



Nutrition of the exercising horse

4th European Workshop on Equine Nutrition (EWEN) 2008

Markku Saastamoinen (ed.)



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Nutrition of the exercising horse

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Nutrition of the exercising horse

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Abstract

The exercising horse competes at various levels in different disciplines and, is increasingly used also for leisure riding and driving as well as hobby farming and agritourism. This many-sided use of the horse of today causes lot of challenges to the people who are responsible for the feeding of horses, but also to feed producers and manufacturers as well. The scientific papers presented in this congress and abstracts collected in this booklet provide an outstanding synthesis of knowledge in physiology and metabolism, the nutritional requirements and feeding strategies of exercising horses. In addition, use of performance aids and the question of feed contaminants and doping are explained and discussed according to EU legislation. The improved knowledge and understanding of the background of the horse's performance and nutritional physiology helps people to meet the nutritional requirements of exercising horses such that their genetic potential can be used properly, as well as that the welfare of the horse can also be concerned at maximum level. These materials are the third step of further discussion on the evaluation and prediction of the requirements of different types of horses covered in the scope of the working group Nutrition of the Horse commission of European Association of Animal Production (EAAP).

Index words: equine, horse, nutrition, exercising, nutritional requirements

Urheiluhevosen ravitseminen ja ruokinta

Markku Saastamoinen (toim.)

Maa- ja elintarviketalouden tutkimuskeskus, Hevostutkimus, Varsanojantie 63, 32100 Ypäjä

Tiivistelmä

Nykypäivän hevonen on huippu-urheilija tai vapaa-ajan harrastuksen väline. Hevosurheilussa hevonen kilpailee monissa eri lajeissa ratsastuksessa ja käärrurheilussa. Ihmisten vapaa-ajan toiminnoissa hevosta käytetään niin ikään monella eri tavalla ratsastus- ja ajo-harrastuksessa, matkailussa tai kevyessä maa- ja metsätaloustyössä. Tällainen hevosen monikäyttöisyys asettaa suuria haasteita niin käytännön ruokinnan toteutuksessa kuin rehu-teollisuudellekin. Tässä Suomessa ja Pohjoismaissa ensimmäistä kertaa järjestettävän kongressin – European Workshop on Equine Nutrition (EWEN) - esitykset on koottu tähän kongressijulkaisuun. Ne ovat laaja katsaus ravitsemusfysiologiaan ja ravinnontarpeisiin lihastyötä tekevillä hevosilla. Esityksissä tarkastellaan myös mahdollisuuksia vaikuttaa hevosten suorituskykyyn ravitsemuksellisin keinoin. Lisäksi tuodaan esiin ravitsemukseen ja antidopingtoimintaan liittyvää EU-lainsäädäntöä. Hevosten ja niiden ruokinnan parissa työskentelevien ihmisten tiedon ja taitojen lisääminen ja hevosen ymmärtämisen parane-minen auttavat huolehtimaan yhä paremmin hevosen hyvinvoinnista siten, että samalla pystytään hyödyntämään hevosen geneettinen potentiaali urheilusuorituksissa ja muissa nykyhevosen tehtävissä. Kongressi on osa Euroopan Kotieläinjärjestöjen Yhdistyksen (European Association of Animal Production - EAAP) Hevoskomission alaisen hevosten ravitsemusta käsittelevän työryhmän toimintaa.

Asiasanat: hevonen, ravitseminen, valmennus, ravinnontarve

Foreword

This booklet is a compilation of abstracts of papers presented at the 4th European Workshop on Equine Nutrition (EWEN), held in Forssa, Finland, 23rd-25th July, 2008. The meeting was organised by Agrifood Research Finland (MTT) and, was placed under the umbrella of the Horse commission of the European Association for Animal Production (EAAP) as a satellite of the annual meeting of EAAP.

The current workshop is dealing with the exercising horse which plays a key role in the new competitive context of today's equine industry, where the exercising horse should either competes at various levels in the various disciplines, or is used for riding education, leisure riding, hobby farming, agritourism, therapy etc. Thus, improvement in our knowledge of exercise and nutrition physiology is of major importance to outline and disseminate relevant feeding systems to the equine industry. Exercising physiology is intensively studied and discussed in the scope of ICEEP conferences. Consequently, the 2008 EWEN is focused on the nutrition and to some extent on the interactions between nutrition and physiology. In addition, there was discussion from both the scientific and regulatory point of view of the performance aids and doping contaminants.

The scientific programme included five main topics designed in seven sessions with reports given by invited speakers, original research papers and posters. A round table was organised with scientists from public organisation and equine industry (Feeds companies) with the expertise of a representative of DG SANCO in Brussels. The scientific programme was stated by an International Scientific Committee with the following members:

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Miraglia, Nicoletta, Italia, University of Molise
Saastamoinen, Markku, Finland, Agrifood Research Finland
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The meeting was financially supported by: European Association for Animal Production – EAAP, Agrifood Research Finland – MTT, The Finnish Trotting and Breeding Association – Hippos, The Equestrian Federation of Finland – SRL, Association of Rural Advisory Centres – ProAgria, City of Forssa, Municipality of Ypäjä, Alltech (Ireland), Agrimarket (Finland), Hiven (Finland), Suomen Rehu (Finland), Waltham Mars Horsecare (UK), Cavalor (Belgium), Wahlsten (Finland), Fingrain (Finland) and Biofarm (Finland). We want to thank all above supporters.

Markku Saastamoinen
National Organising committee

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International Scientific committee

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 The logo for MTT (Metsäntutkimuskeskus) features a stylized 'G' shape composed of three segments: a blue top-left, a green bottom-left, and a yellow bottom-right. To the right of this symbol, the letters 'MTT' are written in a bold, grey, sans-serif font.	 The logo for the European Association of Animal Production (EAAEP) is circular. It features a blue silhouette of a horse's head in profile, facing right. The text 'EAAEP · EUROPA' is written in blue along the top inner edge of the circle, and 'E.A.K. · FEZ.' is written along the bottom inner edge.
 The logo for the European Workshop on Equine Nutrition features a black silhouette of a horse grazing in a field, enclosed within a circular border of twelve small stars. Below the circle, the text 'European Workshop on Equine Nutrition' is written in a small, black, sans-serif font.	 The logo for Ypäjä features the word 'YPÄJÄ' in a large, green, serif font. Below the text is a blue, wavy horizontal line that resembles a stylized wave or a ribbon.
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VILJA-ALAN YHTEISTYÖRYHMÄ



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Blood glucose in the horse at rest and exercise

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Abstract

This paper reviews different aspects affecting equine blood glucose concentration and contrasts them with those in man. The effects of feeding, exercise and disease on blood glucose are also discussed. Glucose is an energy substrate for all cells and the principal fuel for the brain. Maintenance of glucose supply to working skeletal muscle from muscle glycogen and blood glucose is critical to sustain work output during exercise. Glucose metabolism has been intensively studied in human athletes due to the crucial roles of muscle glycogen stores and blood glucose. The changes in equine blood glucose concentration are qualitatively very similar to those in humans. However, regardless of many similarities, the results of such human studies cannot be directly applied to horses, because different animal species are specifically adapted to meet their own unique requirements. It is known that horses do have many species specific-features in their carbohydrate metabolism which are still incompletely understood. Further research is needed both in healthy horses and in horses with disturbances in their carbohydrate metabolism to give a more comprehensive understanding of metabolic responses and regulation in horses.

