KRMIVA

IMPORTANCE OF FIBRE DIET - HAY FOR HORSE FEEDING

VAŽNOST VLAKNASTE KRME - SIJENA U HRANIDBI KONJA

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ABSTRACT

Horses have evolved over millions of years as grazers. Since horses are hindgut fermenters their digestive tract is designed in the fashion to allow them to ingest large quantities of forage in continuous fashion. During the process of domestication the breeders invented feeding with a high content of cereal starch to increase the physical and productive abilities of horses. This kind of feeding very often leads to undesirable physical and mental consequences. In order to balance the daily ration, forage analysis should be performed. In assessing the suitability of a particular forage for horses, several factors affecting forage quality are discussed such as species, stage of maturity and inhibitory substances. To accurately calculate the contribution that forage makes to the horse's overall feeding program forage intake must be evaluated in order to avoid some serious errors in feeding.

Keywords: Forage feeding, chemical analyses, fibre composition, energetic value, feed intake, pasture analyses, inhibitory substances, digestive disturbances, minerak composition.

INTRODUCTION

Horses have evolved over millions of years as grazers, with specialised digestive tracts adapted to digest and metabolise feeds with high content of plant fibre. Since horses are hindgut fermenters their digestive tract is designed in the fashion to allow them to ingest large quantities of forage in continuous fashion. During the process of domestication the breeders invented feeding with a high content of cereal starch to increase the physical and productive abilities of horses. This kind of feeding very often leads to undesirable physical and mental consequences. Forage should therefore remain the foundation of a horse's feeding program, regardless of where it is raised or how it is used. In order to balance the daily ration, forage analysis should be performed. Forage analysis is fairly useless, if its composition can not be correctly interpreted and used as a basis for an adequate feeding program.

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DIGESTIVE FUNCTION

Horses are classified anatomically as non-ruminant herbivores or hindgut fermenters. The equine digestive tract is designed in this fashion to allow the horse to ingest large quantities of forage in a continuous fashion. The fibre is also important to maintain a constant feed source for the beneficial bacteria in the hindgut. The small capacity of the upper part of tract is not well suited for large single meals, a fact which is often ignored by horsemen. Large single meals of grain overwhelm the digestive capacity of stomach and small intestine resulting in rapid fermentation of the grain carbohydrates by the microflora in the hindgut. The fermentation with large quantities of by-products may result in a wide range of problems including colic and laminitis. The fact that horses are hindgut fermenters has several implications for the feeding program. First, since the horses are designed to live on forage, any feeding program that neglects fibre will result in undersirable physical and mental consequences (Haenlein et al., 1966). Horses have a psychological need for the full feeling that fibre provides. Horses fed fibre deficient diets will in extreme cases become chronic woodchewers (Haenlein, 1969).

Forage should remain the foundation of a horse's feeding program, regardless of where it is raised or how it is used. Additional grains or protein and mineral supplements should only be used to supply essential nutrients not contained in the forage. This is the most logical and economical way to approach feeding horses, because it eliminates the needless duplication or dangerous excess of fortification. The problem with this method of ration balancing is that the quantity and quality of forage or grazed grass eaten by horses is not precisely known.

FORAGE COMPOSITION

Forage is composed of two components, cell contents and cell walls. Cell contents contain most of the protein, and all of the starch, sugars, lipids, organic acids and soluble ash found in the plant. These components are degraded by enzymes produced by the horse and are highly digestible. The cell wall contains the fibrous portion of the plant which is resistant to digestive enzymes produced by horse. The primary components of the cell wall are cellulose, hemicellulose, and lignin. The nutritive. value of forages is determined by two factors:

1. Fibre content (The proportion of the plant that is composed of cell wall)

2. Fibre quality (The degree of lignification)

These factors are important because the horse can digest practically all of the cell contents contained in forage, but bacterial fermentation can only digest 50% or less of the plant cell wall. The degree to which plant cell wall is digestible is largely dependent on the amount of lignin that it contains, and it can be determined by having the forage chemically analysed.

Table 1: Estimated true digestibility of different chemical fractions of forage (adapted from Fonnesbeck, 1969).

Tablica 1.Procijenjena stvarna probavljivost raznih kemijskih sastojaka krme (prema Fonnesbecku, 1969.)

