-45 L water (3-7 L/100 kg bodyweight) on a daily basis. A greater part of the horse’s water requirements are met through the consumption of feed, since feed will contain some water. Horses consuming lush pasture will receive the majority of their water needs from the grass.

Fibre intake affects water requirements because plant fibre is less digestible and has a higher water capacity, which results in greater fecal water loss. Horses consuming all-hay diets drink substantially more than horses fed a diet containing a large amount of concentrate or a complete pellet diet. Three litres of water are generally needed for every kg of food consumed for effective digestion. Fibre intake also affects the plasma volume in the blood. The consumption of large amounts of forage signals water in the interstitial space of the body to move into the gut, resulting in lower blood plasma volume. Sodium concentrations increase when the blood plasma volume decreases, which triggers the horse to drink water.

Body condition also has an influence on water intake. Horses with higher body fat will drink less water because fat contains less water than protein. Hence, horses with optimal body conditions will consume greater amounts of water.

Dehydration Symptoms

Dehydration occurs when the horse's body loses excessive amounts of water. It can lead to impaction colic, hindgut acidosis, gastric ulcers and reduced feed intake. The degree of dehydration can be divided into three groups: mild dehydration (5-7% water loss), moderate dehydration (8-10% water loss) and severe dehydration (>10% water loss).

The most common test used to determine the hydration status of a horse is the skin pinch test. As the horse becomes dehydrated, the skin loses its elasticity due to the loss of water. If the skin is pulled up or tented in a well hydrated horse, the skin will snap back to the pre-pinch position in less than one second. The best place to perform the skin pinch test is at the point of the shoulder, which has a consistent tension in the skin. To perform the pinch test, take a fold of skin between the thumb and forefinger, lift it away from the underlying tissues, slightly twist and release (Figure 1). A skin fold that remains for over two seconds indicates dehydration. A delay of 5 seconds is serious and a veterinarian should be consulted immediately. It is important to know the normal skin pinch result of your horse as there can be variation due to age and breed. Older horses tend to lose the natural elasticity in the skin so it can take longer for the skin to return to its normal position. It is also important to test the same area of the skin each time to maintain consistency of the results.

Figure 1: Skin pinch test on a horse to determine its hydration status (King & Ecker).



Capillary refill time is another method used to evaluate the extent of dehydration. Firmly press your thumb against the horse's gums. After quickly removing the pressure, you can observe the time it takes for the pinkish colour of the gums to return to the white spot made by your thumb. Normal colour refill time is one second or less, longer times indicate dehydration.

Mild dehydration symptoms include a decrease in the skin turgor, or a skin pinch test result of more than two seconds. Moderately dehydrated horses will have sunken eyes, lack of luster of the outer surface of the cornea and depression. A severely dehydrated horse will have sticky or dry oral mucous membranes (nose and mouth), the inside of the eyelids are bright red, cold extremities (ears and legs), lack of sweating, increased

respiration and an elevated heart rate. An elevated heart rate may also be a symptom of another cause, such as pain. Severe dehydration can also result in shock and death.

A case of mild dehydration can be easily corrected by offering water and electrolytes, which is discussed later in this article. Horses with moderate to severe dehydration status should receive prompt veterinarian care. Oral or intravenous administration of fluids and electrolytes will be used, depending on the severity of dehydration.

Electrolytes

During exercise, the horse will sweat to remove the excess heat, a byproduct of work. Sweating helps cool the body, but also causes electrolyte loss. It is very important that a performance horse begins a competition with optimal levels of fluid and electrolytes in its body and that these nutrients are replaced throughout the competition.

Electrolytes important to the horse include sodium (Na^+), potassium (K^+), chloride (Cl^-), and magnesium (Mg^{++}). Electrolytes regulate the fluid balance in the body; without them, water moves freely across cell membranes. They also regulate the acid-base balance of the body (homeostasis of the body fluids with a normal pH range between 7.42 and 7.45) and establish electrical gradients across cell membranes which are required for normal nerve and muscle activity. Thus, electrolyte deficiencies or imbalances can have a negative effect on nerve and muscle function. Kidneys play a vital role in electrolyte balance as well. While there is some electrolyte loss in manure, very little sodium is excreted via the urine. However, due to the substantial dietary intake of potassium (primarily from forage), the kidney will excrete this electrolyte in large amounts. Thus it is not necessary to replace potassium in an electrolyte supplement because the horse receives plenty from its diet.