Keywords: glucose, horses, exercise, feeding, insulin resistance

Triglyceride storage in skeletal muscle

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Abstract

When muscle fibres contract they rely on fuels from extra- and intramuscular fat and carbohydrate sources. The most important fuels are free fatty acids from blood and intramuscular triglyceride stores and glucose from blood and intramuscular glycogen stores. The fat stores in the body are the largest nutrient reserve whereas carbohydrate stores are limited. Fat is a more efficient fuel for producing energy whereas the rate of energy production is more rapid from carbohydrate sources. Many studies on horses have investigated changes in blood-borne substrates and glycogen stores with different types of exercise, training and diets. Only a few studies have looked at the muscle triglyceride stores. These studies have used the muscle biopsy technique and report large individual variations in triglyceride stores in the gluteus muscle of horses. Furthermore, results show that fat is mainly stored in slow contracting type I fibres and fast contracting type IIA fibres and hardly not at all in type IIB fibres whereas glycogen is stored in all fibre types. Exercise studies indicate that triglyceride stores are utilised to a great extent during prolonged exercise and especially within type I fibres whereas utilisation during more intense exercise is unclear. Availability of blood-borne substrates, and different metabolic profile between fibre types and the extent to which the fibres are recruited during exercise are all factors that influence intramuscular substrate storage and utilisation. An increased capacity for muscle triglyceride storage is observed with age and training. Some horses with poor training and/or racing performance have low muscle triglyceride stores. Influence of different diets on triglyceride storage in muscle is not clear but results indicate a greater reliance on fat oxidation after fat rich diets. More research is needed to clarify the role of fatty acids in blood and of triglyceride stores in muscle for energy production during different types of exercise and duration. The effect of different diets on muscle triglyceride storage also needs to be further investigated.

Keywords: horse, fibre types, fatty acids, glycogen, enzyme activity

Muscle-lactate and its transport across membranes in horses: A review

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Abstract

Horses have high oxidative capacity, but during maximal effort a considerable percentage of energy is produced by anaerobic glycolysis as indicated by the production of lactate and protons. To maintain intracellular pH, efflux of lactate and protons is facilitated by monocarboxylate transporters (MCT), which cotransport these two ions. Mainly two MCT isoforms, MCT1 and MCT4, are expressed in equine muscles. Both of these need an ancillary protein, CD147, for full activity and their proper orientation on membranes. Lactate efflux depends also on the proton gradient between muscle and blood plasma, and to keep up this gradient lactate and protons are taken up by tissues that rely on oxidative metabolism, but also by red blood cells (RBC), which during exercise act as a lactate sink. In equine skeletal muscle and RBC the expression of CD147 is bimodally distributed with 25% of standardbred horses showing low expression in comparison to the rest 75%. The lactate transport activity is autosomally inherited with the high activity being the dominant form. Equine MCT1, MCT4 and CD147 have been sequenced, but the polymorphisms in the coding region of MCT1 and CD147 or the promoter region of CD147 cannot explain the differences in the lactate transport activity leaving the reason for differences in lactate transport activity to be solved.

Keywords: horse, acidosis, monocarboxylate transporter, MCT, CD147

α -Lipoic acid attenuates exercise-induced oxidative stress and enhances oxidative metabolism in standardbred trotters

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Abstract

While antioxidant supplementation apparently decreases exercise-induced oxidative stress, there is also a risk of attenuating the physiological response of tissues to exercise and blunting the adaptations. In this study we examined the protective role of natural thiol antioxidant, α -lipoic acid (LA) supplementation at rest and during recovery after an acute exercise in plasma and in skeletal muscle of horse. Six standardbred trotters were examined on the treadmill and exercised 75 min at individually defined aerobic level. They were supplemented orally with LA (25 mg kg⁻¹ day⁻¹) for five weeks without any additional vitamins. Using electro paramagnetic resonance assay, we showed that strenuous aerobic exercise increases significantly free radical formation in gluteus medius muscle during control period but not after LA-supplementation. LA-supplementation decreased the amount of post-exercise lipid hydroperoxides in plasma and exercise-induced increase in malondialdehyde; a marker of lipid peroxidation in plasma and muscle. We also observed the reduced exercise-induced increase in plasma CK and ASAT in LA-supplemented horses supporting the membrane protecting features of LA. There was no difference in muscle protein carbonyl levels; a marker of protein oxidation. Interestingly, LA increased the oxidative capacity of the muscle measured by citrate synthase activity and lowered the blood lactate concentration during exercise. Our results suggest that LA-supplementation appears to decrease exercise-induced oxidative stress at lipid phase without impairing the athletic capacity of the muscle in horse.

Keywords: α -lipoic acid, horse, exercise, oxidative stress, recovery

Physiology of intake and digestion in Equine animals

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Abstract

This review focuses on some recent advances in our understanding of the physiological mechanisms involved in intake and digestion. Different factors, either intrinsic or external to the individual, which can impact the intake and digestion of feeds are discussed with a special focus on the effect of feeding practices and exercise of sport and race horses so far removed from their natural environment. Exercise probably has an impact on the physiology of intake and digestion but it is not well documented mainly due to methodological limits. The motivation of a horse for ingesting a feedstuff is strongly influenced by the feed palatability (related to the smell, taste, appearance or texture). Feed intake integrates probably the nutritive value of a feed as well as its hedonic value or its aversion value. There is also large individual variation that should be taken into account when feeding different horses. It seems that gastric or cecal repletion had no effect on subsequent feeding behaviour. Feed intake is regulated on a short term by glucose and acetate and by leptin and ghrelin hormones and on a long term by the nutritional needs of the organism, which are modified by on the physiological status, activity and thermoregulation. Regarding the implication on energetic yield, digestion in horses shall be studied in the various compartments of the digestive tract. Most studies are conducted on apparent digestibility and mean retention time in the total gastro-intestinal tract which limits the comprehension of partial digestibility. Digestion of starch starts in the stomach with enzymes from the host and originated from abundant autochthonous microorganisms. In the small intestine, digestion is primarily under the control of the host enzymatic secretions that breakdown carbohydrates, fat and protein. Microbial cell-walls degradation occurs in the favourable ecosystem of the hindgut.

Keywords: horse, intake, digestion, physiology, exercise

Thermoregulation in the horse at rest and during exercise

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Abstract

Metabolism results in the production of heat. During exercise the rate of heat production may exceed that at rest by a factor of forty times due to increased metabolic activity within working muscles. As heat production is related to the level of metabolic activity, metabolic heat production is easily estimated from whole body oxygen consumption measurements. As an animal with a high mass specific maximal oxygen uptake, the horse has a high capacity for heat production even when scaled for body mass. For athletic horses the relationship between body mass and body surface area allows heat retention, which is advantageous in cool but disadvantageous in hot climates. Horses rely primarily on sweating to dissipate heat and possess a sweating capacity unequalled in the animal kingdom with regional rates of up to 50 ml/m²/min and whole body losses of 15 l/h. The horse also has a high capacity for thermotolerance, which it requires when muscle temperatures can reach 48°C and rectal temperatures in excess of 42°C. As part of its ability to tolerate such temperatures the horse does possess some capacity for selective brain cooling. In the last decade and a half, advances in understanding of thermoregulation in the athletic horse were driven by Olympic Games and World Equestrian Games being held in thermally adverse environments. These studies lead to developments in areas such as transport, acclimatisation, competition scheduling, competitive demands, assessment of thermal stress and cooling.