Chemical Fraction Kemijski sastojak	Estimated true Digestibility % Procijenjena stvarna probavljivost (%)
CELL WALL – Stjenka stanice	
Cellulose – Celuloza	43.4
Hemicellulose – Hemiceluloza	49.5
Lignin Lignin	0
CELL CONTENTS Sadržaj stanice	
Protein – Bjelančevina	81.7
Soluble Carbohydrate Topivi ugljikohidrati	100.0
Ether extract – Eterni ekstrakt	75.1
Ash – Pepeo	90.5

FORAGE ANALYSIS

A great deal can be learned about the nutritive value and mineral content of a forage by having it chemically analysed. Of course, forage analysis is fairly useless if the results can not be interpreted and thus inadequate feeding program may result. Pasture and hay contain all macro and micro minerals required by a horse as shown in table 2.

Table 2. Macro and micro mineral content in pasture and hay consumed by foals designed for meat production (Gatta, D. et al 1995)

Tablica 2.Sadržaj makro i mikro minerala u paši i sijenu što ga pojede ždrijebad namijenjena za proizvodnju mesa (Gatta, D. et al. 1995.)

Elements - Elementi	Al	B	Ba	Ca	Cd	Cr	Cu	Fe	K	Mg
	mg/kg	mg/kg	mg/kg	%	µg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Pasture - Paša				0.68			12.97	626.1	1665	1811.25
St.d.				0.26			0.95	240.72	188.50	240.80
Hay - Sijeno	387.75	16	22.8	0.88	99.8	3.32	5.89	429	1375	1708
St.d.	149.22		2.10	0.18	0.18	2.30	0.98	40.82	486.20	85.23

Elements - Elementi	Mn	Na	Ni	P	Pb	S	Sr	Ti	Zn	Se
	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	µg/kg	mg/kg	µg/kg
Pasture - Paša	269.42	328.75		0.17					77.91	
ST.d	107.43	75.68		0.04					16.83	
Hay - Sijeno	46.05	694.5	1.41	0.15	1.02	1846.75	36.92	12.20	26.05	124.67
St.d.	3.70	129.53	0.80	0.01		41.77	7.24	1.85	3.91	8.33

In feeding evaluation program for horses hay and pasture mineral analysis represents basis for adequate balancing their daily requirements. Most of the minerals supplemented to the horses are Ca, P. Mg, Na, Cu, Zn, Mn, Se, J. Co, and recently Cr.

CALCULATED VALUES

There are two values that can be calculated from a forage analysis that are very useful in evaluating its quality. First. the amount of soluble carbohydrate or sugar can be calculated. The original was to calculate this was as nitrogen free extract (NFE) = 100 - crude protein - crude fat - crude fibre - ash. This is not a good way to estimate soluble sugar because a lot of the cell wall components end up in the NFE estimate since they are not recovered in the crude fibre fraction. True cell soluble sugars are completely digestible by horses, so any of the cell wall that escapes crude fibre detection is falsely estimated to be completely digestible. A much better was to estimate this (NFE) fraction is to substitute neutral detergent fibre (NDF) for crude fibre. By doing this, what is left by subtraction is likely to be readily digestible by the horse.

The second value that is often calculated for forage is energy content. This is expressed as either digestible energy (DE) in calories or joules per kilogram or as a percentage of total digestible nutrients (TDN %). For all practical purposes, these various expressions of dietary energy are interchangeable. TDN % x 4.4 = DE (Mcal/kg). It is important to realise that both DE and TDN are only estimates of the actual digestible energy content of

forage and they are based on the relationship between some of the components in forage (ADF - acid detergent fibre, protein) and the digestible energy content of feeds determined in actual digestion trials with animals (horses if possible).

By using TDN (total digestible nutrients) one can calculate DE (digestible energy) as follows:

TDN = %DCP + %DNFE + %DCF x 2.25

TDN - total digestible nutrients

DCP - digestible crude protein

DNFE - digestible nitrogen free extract

DCF - digestible crude fat

DCF should be multiplied with factor 2.25 because fat contains 2.25 times more energy than carbohydrates. TDN of hay ranges between 35 - 60 %. Digestible energy (DE) can be calculated according to the equation that uses Acid Detergent Fibre (ADF) and crude protein (CP).