Horse sweat contains high levels of chloride, sodium and potassium. When horses sweat heavily, they lose considerable quantities of these electrolytes. The environmental conditions, and the duration and intensity of exercise affect the loss of fluid and electrolytes during exercise. Depending on the ambient temperature (environmental temperature), horses can lose 1.2 to 2.7% of their body weight in sweat (Figure 2). Horses can sweat at a rate of 10 L/hr if they are working very hard in hot weather.

Figure 2. Sweat loss in a 500 kg horse during cool and hot ambient temperatures. (Geor, 2000)

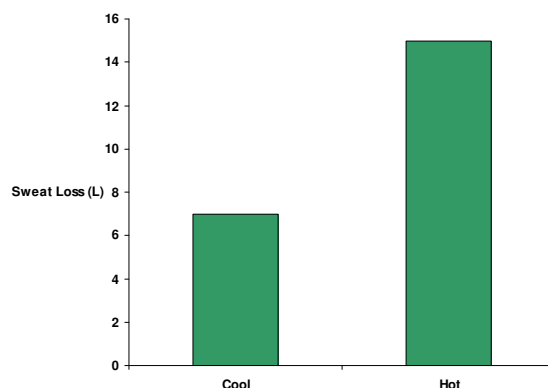


Table 1 shows the daily requirement levels of Na^+ , Cl^- , K^+ , and Mg^{++} by a horse at rest, and after exercising hard enough to lose 5, 10, 25, or 40 litres of sweat. Sweat loss between 5 to 10 litres would apply to a horse exercising at low intensity (12-18 km/hr) and horses at high intensity exercise (30-35 km/hr) can have losses up to 25 litres. 40 litres of fluid loss is most likely seen in an exhausted, dehydrated endurance horse that is at a high risk of dying.

Electrolyte	Rest	Sweat Loss (Litre/day)			
		5	10	25	40
Sodium (Na^+)	10	27	43	96	142
Chloride (Cl^-)	10	41	71	163	254
Potassium (K^+)	25	34	43	70	97
Magnesium (Mg^{++})	10	12	13	19	24

Table 1. Total daily electrolyte requirements (grams/day) as a function of sweat loss. (Pagan, 1998)

Dehydration and Electrolyte Imbalances

Without the replenishment of water and electrolytes, a horse will become dehydrated and develop electrolyte imbalances, which can negatively affect its performance. Excessive electrolyte loss can result in several neuromuscular and systemic disturbances including, tying up, muscle cramps, systemic alkalosis and thumps. They may also have reduced sweating rates and therefore a reduced ability to manage body temperature. Laurie Lawrence (1996), a University of Kentucky professor, indicates that electrolyte concentrations in the blood may play a role in the horse's thirst response or desire to drink. Thirst is stimulated as water is lost from the blood and the electrolytes in the blood become more concentrated, causing the blood to become "salty". This triggers the brain to tell the horse that he is thirsty and needs to consume water. When horses sweat heavily and lose a large amount of sodium, their thirst response may be depressed, resulting in the horse consuming inadequate fluids to maintain hydration.

Tying-Up

Dehydration as a result of exercise can be serious as there is a demand to nourish body cells, carry waste away from muscles and to help remove heat created during muscle contraction. The muscle becomes less responsive with fluid loss and electrolyte imbalance during exercise. This is evident in a horse that is trembling, reluctant to move when asked and one that appears uncoordinated. If dehydration and electrolyte imbalance are not corrected, muscle death can occur which can lead to tying-up (Exertional Rhabdomyolysis).