Key words: horse, thermoregulation, exercise, heat, cold

Horse transport

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Abstract

Transport of horses by road is extremely common and even air transport, though nowhere near as common, is considered routine. However transport is an unusual experience for horses and presents them with many potential stressors, including separation, noise, movement, space restriction, reduced air quality, reduced access to feed and water and an elevated head position. By far the majority of published information on transport relates to the sport or racehorse and in many cases to populations of animals acclimatised to transport. Much less has been published relating to the transport of horses for slaughter. Under these circumstances the animals being transported may be old and or ill or injured. They are usually transported with less concern than animals with a higher economic value and the level of stressors to which they are exposed may be higher resulting in failure to eat and drink sufficiently during transport. Other animals bred specifically for human consumption may have limited or no prior experience of transport. Transport has the potential to adversely affect almost all body systems, but it is the musculoskeletal, GI and respiratory tracts that are most commonly affected. An understanding of the effects of transport on the horse can permit the adoption of management practices that can improve the health and welfare of horse during transport.

Key words: horse, transport, road, air

Digestibility and plasma glucose and insulin concentrations in athletic horses after abrupt feed changes between grass silage and hay

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Abstract

The aim of the study was to investigate effects on digestibility, faecal dry matter (DM) and plasma glucose and insulin levels in standardbred horses in training following abrupt feed changes between grass silage and hay. Five geldings, in race condition, were used. A silage (45% DM) and hay-only diet (82% DM) were fed (11.6 MJ ME/kg DM, 2 kg DM/100 kg BW and day) in a cross-over design. Horses were randomised on diets and the silage and hay was fed in a 9 days pre-period before the start of the experiment. Each experimental period started with an abrupt change of diet. The grass forages (timothy, meadow fescue) were a first cut harvested in the same field on the same day. Total faecal collection was performed the first 48 hours after the feed change. Blood was drawn before and 24 hours after feed change (before the morning feeding). Analysis of variance was performed. The DM digestibility was higher on the silage than on the hay diet (69.5 vs. 65.4 %, SEM 0.9, $P<0.01$). The plasma insulin concentration increased when horses were shifted to the silage ($P<0.01$). The 24 h plasma glucose concentration tended to be higher ($P=0.09$) on the silage compared to the hay diet. In conclusion, within 48 hours after a change between silage or hay diets DM digestibility and glucose metabolism was altered in athletic horses. The suggested alterations in the metabolism need further investigations.

Key words: digestibility, equine, glucose, insulin, silage

Effect of a moderate dietary fat supplementation on the digestive function in the horse

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Abstract

Supplementing athletic horses with fat to meet their high energy requirements may have a detrimental impact on the digestibility of fibre when fat was supplemented at the expense of an iso-energetic amount of non-structural carbohydrates (Jansen *et al.*, 2000, 2002, 2007). The objective of this study was to determine the effect of a moderate fat supplementation on the total tract apparent digestibility and the colonic bacterial ecosystem. Six fistulated horses (449 +/- 33 kg) used in a double (3x3) Latin square experiment received a diet consisting of a forage-to-concentrate ratio of 67:33 on DM basis. Three fat concentrations were tested in the concentrate: 4.0, 7.0 and 8.8 % DM, respectively. Mean daily DM intake was 1.7% BW divided in two equal meals of hay and concentrate. The apparent digestibility (DM, TDF, NDF, ADF, Fat) was measured by total collection of faeces during 5 days. The anaerobic flora (total, cellulolytic, amylolytic, lacticolytic) and VFA concentrations and pH were determined in the colonic content collected 4 hours after the morning meal. The total fat intake 42, 59 and 69 g/100 kg BW for the rations composed of 4.0, 7.0 and 8.8% of fat in the concentrate. The digestibilities of DM, fat, TDF, NDF and ADF were not altered by the fat supplementation. In agreement with Jansen *et al.* (2007), the pH, total and cellulolytic bacterial concentrations in the content of the hindgut were not modified. Consequently, a moderate fat supplementation increased the energetic supply without any adverse effects on the hindgut ecosystem.

Key words: horse, fat, digestibility, colonic ecosystem

Energy requirements and allowances of exercising horse

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Abstract

In this review, requirements proposed by several countries using different systems (NRC-2007, GEH-1994, INRA-1990, CVB-2006, SCAN-2004) are described and discussed. Energy requirements are evaluated using either factorial method (GEH-1994 and CVB-2006) and a model which predicts oxygen consumption or feeding trial method (INRA-1990) based on nutritional balance which include the variation of body weight and body condition score whereas the intensity of work is stated both on oxygen consumption and practical observations. NRC-2007 and SCAN-2004 proposed to assign the increments of exercise requirement as multiple of maintenance requirement based more or less on factorial method. The increments of the requirements with the intensity of exercise in respect of maintenance (base =100) are more or less consistent between the different systems, in spite the intensity of exercise does not means the same work and the model used to predict oxygen consumption are different. Additional requirements to young horses (yearlings and long yearlings) during the training period are requested and suggested by all the systems to support the increase of the muscle mass due to simultaneous late growth and exercise. Recommended allowances including requirements for different body weight and exercise intensity are provided by all the systems but the range of intake capacity - diet composition and key body condition score along the training and competition period are not always suggested.

Key words: horse, exercise, energy, requirements

The suitability of heart rate in the prediction of oxygen consumption, energy expenditure and energy requirement for the exercising horse

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Abstract

Oxygen consumption of an animal reflects the oxydative processes to deliver energy which is not exclusively but in majority shuttled by ATP. The circulation is responsible to submit sufficient oxygen to the tissues and to respond on increased demand. Therefore heart rate must be an indicator for oxygen consumption. Based on literature data it is possible to derive a suitable model to predict oxygen consumption by heart rate and consequently energy expenditure. A major problem is to recognize anaerobic energy supply. The lactate accumulation in blood is the only parameter which reflects this metabolic segment. Taking an energy equivalent for lactate into account, it is possible to add the anaerobic part of energy expenditure to the major fraction coming from aerobic energy metabolism. A still unsolved problem in any system for estimating energy expenditure is the change in basal metabolic rate in trained vs. untrained individuals and, even more important, the needs for restoration. Regardless of these shortages the heart rate as a predictor of energy expenditure seems to be more applicable to the exercising horse in the field as it reflects any energy relevant influence from the environment. The classic approach by setting speed as an independent variable is insensitive in that point. Using utilization ratios the energy expenditure can be converted to digestible energy or other systems to express requirements. Taking energy expenditure for metabolizable energy seems to be the most promising step.