TDN = 78.5 - 1.01% ADF + 0.823% CP

DE (Mcal/kg) = 0.255 + 0,366 % TDN 2.2

DE can also be calculated with equation by Drepper (1974), which uses digestible crude nutrients:

DE (Kcal/kg) = 5.1 DCP + 9.1 DCF + 4.1 DCF + DNFE

FACTORS AFFECTING FORAGE QUALITY

There are a number of factors which can affect the quality of forage. Most important of these are the species of plant (botanical composition of grassland or pasture), stage of maturity, soil characteristics and content of digestion inhibitory substances. All of these factors should be considered when assessing the suitability of a particular forage for horses.

Most plants that serve as forage for horses can be divided into three different categories (following the botanical composition of grass sward), grasses, legumes and herbs. Grasses contain much structural matter in their leaves and leaf sheaths and these can be as important or more important than the stem in holding the plant erect. The most important and suitable grasses used as forage for horses are timothy *(Phleum pratense),* orchard grass *(Dactylis glomerata),* perennial ryegrass *(Lolium perenne),* red fescue *(Festuca rubra)* ... It must be emphasised, that different grass species should be used for pastures due to different demands and growing conditions. For grazing grasses the palatability of each species is much more important than for grasses for conservation because if the species on the pasture is designated as not favoured by a horse it will be left as weed. As we know horses are "difficult" grazers and sometimes they have very peculiar taste so the grasses for pastures must be carefully chosen. The most suitable pasture grasses for horses are perennial ryegrass (*Lolium perenne*), red fescue (*Festuca rubra*), meadow fescue (Festuca pratensis), tall fescue (*Festuca arundinacea*), crested dog's tail (*Cynosurus cristatus*), and some Poa and Agrositis species.

On the other hand, leaves of legumes have very little structural function and tend to be on the ends of woody stems. The primary legumes used as horse forage are alfalfa *(Medicago sativa*) and red clover *(Trifolium pratense*) and for grazing White clover *(Trifolium repens).*

At a similar stage of maturity, legumes tend to be higher in protein, energy and calcium than grasses. Tables 3 and 4 describe the composition of legume and grass hays.

Table 3. Grass hay

Tablica 3. Sijeno trave

Stage of Maturity Stupanj zrelosti	CP %	ADF%	NDF%
Pre - bloom - Prije cvatnje	> 19	< 31	< 40
Full - bloom - Puna cvatnja	< 13	> 41	> 51

Table 4. Legume hay

Tablica 4. Sijeno mahunarki

Stage of Maturity Stupanj zrelosti	CP %	ADF%	NDF%
Pre - head - Prije glavice	> 18	< 33	< 55
Post - head - Poslije glavice	< 8	> 41	> 65

ADF (lignin plus cellulose) does not vary that much between grasses and legumes at the same stage of maturity. NDF (lignin + cellulose + hemi-cellulose), however, it is much higher in grasses than in legumes. This is because grasses contain a great deal more hemicellulose than legumes. Therefore, evaluating the fibre content of forage based on ADF alone underestimates the total cell wall content and overestimates the total energy content of a grass. Remember, hemi-cellulose is only 50% digested in the horse and cell solubles are almost completely digested. By only considering ADF, the assumption is that the rest of the forage (besides protein, fat and ash) is soluble sugar. This is truer in legumes which only contain around 10% hemicellulose than in grasses which can have hemicellulose contents of 30%.

The third constituent of forage are herbs. This group is constituted from all non legume and non grass species. It can also be very important although it is often neglected. Many herbs are very rich in minerals, vitamins and some medicinal compounds, and can play an important part in a horse diet. The most suitable herbs for horses are dendelion (*Taraxacum officinale*), narrow - leaved plantain (*Plantago lanceolata*), chicory (*Cichorium intybus*), Yarrow (*Achillea millefolium*), burnet (*Sanguisorba minor*), comfrey (*Symphytum officinale*).

The fibre that is in legumes tends to be less digestible than the fibre in grasses, largely because legumes tend to have a higher lignin content per unit of total fibre. This means that the digestible fibre content of grasses in much higher than it is in legumes of similar maturity. Because of the factors mentioned above, legumes contain 20 - 25% more digestible energy than grasses at the same maturity. In certain instances, the amount of legume hay feed may be limited, so that the horses do not get too fat. This can result in intakes of digestible fibre that are below optimal levels to provide normal microbial environment in digestive tract, and especially in hindgut.