Metabolic Alkalosis

Metabolic Alkalosis occurs when chloride loss through sweating decreases the chloride concentrations in the blood plasma. Alkalosis inhibits respiration, resulting in decreased carbon dioxide excretion and oxygen intake and thus the unavailability of oxygen for

energy production. This leads to inadequate energy production and consequently fatigue or exhaustion.

Thumps

Thumps, clinically known as Synchronous Diaphragmatic Flutter, is a clinical sign of severe electrolyte loss. This is a condition in which the diaphragm contracts with each heart beat. The exact cause is not quite known, but it is known that the phrenic nerve becomes hyper excitable, possibly due to electrolyte imbalance. When this nerve is hyper excitable it is easily stimulated by the electrical impulses that normally travel across the heart. The phrenic nerve, which lies directly across the heart, controls the contraction of the diaphragm and thus hyper stimulation results in hyper stimulation of the diaphragm, which then contracts simultaneously with the heart beat. A thumping horse breathes in time with its heartbeat. This non-life threatening condition is somewhat similar to hiccups. However, the electrolyte imbalance and dehydration can be a serious problem if not treated. Thumps is very rare and is usually only seen in horses that have not been properly conditioned for an endurance race or one that has not ingested sufficient quantities of water during competition on a hot day.

Water and Electrolyte Deficiency Prevention

The best method in preventing water loss is frequent fluid ingestion. Unfortunately, it sounds easier than it is, as many horses do not exhibit a strong thirst response, particularly during endurance or similar long term activities. Causes for a poor thirst response during an event include excitement, fatigue, palatability, and the loss of sodium that accompanies water loss in sweating horses.

Allowing a horse to drink during training will increase the chances that it will drink during an event. Horses will often not drink unfamiliar water as it tastes different. If bringing your own water from home isn't an option, adding flavouring, such as unsweetened Kool-Aid mix or apple juice, to your horse's water for several days before an event and then flavouring the water available at the event can encourage the horse to consume water that is otherwise unpalatable. Providing forage may also increase water consumption. Offering a sloppy mash of feed mixed in with lots of water or wetting down the hay can encourage higher fluid intake.

Horses that are not heavily exercised and have continuous access to good quality forage and a salt block will most likely have adequate amounts of the four electrolytes (Na^+ , Cl^- , K^+ , and Mg^{++}). A horse at rest will normally consume an average 50 g of salt per day from a salt lick. Horses will increase their salt intake to compensate for their losses when they are regularly exercised. For horses that are worked very hard over several days, such as endurance horses, a salt block and a regular diet will not be sufficient to replace their sweat losses. Thus, loose white salt must be provided in the diet for horses that are heavily exercised and sweat heavily.

How much salt should be added to the ration?

Horses in regular training should be given 2 ounces (56 grams) of salt split between the morning and evening feedings during low to moderate ambient temperatures. When

ambient temperatures are higher in the summer months and sweat losses are much higher, 3 to 5 ounces (175-125 grams) of salt are recommended. Salt supplementation can be in the form of plain table salt or a ratio of 3:1 regular salt to “Lite salt” (potassium chloride). Although Lite salt is a good source of potassium, potassium supplementation is not always required as good quality hay should supply adequate amounts. Table 2 shows the daily requirements of electrolytes for horses at rest and exercising at different intensities.

Electrolyte	Rest	Work Intensity		
		Light	Moderate	Heavy
Sodium (Na⁺)	10	20	50	125
Chloride (Cl⁻)	10	25	70	175
Potassium (K⁺)	25	30	44	75
Magnesium (Mg⁺⁺)	10	11	14	15-19

Table 2. Daily Requirements of sodium, potassium, chloride, and magnesium (grams/day) for horses exercising at different intensities. (Pagan, 1998)

Providing electrolyte supplementation just before and during exercise is also an effective way of controlling electrolyte balance in the performance horse. Typically electrolytes administered as a paste via a dosing syringe are ideal and easy to use. While the addition of some sugar in an electrolyte supplement aids in rapid uptake from the gastrointestinal tract, avoid those containing large quantities of sugar as they will provide a surge of glucose in the bloodstream which will in turn cause a release of insulin. Insulin promotes glucose intake from the blood and could cause the horse to have a “sugar crash” while exercising. **McIntosh Electro-Blend Paste or Powder** is an excellent sugar free electrolyte supplement for horses. There are a lot of electrolyte supplements in the market, so read the labels carefully to determine which one is suited for your horse. **Appendix A** contains a few equine electrolyte supplements available from your Shur-Gain Dealer.