Key words: horse, exercise, heart rate, oxygen consumption, energy expenditure

Practical assessment of work-level in equines

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Abstract

Energy evaluation systems apply a varying range of methods for the practitioner to estimate energy requirements above maintenance for working horse. Current systems generally incorporate some measure of intensity and duration but repetition, different training sessions or additional effort are generally neglected. As these systems try and cover every aspect of horse sport, rider level and training schedule these general tables can only remain very rough guides. This paper introduces a possible method incorporating the best of current systems with a novel approach for practical application. The work level system reported here has been developed to incorporate methods used in all systems but also to allow further depth in evaluation for the lay person. It attempts to bring together the best of current systems a novel approach for practical application. Exercise levels are evaluated for individual types of exercise (e.g. lunging, hacking out, schooling, jump-schooling, dressage etc.). Once these have been determined the horse trainer needs to put down 4 scores for each exercise type undertaken per week. To assess exercise levels per type of training a duration score and intensity score has been developed. There is a good correlation between recent formulas incorporating heart rate and oxygen consumption and the proposed work level system. This means layperson can assess work levels of their horses much more accurately without the use of a calculator or complicated formulas. In practice, body condition score will be used primarily to assess if horses receive the correct energy required from their feed. However, generally ration calculations are not carried out in detail unless there is either a problem with body condition, health or performance. In these cases evaluating exercise levels correctly is important as these form the basis for assessing the protein, mineral and vitamin requirements of horses.

Key words: equine work level, energy requirements, training programmes

Heat balance in trotters during intense exercise

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Abstract

The aim of this pilot study was to investigate heat balance; especially heat loss and heat load. Four standardbred trotters (geldings, 3-8 years, 420-520 kg) performed twice an inclined (1.4°) incremental treadmill exercise test in two minutes steps (7, 8, 9, 10 and 11 m/s) in indoor conditions (15°C, 40% Relative humidity). The recovery was monitored for 120 minutes. We measured throughout the entire experiment: heart rate, respiratory rate and temperatures in central venous blood, the *gluteus medius* muscle and radiated from skin. Oxygen uptake and sweat rate were measured during exercise and 30 minutes after exercise. The rate of non-evaporative heat loss was estimated from measured parameters. The data were analysed for correlations. The results showed that as the intensity of work increase, the pathways of dissipated heat shifted; skin non-evaporative (75%→20%), sweat (4%→55%), and respiratory (21%→25%) heat loss. We found the following correlations between 1) central venous temperature and muscle temperature ($R^2= 0.81$), 2) central venous temperature and oxygen uptake ($R^2= 0.85$), 3) intensity of work (% VO_2 max) and momentary heat load in $\text{W}\cdot\text{m}^{-2}$ ($R^2= 0.97$), 4) accumulated heat load and muscle temperature (individual $R^2= 0.94-0.99$, overall $R^2= 0.71$) during exercise, where specific heat of the horse was estimated to $2500 \text{ J}\cdot\text{kg}^{-1}\cdot^\circ\text{C}^{-1}$. During recovery there was no obvious correlation between accumulated heat load and muscle temperature, which indicated a shift of heat within the body. The results obtained provide useful data for modelling heat balance and thermoregulation within the horse during exercise, especially the preliminary estimation of specific heat.

Key words: horse, thermoregulation, specific heat, oxygen uptake, muscle temperature

Selected aspects of nitrogen metabolism in exercising horses

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Abstract

Goal in deriving requirements is to combine objective criteria about quantity of a nutrient that defines dependent functions. In the case of nitrogen and exercise it becomes evident that muscle activity is not a function depending on a defined quantity of nitrogen; consequently the factorial approach in formulation of requirements answers, exercise needs no protein. But simply the fact that the involved tissue is rich in complex nitrogenous structures like mitochondria, stimulate the question how intensively muscle cell nitrogen is in touch with the kinetic energy performing process of the cell. There are clear changes in the plasma as well muscle amino acid profile; alanine and branched amino acids are of major interest. In a nonspecific response on this kind of amino acid abrasion protein supply should be above maintenance level. The actual recommendations of the NRC include an adjusting factor for protein intake in exercising horses. There is growing knowledge about the degree in amino acid utilization during exercise and the response of the muscle performance on specific amino acids. On the other hand, an overconsumption of protein is inappropriate as it can result in heat and metabolic load of the horse. In conclusion the role of single amino acids for regulation of muscle energy metabolism and restoration, for the mechanisms of fatigue and recovery are challenging further research.

Key word horse, exercise, nitrogen, metabolism

Protein requirements and allowances of the exercising horse

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Abstract

Protein requirements are evaluated using either factorial method which results to different protein/energy -ratios for maintenance and work and with intensity of exercise (NRC, 2007) or a constant ratio, assuming that the ratio is the same for work and maintenance whatever the intensity (all other systems). The increments of the requirements with the intensity of exercise in respect of maintenance (base = 100) is close in all the European systems (125-200 percent) but much higher than that of NRC systems (110-140 percent) whatever the intensity. Extra requirements to support the increase of the muscle mass in the adult individuals are not well established. Additional requirements are requested to support simultaneous late growth and early training in young horses. Requirements in essential amino acids are not yet well defined except for lysine mainly in growing horses. The benefit of branched-chain amino acids supplementation is not yet demonstrated. The effect of excess of protein in diet is still questionable. Recommended allowances including requirements for different body weight and exercise intensity are provided by all the systems but the range of intake capacity – diet composition and key body condition score along the training and competition periods are note always suggested.

Key words: horse, exercise, protein, requirements, allowances

Effect of grass species and time of cutting on *in vivo* digestibility in horses and sheep

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Abstract

Two digestibility trials evaluating six different silages fed simultaneously to mares and rams were conducted to compare the digestibility by the two animal species. Timothy/meadow fescue (TMF) and tall fescue (TF) silages made at three different cutting times in round-bales were fed according to an unbalanced 6 x 4 Latin square design with 3-week experimental periods. A 5-day faeces collection period was used for mares and a 7-day collection period for rams. During the collection periods the animals were fed at the maintenance level (60 and 41 g DM/kgW^{0.75}/day for mares and rams, respectively). The mares and rams preferred TMF silage to TF silage. As growth stage proceeded, the digestibility decreased in both grass species. The digestibility of the TMF silage was markedly better than that of the TF silage cut at the same time. The digestibility values obtained by rams were higher than those obtained by mares. The organic matter digestibility (OMD) of TMF silages at the first, second and third cutting time was 67.3, 56.7 and 51.7%, respectively, in mares and 75.7, 68.0 and 63.4%, respectively, in rams. The respective OMD of TF silages in mares was 60.9, 52.7 and 45.7% and in rams 74.0, 66.9 and 59.2%.

Key words: digestibility, grass, horse, sheep, silage

Benefits of yeast culture supplementation in diets for horses

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Abstract

Feeding strategies for performance horses using mainly high starch diets, can result in enhanced susceptibility to colic or laminitis (Kronfeld and Harris, 1997). The incidence of which can be reduced through the use of beneficial microbial supplement that increase nutrient availability, modify gut microflora and enhance performance. One source is a live culture of the yeast *Saccharomyces cerevisiae* (Yea-Sacc®¹⁰²⁶; CBS 493.94, Alltech Inc, USA). The addition of *Saccharomyces cerevisiae* limits the extent of undesirable changes in the intestinal ecosystem of the horse. It can improve the microbial balance in the hindgut of horses, stimulating the population of fibre digesting bacteria and their activity. Such yeast cultures have also been found to increase the digestibility of dietary nutrients, particularly ADF due to its positive effect on the number and activity of cellulolytic bacteria. In the case of high starch diets, where there may be a negative digestive interaction between starch and cellulose which can lead to digestive disorders, supplementation with yeast culture might limit the effect by rebalancing the complex microbial population of the hind gut yeast cultures. In improving fibre digestibility, supplementation with a yeast culture would increase nutrients supply, namely of energy and nitrogen to some extent and as a result the performance of horses: lactating mare, foals and yearling. In conclusion, increasing number of studies have shown that supplementation with a yeast culture significantly improves the digestibility of fibre within the diets and goes some way to counteracting the negative effects of diets containing high levels of starch.