When forage is grazed as pasture, its nutrient quality is almost always higher when it is harvested as hay. Spring pasture can be quite low in fibre content and high in soluble carbohydrates and proteins. In such circumstances, because of the unbalanced diet, some orthopedic disease can occur especially in foals. High portion of proteins and soluble carbohydrates in grazed sward have influence on the production of growing hormone (Kronfeld et al., 1990). At this time of year, it is often a good management practice to continue to offer horses on pasture additional hay even if the pasture appears thick and lush. If the horses are getting adequate fibre from the pasture, then they will ignore the hay.

Besides lignin, a number of other substances in forage can reduce digestibility of fibre and minerals. Silica is used as a structural element complementing lignin to strengthen and add rigidity to cell walls. Legumes restrict absorption of silica and never contain more than a few hundred ppm in their tissue (Van Soest, 1982). There are also substances in forage that can inhibit mineral digestibility. Two that are particularly impor-tant are phytate and oxalate. Phytates contain phosphorus in a bound form that is unavailable to the horse. Phytate may also inhibit the digestibility of other minerals such as calcium, zinc and iodine. In feeding programs for horses the addition of yeast culture (*Streptomyces Cerevisiae*) has been practised recently. It improves the utilisation of phytate phosphorus by the horse and also impoves zinc digestibility (Pagan, 1989).

FORAGE INTAKE

To accurately calculate the contribution that forage makes to the horse's overall feeding program, forage intake as well as composition must be known. Hay intake can be determined by simply recording the total weight of hay offered minus any hay wasted or refused. This record does not take into account the differences in composition between hay that is eaten and that consumed, but is accurate enough to do a good evaluation in the field. It is more complicated and less accurate enough to do a good evaluation in the field. It is more complicated and less accurate to estimate the intake on pastures. The average intake can be calculated from differences between available herbage on open pasture and in the exclosure cages. The amount of available herbage (kg of dry matter / ha), can be accurately measured with electronic device - Pasture Gauge.

Table 5 gives a range of forage and concentrate intakes for various classes of horses based on their body weight.

Table 5. Expected feed consumption by horses (NRC, 1989)

Tablica 5. Očekivana potrošnja hrane konja (NRC, 1989.)

Horse – Konj	% of body weight - % tjelesne težine		% of diet - % hrane	
	Forage Krma	Concentrate Koncentrat	Forage Krma	Concentrate Koncentrat
Maintenance – Uzdržna	1.0-2.0	0-1.0	50-100	0-50
Pregnant mare – Bređa kobila	1.0-2.0	0.3-1.0	50-85	15-50
Lactating mare (early) – Kobila dojilja (rano)	1.0-2.5	0.5-2.0	33.85	15-66
Lactating mare (late) – Kobila dojilja (kasno)	1.0-2.0	0.5-1.5	40-80	20-60
Weanling – Odbijeni	0.5-1.8	1.0-3.0	30-65	35-70
Yearling – Jednogodišnjaci	1.0-2.5	0.5-2.0	33-80	20-66
Performance horse – Radni konj	1.0-2.0	0.5-2.0	33-80	20-66

These estimates illustrate how much forage quality and level of intake can affect a horse's overall feeding program. Not taking into account the contribution that forage makes to a horse's overall nutrient intake can result in some serious errors in feeding, and at very least it will result in unnecessary and expensive supplementation.

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SAŽETAK

Konji već milijunima godina pasu. Budući da se kod njih fermentacija odvija u zadnjem crijevu njihov probavni trakt radi tako da mogu neprekidno gutati velike količine krme. U procesu pripitomljavanja uzgajači su otkrili hranu s visokim sadržajem škroba žitarica da bi povećali fizičke i produktivne sposobnosti konja. Ova vrst hranjenja vrlo često dovodi do nepoželjnih fizičkih i mentalnih posljedica. Kako bi se uravnotežile dnevne količine valja analizirati krmu. U ocjenjivanju prikladnosti određene krme za konje raspravlja se o nekoliko čimbenika koji djeluju na kakvoću krme, kao što su vrsta, stupanj zrelosti i inhibitorne tvari. Radi točnog izračunavanja doprinosa krme sveukupnom programu hranidbe konja valja procijeniti unošenje krme da se izbjegnu ozbiljne pogreške u hranidbi.

Ključne riječi: hranjenje krmivom, kemijske analize, sastav vlaknine, energetska vrijednost, inhibitorne tvari, probavni poremećaji, mineralni sastav