Administering electrolytes in the form of a paste or in the feed will also eliminate any possible negative effects on water intake. Regardless of the type of electrolyte supplement used, water should be available and consumed in order to provide the maximum benefit of the administered electrolytes. It is important to note that administering electrolytes to a horse that is very dehydrated or experiencing metabolic problems should only be performed while under the supervision of a veterinarian. Administering electrolytes to a dehydrated horse that is not drinking can cause further dehydration, colic and possibly death.

Providing electrolytes to horses that do not require them could actually be harmful. Horses do not “store” sodium, potassium and chloride in their bodies - excess is rapidly flushed out of the body via urine to keep their body chemistry in balance – which results in the use of its water reserves. Excessive water loss can lead to dehydration.

Summary

Some key strategies in maintaining adequate water and electrolyte balance in the performance horse are:

1. Provide a high quality, well-balanced diet on a daily basis, with free access to a salt block and fresh, clean water.
2. Supply adequate forage to your horse. Roughage will help retain water and electrolytes in the hind gut prior to a competition.
3. Only provide electrolytes to horses that really need it.
4. Provide some electrolytes in the diet just prior to the event. Electrolytes, like water, will be retained in the hindgut for a period of time and then absorbed.
5. Provide small doses of electrolytes at rest periods, before the horse gets dehydrated.
6. Water should be available and encourage the horse to drink. Keep track of how much water your horse is consuming. Do not give a horse electrolyte supplements if it is not drinking.
7. Monitor the horse carefully after the event is over. It is best to wait several hours after finishing the long ride before transporting the horse. Transportation can cause dehydration, which may result in serious problems such as colic if you transport an already dehydrated horse.

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Appendix A: Electrolyte Supplements for Horses.

1. Electro-Blend Paste (McIntosh Pro-Line)



Nutrient	Amount	Nutrient	Amount
Sodium (Na) Min	20.00%	Potassium (K) Min	19.00%
Sodium (Na) Max	22.00%	Copper (Cu) Min	300 ppm
Calcium (Ca) Min	1.50%	Zinc (Zn) Min	600 ppm
Calcium (Ca) Max	1.80%	Manganese (Mn) Min	600 ppm
Magnesium (Mg) Min	1.00%	Vitamin D3	6600 IU/kg

Electro-Blend Paste is designed for that extra electrolyte boost needed for the on-the-go performance horse. McIntosh Pro Line Electrolyte Paste is sugar and filler free. Only the highest quality source materials are used in the manufacturing of Electro-Blend. Available in an 80 ml – 3 dose tube.

2. Electro-Blend Powder (McIntosh Pro Line)



Nutrient	Amount	Nutrient	Amount
Sodium (Na) Min	20.00%	Potassium (K) Min	19.00%
Sodium (Na) Max	22.00%	Copper (Cu) Min	300 ppm
Calcium (Ca) Min	1.50%	Zinc (Zn) Min	600 ppm
Calcium (Ca) Max	1.80%	Manganese (Mn) Min	600 ppm
Magnesium (Mg) Min	1.00%	Vitamin D3	6600 IU/kg

Electro-Blend electrolyte powder will replace essential nutrients lost through sweat and heavy work. **Electro-Blend** is sugar and filler free. Only the highest quality source materials are used in the manufacturing of **Electro-Blend**. It is recommended to feed **Electro-Blend** in your horse's daily feed ration to ensure that your horse consumes its entire daily dose. Just 20 grams of McIntosh Pro Line **Electro-Blend** fed daily will help hydrate your horse properly. Available in 50 day supply – 1 kg pouches.