Key words: horse, starch diet, yeast, digestion, performance

The effect of *Saccharomyces cerevisiae* CBS 493.94 level on *in vitro* fermentation using faecal inoculum from horses fed diets with different fibre concentrations

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Abstract

According to regulations, 4×10^9 CFU / kg feed is the lowest dose of Yea-Sacc[®] recommended for horses. In order to decrease this dosage an experiment was conducted to test the effect of three levels of live yeast of *Saccharomyces cerevisiae* CBS 493.94 (Yea-Sacc[®]) on the *in vitro* digestibility and on the fermentation patterns using fecal inoculum from horses fed diets with different fiber concentrations. The three levels were 4.5×10^8 , 9×10^8 and 4.5×10^9 CFU/ kg DM intake, and their influence were studied using the gas production method and *in vitro* batch incubations to estimate the digestibility of the diets and some end products of fermentation. Our data show that Yea-Sacc[®] incorporation level improved the *in vitro* fermentation of all studied diets. However, no significant improvement was observed with the increase of incorporation from 9×10^8 to 4.5×10^9 CFU / kg DM intake levels.

Key words: Yea-Sacc[®]; gas production; in vitro digestibility; fermentation parameters, horse

Effect of hydrolysed yeast (*Saccharomyces cerevisiae*) product (Progut™) on the microbial flora of the horse

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Abstract

Prebiotics can be used in equine nutrition as balancing factors in stressful situations. In this research we studied the effect of hydrolysed yeast product (Progut™) on the microbial flora of a horse as determined in faeces. Progut™ is hydrolysed yeast product manufactured from brewer's yeast (*Saccharomyces cerevisiae*). Ten Finnhorse mares were fed basal diet of hay and oats for three weeks before first microbial samples were taken. After the first samples, yeast hydrolysate was added on the diet and after feeding period of another three weeks the second microbial sample was taken. Aerobic and anaerobic total bacteria, enterobacteria, *Lactobacillus*, lactate producing bacteria, bifidobacteria and *Bacteroides-Prevotella* were determined from faeces. Volatile fatty acids (VFA) and pH were also determined. The total count of aerobic bacteria declined after the addition of the yeast product. The enterobacteria and *Bacteroides-Prevotella* -group increased and bifidobacteria decreased. No change was observed in total anaerobic bacteria, lactic acid bacteria or *Lactobacillus*. VFAs were more homogenous between animals after yeast product addition.

Key words: horse, yeast, Saccharomyces cerevisiae, bacteria

Major mineral and trace element requirements and function in exercising horses

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Abstract

Major minerals, such as calcium, phosphorus, magnesium, and sulphur, and trace elements, such as copper, zinc, selenium, cobalt, iodine, iron, and manganese, contribute to fundamental biological processes including muscle contraction, enzyme activities, neural excitability, and membrane permeability. However, the mineral requirements for major minerals and trace elements are poorly understood as only small amounts are lost via sweat during exercise. The higher requirement for calcium, phosphorus, and magnesium during exercise as compared to maintenance is related to their structural roles in bones. A possible increase in trace element requirements to optimise biological processes still needs to be established scientifically. This review highlights the important roles and functions of these elements as they contribute to fundamental biological processes during exercise.

Key words: major minerals, trace elements, biological processes, exercise, horse

Electrolyte requirements and supplementation in exercising horses

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Abstract

Nowadays it is necessary to have a multidisciplinary approach to the horse, to find the key for the optimal performance not only by considering macronutrients such as protein, fat and sugar, but also minerals, like electrolytes. The electrolytes include minerals, such as sodium (Na), potassium (K) chloride (Cl), calcium (Ca) and magnesium (Mg), that when dissolving in a appropriate solvent are ionized and conduct an electric current. In the body ions are dissolved in three main compartments: the fluid within the cells, the fluid in the space surrounding the cells, and the blood. They affect many metabolic processes such as the passage of fluid between and within cells (osmosis), the function of the neuromuscular system, the acid-base balance and pH, and the thermoregulatory process. The body maintains the optimal concentration of electrolytes in each compartment by moving electrolytes into or out of the cells. They are very important for the organisms because there is a continuing loss from the body and there are no body stores of electrolytes other than those carried in the gastrointestinal tract. This review analyses the main characteristics of the most important electrolytes for horses with particular emphasis to sodium, potassium and chloride. Also calcium and magnesium, even if they are generally considered for its pivotal role in the bone metabolism, are considered as electrolytes present in plasma and extracellular fluids.

Key words: electrolytes, horse, sweat, acid base balance, requirements

Vitamin requirements and supplementation in athletic horses

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Abstract

In the preparation of this paper, studies on the vitamin requirements of performance horses were reviewed. According to several studies and in line with current NRC recommendations, the core requirements of many vitamins do not appear to be much higher in performance horses than in horses at maintenance, and any increase in requirements should be compensated for by the increase in appetite and daily feed intake associated with the increased workload. This suggests that exercise *per se* does not seem to have any major influence on the vitamin needs of horses. The requirements for water-soluble vitamins normally can be assumed to be met by typical equine rations in combination with the synthesis of vitamins in the body. However, if the vitamin contents of the basal feeds are reduced and/or the microbial vitamin synthesis of the horse is compromised, there may be need for additional vitamin supplementation. Lack of sunlight and access to pasture may also affect vitamin status and therefore the need for additional supplementation. In addition, the intake of some vitamins may be inadequate when forage-limited diets or forage rich diets (especially preserved forages) are fed. Processing and storage can affect the content of many vitamins in feeds and forages. With respect to the active exercising horse some vitamins may have additional health benefits such as support for healthy airways and the immune system, which may influence the performance capacity of the horse and raise the requirements. Perhaps the most accurate recommendations can be given for vitamin E, whereas the recommendations for other vitamins are more approximate. In the new, sixth revised edition of the NRC (2007) all vitamin recommendations are unchanged compared to the previous edition (NRC 1989). However, our review has highlighted the need for more research into the influence of vitamins on the performance of horses in intense exercise especially with respect to the B-complex vitamins.