3. Electrolytes Plus (Vétoquinol)

Active Ingredients	per 400 g	Active Ingredients	per 400 g
Vitamin A (Vitamin A Acetate)	1 280 000 I.U.	Riboflavin	1280 mg
Vitamin D3 (Cholecalciferol)	1 000 000 I.U.	Choline bitartrate	5760 mg
Vitamin E (dl-alpha-tocopheryl acetate)	1 500 I.U.	Sodium chloride	277.71 g
Vitamin B12	2560 mcg	Sodium acetate	35.71 g
Folic acid	150 mg	Sodium diacetate	7.14 g
Menadione (menadione sodium bisulfite)	500 mg	Potassium chloride (potassium eq. 7.48 g)	14.28 g
Calcium-d-pantothenate	3200 mg	Magnesium chloride (magnesium eq. 1.82 g)	7.14 g
Niacinamide	6720 mg	Calcium acetate (calcium eq. 1.81 g)	7.14 g

Electrolytes Plus is a water soluble multi-vitamin and electrolyte mixture for chickens, turkeys, swine, cattle, sheep and horses. It is used as an aid in:

1. Stimulating appetite during periods of stress
2. The prevention of vitamin deficiencies when animals are off normal feed.
3. Correcting dehydrations and electrolyte imbalance.

DOSAGE (In drinking water): Dissolve 400 g (1 pouch) of powder in 750 L of drinking water. Treat for 5 days or until feed consumption returns to normal and the effects of dehydration disappear.

4. Mega Jug (McIntosh Pro Line)



Nutrient	Amount	Nutrient	Amount
Calcium (Ca) Min	0.60%	Chloride (Cl) Min	18.00%
Calcium (Ca) Max	1.20%	Vitamin D 3 Min	5200 IU
Sodium (Na) Min	8.00%	Vitamin E	35 IU
Sodium (Na) Max	9.00%	Vitamin K	400 mcg
Magnesium (Mg) Min	0.40%	Vitamin B12	53 mcg
Potassium (K) Min	7.00%	Riboflavin	1800 mcg
Copper (Cu) Min	112 ppm	Thiamin	2800 mcg
Zinc (Zn) Min	218 ppm	Vitamin C	20,000 mcg
Manganese (Mn)	218 ppm	Folic Acid	1500 mcg

Mega Jug – the most complete formulation available today for rehydration. It replaces fluids and nutrients lost through sweat and heavy exercise. Mega Jus replaces essential vitamins, minerals, amino acids and fatty acids that are excreted or utilized during heavy workouts, gaming, racing and during hot weather. Use Mega Jug before and after performance. Available in a 100 ml – 4 dose syringe.

Suggested use: Two doses (50 ml) prior to an event, or after an event. One dose (25 ml) during regular exercising days.

5. Stress Aid (Vétoquinol)

Active Ingredients	per 100 g	Active Ingredients	per 400 g
Vitamin A (vitamin A acetate)	2 566 000 I.U.	Biotin	18 700 mcg
Vitamin D3 (colecalfiferol)	561 000 I.U.	Vitamin B 12	3 740 mcg
Vitamin E (dl-alpha tocopheryl acetate)	1 870 I.U.	Ascorbic acid	555 mg
Thiamine hydrochloride	462.5 mg	Menadione sodium bisulfite	748 mg
Riboflavin	1 122 mg	Sodium chloride	49.3 g
Calcium d-pantothenate	3 252 mg	Sodium acetate	4.166 g
Niacinamide	4 488 mg	Sodium diacetate	2.083 g
Pyridoxine hydrochloride	448.8 mg	Sodium bicarbonate	4.166 g
Folic acid	112.2 mg	Potassium chloride	12.49 g

Stress Aid is a water soluble premix of vitamins and electrolytes. It is used as an aid in the treatment of vitamin deficiencies and correcting electrolyte imbalance due to malnutrition in horses, poultry, swine and cattle.

Dosage: Add 2.5 g of powder in the drinking water consumed daily by each animal (400 kg body weight), for 4 to 6 days.