Key words: vitamins, fat-soluble vitamins, B-complex vitamins, exercise, requirements

Organic selenium and the exercising horse

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Abstract

In horses, adequate dietary selenium (Se) is essential to support a range of selenoproteins and seleno-dependent enzymes including glutathione peroxidase (GPx) and thioredoxin reductase, which are vital for optimum functioning of the antioxidant, immune and reproductive systems. The natural abundance of Se in pastures, grains and forages displays marked geographical variation, but mostly only low levels of Se are present. Consequently, dietary supplementation is essential for horses and commonly implemented at the point of (feed) manufacture. Historically, inorganic Se sources, such as selenite, have been used, but margin of safety is narrow and efficacy has been questioned. More recently, replacement with organic Se sources, such as Se-enriched yeasts (containing selenomethionine and selenocysteine) has been advocated. A growing body of research suggests that organic Se sources enhance Se incorporation into tissues both at rest and during exercise and increases Se status, enzyme activities, antioxidant capacity and immune function in mature horses and foals. Organic Se appears to cause a greater relative increase in plasma Se over 28 d compared with selenite, although comparative effects were similar over 56 d for skeletal muscle Se and GPx and plasma GPx. Organic Se also produced a greater numerical but statistically insignificant increase in blood GPx activity than selenite during supplementation to horses over 112 d. Post-supplementation decline in blood GPx activity was also reduced in horses receiving organic Se. Other studies have indicated that pre- and post-partum organic Se supplementation in mares confers subsequent benefits in the foal through improved Se status.

Key words: horse, organic and inorganic selenium, status, exercise, supplementation

Cereals, hay and straw naturally enriched in Se by use of fertilizers in horses diets: effects on a standardized exercise test

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Abstract

Selenium (Se) is a trace element of importance for animal health. Selenate, contained in fertilizers is naturally transformed in organic Se forms by the plants. Three g Se/ha were applied with the fertilizer in pastures for hay production and 4 g Se/ha were spread with the third nitrogen application on winter barley and on spelt fields. These feedstuffs along with similar feedstuffs grown without Se were used in a 570 g/kg concentrate-430 g/kg roughage diet. They were offered to six horses during two 56 days periods, transition excluded, of a cross-over design. On the end of each period the horses were submitted to a well-defined treadmill training. The Se concentrations were 63 and 297 µg/kg DM in the control and Se diets. Plasma Se concentrations were on average 111.9 ± 3.67 µg/l and 142.7 ± 3.16 µg/l ($P < 0.001$) in the control and Se groups. In the control group one horse suffered from myopathy at the end of the test. When the horses were offered the control diet the speed of the treadmill was 3.9, 4.2 and, 4.6 m/sec in order to achieve the targeted steps of the standardized exercise; the corresponding speed with the Se diet was 3.8, 4.1 and 4.4 m/s. The recovery in both heart and respiratory rates were improved after the test. Before the exercise, the LDH activities were similar in both groups while AST and CPK activities tended to be lower with Se (400 ± 11.5 vs. 843 ± 278.3 IU/l, $P < 0.19$, 231 ± 22.4 vs. 267 ± 48.1 IU/l, $P < 0.29$). One hour after the test, the activities of two enzymes -AST and LDH- increased to a much lesser extend in the Se group than in the control group (463 ± 20.3 vs. 400 ± 11.5 and 1010 ± 196.3 vs. 843 ± 278.3 IU/l for AST; 952 ± 265.1 vs. 572 ± 9.1 and 1117 ± 170.3 vs. 572 ± 108.6 IU/l for LDH). By contrast, the extend of the increase in CPK activity was larger in the Se group (2795 ± 1723.9 , 534 ± 132.0 and 231 ± 22.4 IU/l vs. 1586 ± 1024.4 , 332 ± 70.9 and 267 ± 48.1 IU/l one and six hours after the test). It appeared, thus, that the feeding of Se enriched feedstuffs reduced the harmful effects of exercise in horses.

Key words: horses, selenium, fertilizers, exercise test

Energy providing nutrient sources

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Abstract

Energy is the most important factor that effects exercise. It derives from different substrates used by the animal to produce a chemical intermediate that fuels all vital functions. The particular pathways and substrates that can be effectively used depend from the intensity and duration of exercise which in turn interact with the nutrient source. Energy providing nutrients are carbohydrates, fat and protein. The latter should not be primarily used for energy because this way is highly inefficient and amino acids may be needed as matter *per se*. Carbohydrates can be roughly subdivided into fermentable carbohydrates (f-CHO) and hydrolysable carbohydrates (h-CHO). f-CHO derive mainly from dietary fibres of roughage which can not be digested by mammalian enzymes but fermented by microbes. This occurs predominantly in the hind gut. Fibrous carbohydrates do not simply act as energy source but additionally help to maintain gut health in general and hydration during the specific situation of long-lasting strenuous exercise. h-CHO are represented by monosaccharides, disaccharides and starch that can potentially be digested by horse-own enzymes in the small intestine. However, high amounts of h-CHO may be critical concerning unfortunately elevated insulinaemic response on the one hand and disturbed hind gut fermentation on the other. Oils and fats can be substituted for h-CHO to increase dietary energy and mitigate of problems associated with starch feeding. However, fats may be problematic through inhibiting microbial fermentation. In general, energy providing nutrients have considerable side effects. To ensure gut health and for metabolic reasons it is recommended to feed no more than 0.3 kg of starchy feeds like cereal grains/kg of body weight (bwt) and day and at most 1.0 g of supplemental fat/kg bwt/day, respectively. On the other hand, 1.0 kg of roughage/kg bwt/day is the upper safe limit that needs to be ensured.

Key words: horse, exercise, energy, protein, carbohydrates, fat

Feeding schedule during competition day in performance horses

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Abstract

This review is focused on the feeding schedule during a competition day. Data from literature suggest that intake of a starchy meal should occur no later than 3-4 h before the onset of exercise (meal size < 0.3% of BW), and that supplementation of electrolytes 4 h before exercise is advisable because voluntary water intake is increased pre-exercise. Roughage should be provided without any limitations, especially before endurance competitions or three-day events. During endurance exercise, electrolyte application is useful only when water is available. Palatable feedstuffs such as steam-flaked corn or alfalfa provide extra energy; in addition, glucose intake (1 g glucose/kg BW) may support maintenance of higher blood glucose levels. After strenuous competition races, rehydration strategies are improved by addition of electrolytes to the water, or voluntary intake of water is improved by the application of concentrated electrolyte pastes or palatable feed mixtures with electrolytes. Hay ad libitum should be offered first to the horses after exercise; a starchy meal (meal size < 0.3% of BW) can be offered 2-4 h after cessation of exercise.

Key words: energy, electrolytes, water, glycogen, sweat, performance horse

Feeding horses in hot and humid conditions

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Abstract

The aim of this paper is to review feeding and management of the athletic horse in hot and humid conditions, which challenges the thermoregulatory system due to physical limitations of rate of heat loss. The following major recommendations for horse practice were concluded. The horse needs to acclimate three weeks to hot and humid conditions before maximal exercise can be performed. Adjust the workload to the actual climate conditions and if possible let the horse work during mornings and evenings. A suitable diet for high performing horses is a mix of hay/oats/vegetable oil (45/45/10) to get a lower heat production. The protein intake should be adequate with the right quality but kept as low as possible. Feed roughage during the cold part of the day to ease the heat load from fermentation. Extra water and electrolytes are lost due to increased sweat loss. Water is recommended to be offered ad lib from a bucket, which can increase the intake by 30%. Extra salt (NaCl) need to be added to the feed, but only supplement potassium after exercise in recovery. Keep the horse lean and clip it to facilitate heat loss and keep as much as possible out of bright sunlight.

Key words: horse, heat, acclimation, nutrition, electrolytes

Feeding growing race horses in work

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Abstract

The athletic demands we put on horses in the racing industry require 1.5 to 3 year old, still growing horses, to be worked well above light exercise level. Therefore, the nutrient needs for such horses consist not only of maintenance, voluntary activity (play, group interaction) and growth but also of requirements for work. This leads to increased requirements for all nutrients. In practice, horse trainers alter energy intake of working youngsters according to body condition. The feeding levels are determined from experience and daily observation of horses and the choice of feed also often is made according to tradition and previous experience. Additional energy for growth and work is recommended for heat production when horses are kept in loose housing below thermal neutral temperature (Nordic countries). Although quality of protein is important, excess protein may have a detrimental effect on the performance of young horses. Exercise will increase load bearing qualities of the musco-skeletal system but if training and nutrition are not optimised, bucked shins, micro-fractures, haemorrhage and stress fractures may occur. Therefore, special attention needs to be given to mineral and vitamin supply. There is a risk that young racehorses may receive diets deficient in calcium, relative to the increased need for accelerated bone metabolism at onset of training. In conjunction with this the requirements of vitamin D also increase in young horses entering training because of increased bone modelling. When feeding traditional straight grains a balancer or supplement are recommended. To maintain a healthy digestive tract and good welfare of young horses in training an adequate supply of structural fibre is required when stabled – a level of at least 1.2% of BW as forage feed (DM) is recommended. In addition continued grazing during the ‘growing’ and training period will help with temperament and prevention of behavioural problems but also with nutrient balance and digestive tract health.

Key words: young horse, growth, exercise, nutrient requirements, health

Nutrient intake in high performance show-jumping horses in France

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Abstract

The nutrient requirements of athletic horses are closely dependent on workload and need to be defined for each discipline. As only few surveys have focused on show-jumping, the aim of the present work was to describe dietary practices in elite show-jumpers in France and compare them with the NRC 2007 recommendations. Seventeen horses (12 stallions, 3 mares, 2 geldings; age 12 ± 1 y; BW 591 ± 13 kg) were included in the study. Their feeds were analysed and their general health, feeding schedule and meal composition were recorded. All data were expressed as mean \pm SEM. Mean digestible energy (DE) intake was 1.4 ± 0.1 times the maintenance requirement but varied considerably (from 1.0 to 1.9) with no effect of gender. Crude protein (CP) intake ranged from 84 to 147 % of the recommendations for exercise horses, with a mean CP:DE ratio of 45 ± 8 g/MCal DE. Mineral intake exceeded the recommendations, except for sodium and chloride. Body condition was satisfactory in all horses indicating that energy intake met the energy requirement for maintenance *plus* exercise, despite large variations between animals. Mineral intake varied widely, and in most cases, the actual intake made any supplementation, especially of calcium, unnecessary. Our results emphasize 1) the imbalanced diets compared to current recommendations and 2) the similar performances of the horses despite the different diets offered to them. They also show that the variation in workload, within a single athletic discipline, may be wide.

Key words: horse, nutrients, balance, show jumper

Variation of fatness and energy content of the body with body condition score in sport horses and its prediction

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Abstract

This study aimed at studying the variation of the weight of adipose tissue and muscles and their energy content in total body; validating a body condition score method (BCS) designed by INRA; and performing models for predicting the weight of adipose tissues and the net energy content (NEC) of the body reserves (e.g. all adipose tissues or/and muscles). Twenty adult horses of French sport breeds (Selle Français or Anglo-Arab) with average body weight of 501 kg and body condition score ranging between 1.0 and 4.5 according to INRA's method (scale 0 to 5), were slaughtered. The muscles and the different adipose tissues (subcutaneous, internal, and inter-muscular) were dissected and weighted. Energy content of all those tissues was determined in each horse using adiabatic calorimeter. The weight of the different adipose tissues (WAT) increased with BCS according to the general models: $WAT (kg) = a \exp^{BCS}$ ($0.986 < R^2 < 0.990$, $P < 0.001$). Energy concentration (Ec) of those different adipose tissues rises with BCS according to the general models: $Ec (kcal/g) = a + b \text{Log BCS}$ ($0.975 < R^2 < 0.990$, $P < 0.001$). Total energy content (TEC) of empty body weight (EBW) rises with BCS according to the general model $EBWTEC (kcal) = a \exp^{BCS}$ ($R^2 = 0.993$, $P < 0.001$). Total energy content of EBW ranges from 297 to 1035 Mcal whereas EBW varies between 335 to 525 kg. All these models of prediction have been used to perform energy balance of exercising horses in the scope of feeding trials implemented to evaluate INRA 1990 requirements.

Key words: horse, body composition, body score, energy

Effects of a forage-only diet on body weight and response to interval training on a track

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Abstract

The effect of a forage-only diet on body weight (BW) and response to interval training was studied in standardbred horses in training. Six geldings were fed a forage-only diet (F, early cut) and a forage/concentrate diet (C) including haylage (late cut, same crop) and concentrate (82 % oats) in a change-over design for 29 days. The feed allowances were isocaloric and iso-nitrogenous. On day 17 an interval training test was performed on a track (6 km warm-up, 4 intervals of 600 m at a predetermined velocity of 10.5-13 m/s, approx. 0.6 % incline). BW was measured before, 15 min and 24 hours after the test. Heart rate was measured before and until 120 min post exercise and breathing frequency until 60 min post exercise. The exercise temperament was assessed by the drivers using a linear index. A blood sample was taken immediately after the last interval for analysis of plasma lactate (pLa). The pre-exercise BW tended to be higher and the 24 h post exercise BW was higher on diet F compared to diet C. There was no significant difference in pLa and temperament index although some individuals showed a numerical increase on diet C. Heart rate and breathing frequency was higher on diet C. In conclusion, a high energy forage-only diet might increase BW but this does not seem to have any impact on performance related parameters during field conditions. In contrast, diet C might have affected the psychological response to exercise and thereby some physiological parameters.

Key words: behaviour, body weight, concentrate, exercise, forage, horse

Energy balance of sport horses working in riding school at two levels of intensity

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Abstract

This trial aims at the validation in field conditions of energy requirements proposed by INRA-1990 for exercising sport horses. Eighteen horses were split up in two groups based on their working intensity: exercised by beginners (group A) or sport (group B) riders. The horses were fed wheat straw, hay and compound feeds, 50-0-50 percent or 27-11-62 percent for groups A and B, respectively. The net energy (NE) content of the two diets, determined by indirect calorimetry according to INRA method, was 0.62 and 0.72 UFC/kg DM for groups A and B, respectively. Horses in groups A and B worked daily 120min and 50min, respectively. The duration of exercise was measured daily and the intensity of exercise was checked once a week by measuring the velocity of the gaits implemented during the work. The body weight (BW) variation, estimated by regression of BW and measured weekly, is slightly positive (+200g/d) for group A and constant for group B. The Body condition score (BCS) variation measured biweekly using INRA 1990 method, (scale 0 to 5) was slightly positive (+0.18 point BCS) for group A and constant for group B. Energy balance was slightly positive for group A (+4percent) and balanced for group B. Nutritional balance is discussed in respect of INRA requirements.

Key words: horse, work, requirement, energy

Growth and conformation changes in the young Lusitano horse: evaluation from birth to one year of age

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Abstract

Nowadays, there is a rising interest in the Lusitano breed as a sport horse. Besides the suggested relationship between growth rate and skeletal development, a better understanding of growing patterns could contribute for an accurate estimation of nutritional requirements in the growing horse. Therefore, the main objective of this study was to evaluate growth and development in Lusitano foals, from birth to one year of age, under extensive management conditions in Portugal. Thirty five foals from three stud farms were monthly weighed and withers height (WH), girth (G) and cannon circumference (CC) were measured. Average age at weaning was 7 mo (209±5d). Quadratic models were best fitted to describe the variation of body weight (BW), G, WH and CC. The effect of farm was significant for BW, G, and CC ($P<0.0001$), suggesting a management influence. Estimated BW at 7 and 12 mo of age in the three groups, varied between 211.1-253.8 kg and 274.6–327.7 kg, respectively, representing 42.2-50.8 % and 54.9-65.5 % of Lusitano mature BW (500kg). ADG until weaning varied between 0.786-0.888 kg/d, decreasing afterwards in the post-weaning period to 0.258-0.493 kg/d. Weight gain between birth and weaning represents 71.5-80.9 % of total weight gain until 12 mo of age. Estimated values for WH, G and CC at 12 mo of age varied between 135.4-140.9 cm, 145.4-157.5 cm and 16.7-19.0 cm, respectively. These results indicate a similar growth pattern to those described in other sport light breeds when submitted to moderate feeding levels, during the first year of life.

Key words: Lusitano horse, growth, development, foals, feeding level

Ergogenic aids in the performance horse

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Abstract

An ergogenic aid can be used to describe any agent, which can increase or improve work production (or exercise performance), resulting in an increase in speed, endurance, or strength. Such aids can be classified as psychological factors; mechanical or biomechanical factors, including improved equipment; chemical or pharmacological agents (e.g. drugs, such as anabolic steroids); physiological improvements (including most importantly those obtained through training) and finally nutritional supplements. Nutritional supplements in particular may improve performance through reducing interruptions to training that minor illnesses and infection can cause, or shorter recovery from a competition or more commonly through provision of increased mechanical energy for work, and/or a delayed onset of fatigue. Although many substances theoretically have ergogenic properties, only limited scientific evidence is available, in the horse, to support the postulated ergogenic effects of most of the products currently on the market. Manufacturers should be encouraged to undertake appropriate scientific trials to support the claims made for many of the products and consumers should be encouraged to ask for evidence in the horse before purchasing. In some areas, the boundaries, between what is and what is not acceptable, are blurred by the fact that many ergogenic aids are found naturally in the body. In this review, the evidence for and against various postulated nutritional ergogenic aids, including creatine, carnitine, oil supplementation, amino acids and β -hydroxy- β -methylbutyrate (HMB), with particular reference to the horse, is examined and discussed.

Key words: equine, horse, performance, ergogenic, nutrition, supplements

Feed contaminants and anti doping tests

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Abstract

Pharmacologically active drugs are considered as prohibited at any concentration (with the exception of threshold drugs) in body fluids collected during racing or equestrian events, even if environmental or feeds contamination might occur. This can create unexpected positive cases when feeds or supplements contain unlisted drugs in supplements or in feeds containing alkaloids such as atropine, scopolamine or caffeine. There are several contamination origins depending on drugs involved. Manufacturing or transportation are major factors which may explain the presence of these drugs in the feed. Two studies were carried out to assess the maximum intake of major contaminants absorbed through the diet that would not result in a positive test in urine. Caffeine, theobromine, theophylline, atropine, scopolamine and morphine were administered orally at different dosages, for 2 days before urine was sampled and submitted to analysis by screening methods. Each cocktail of drugs were administered to two horses. Caffeine: a 10 mg daily intake was found to induce urinary concentrations ranged from 23 to 50 ng/ml; theobromine: a 30 mg daily intake was found to produce urinary concentrations from 700 to 900 ng/ml; theophylline: a 15 mg/day intake was found to induce urinary concentrations of 140-500 ng/ml; atropine: a 10 mg/day intake was found to produce 10 to 25 ng/ml in urine; scopolamine: a 10 mg/day intake was found to give urinary concentrations from 25-140 ng/ml and, finally morphine: a 1 mg/day intake was found to produce a range of 10-15 ng/ml in urine. Horse feeds containing contaminants, even at low levels, may produce positive test results in anti-doping urine analysis. A maximum daily intake or a maximum concentration in feeds must be adopted to avoid inadvertent positive findings in routine tests. The use of feeds or supplements properly tested or guaranteed by manufacturers by an effective quality controlled process is crucial for feeding horses in training or before competition or racing events. The sensitivity of screening tests used to control feeds or feed supplements must at least comply with the concentrations determined in the present study. Nevertheless the lack of international harmonization remains an important issue, a MRL's (Maximum Residue Level) like approach would be the more appropriate as soon as harmonized levels of detection will be adopted.

Key words: horse feed, contaminants, anti-doping, mass spectrometry

Revision of the EU-legislation on the marketing and use of feed with particular focus on nutrition of horses

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Abstract

Currently, the general rules for the marketing of feed are spread over several Directives according to the type of feed concerned. There is Directive 79/373/EEC on compound feed covering also pet food where the rules for the circulation of this feed in the EU are laid down (e.g. labelling requirements). Directive 93/74/EEC lays down the principles for feed-stuffs intended for particular nutritional purposes (“dietetic feeds”). Directive 96/25/EC contains the general rules for the circulation and use of feed materials. Directive 82/471/EEC lays down the marketing conditions for certain products, belonging to the category feed materials, used in animal nutrition (“bio-proteins”). Thus, the current rules are found in old Directives and some 50 amending or implementing acts. This has made existing legislation extremely scattered with many cross references and difficult to understand and implement in a uniform way. Feed legislation sets the rules for the different categories as of feed materials, dietetic feed, feed additives and medicated feed, differentiating between food producing animals and pets. Though horses might not be used for food production in all cases, feed legislation has to consider them as food producing animals because they enter to a significant extent the food chain. The main improvement of the proposal will be achieved by setting modern rules under one Regulation resulting in more legal clarity and a more homogenous market. In particular, the grey zone between feed materials, feed additives and veterinary drugs would be cleared. Further, the use of claims will be better regulated and thus enforceable for the control authorities. On feed intended for particular nutritional purposes, the current system will be more or less retained. The proposal introduces a broad definition of labelling. Consequently, the required truthfulness of the information attributed to a product is not only limited to the sack label but as well to all other material supporting the sale. Additionally, it is highlighted that sales via the internet are covered by the marketing rules. Furthermore, proposal increases the accuracy of the indication of feed materials incorporated in compound feed for food producing animals by requiring the indication in descending order of weight. The exact percentage has to be indicated for raw materials in compound feed that are highlighted on the label. The proposal follows the philosophy that information needed by the feed user for an informed choice and safety relevant information must be provided unequivocally and in a harmonised way throughout the Community. Further labelling particulars can be given on a voluntary basis to fulfil special interest of customers, but then these have to be accurate and understandable for each target group, and the industry could label all details voluntarily. Stakeholders will be encouraged to develop EU codes for good labelling practice in the context of voluntary labelling provisions. The proposal is now in negotiation in the Council of the EU and the European Parliament for adoption.

Key words: EU-legislation, feeds, marketing, horse

