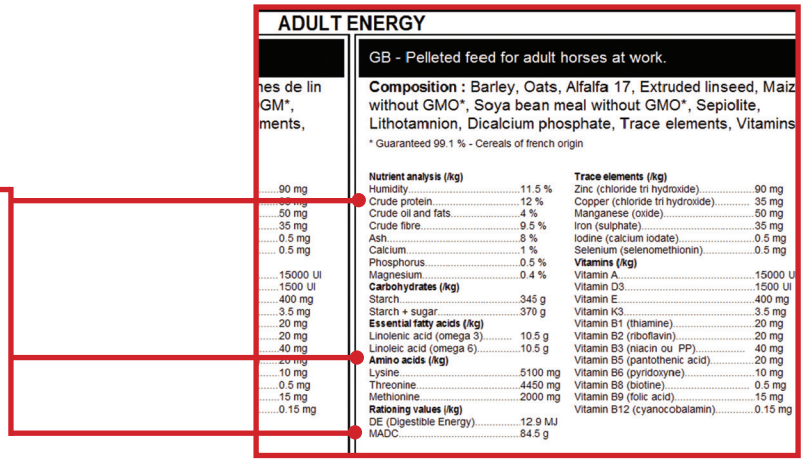
PROTEINS

CRUDE PROTEIN
AMINO ACIDS
DIGESTIBLE PROTEIN



DEFINITION

Proteins are nitrogen (N) rich macromolecules composed of one or more amino-acid chains.

NUTRITIONAL INTEREST

Proteins represent **17 to 19% of the horses' weight**, nearly half of this is found in the muscular mass.

Proteins in the organism are **in permanence degraded and replaced**, in consequence, the daily distribution of a feed ration providing a correct supply of protein is needed.

This is of even greater truth because:

- Unlike fats, momentary excess protein at a given moment cannot be stored in specialised tissues for later use.
- Unlike ruminants, it is practically impossible for the horse to count on an eventual production of amino-acids by his digestive microbial flora.

Covering requirements is therefore primordial, above all at the periods in the horses' life when protein synthesis is intensified:
- **The growing foal** increasing his body mass.
- **The broodmare with foal at foot** producing a protein rich milk.
- **The athletic horse**, for whom repeated work sessions result in the development of his muscular mass.

RECOMMENDED REQUIREMENTS

NOTION OF CRUDE PROTEIN AND DIGESTIBLE PROTEIN

The **crude protein content** in a feed must be **digestible** and able to **cover the horses' requirements in essential amino acids**. This determines the **nitrogenous value**. This value is expressed as the **digestible protein** value in the horse. This parameter tries to take into consideration that non-protein nitrogen (such as ammoniac, ammonium salts, amines etc.) will not be metabolically used by the horse. Certainly it will be absorbed by the digestive tract, however it must be eliminated by the emunctory organs (liver, kidneys etc.), from where there is the risk of overtaxing the organism.

DIGESTIBLE PROTEIN REQUIREMENTS

Requirements are expressed in digestible protein (in g / day) and must be considered in relation to energy needs. To adjust protein levels in the ration we must therefore refer to the **protein to energy ratio** as much as to the quantity of digestible protein provided by the ration.

In the table below, are the recommendations for a horse with (or expected to reach) an adult weight of 500 kg depending on the physiological stage (source: Wolter, 1999; INRA 2012).

SOURCE: WOLTER, 1999 AND INRA, 2012		RATIO DIGESTIBLE PROTEIN/UFC* (in g/UFC)
Adult	Maintenance	≥ 70
	In work	≥ 70
Mares	Gestation 0 - 5 months	≥ 70
	Gestation 6 - 8 months	≥ 80
	Gestation 9 - 11 months	≥ 90
	Lactation 1 - 3 months	≥ 100
	Lactation 4 months	≥ 90
	Lactation 5 - 6 months	≥ 80
Youngster	6 - 18 months	≥ 100

***UFC**: In France, energy values for horse feeds are not expressed in Kcal or MJ/kg but in "Unité Fourragère Cheval" (UFC) (Horse Forage Units). This measure is based on the energy value of a kilo of barley, 1 UFC = the energy provided to the horse by 1 kg of barley.

INDISPENSABLE AMINO-ACIDS REQUIREMENTS

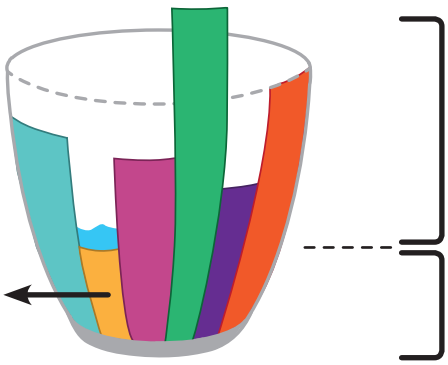
The horse is not **able to synthesise**, or at insufficient speed, the **9 essential amino-acids**: leucine, isoleucine, valine, methionine, phenylalanine, threonine, lysine, tryptophan and histidine. Furthermore, as opposed to ruminants, he is more or less unable to count upon an eventual auto-supplementation of microbial produced nitrogen.

The horse is thus **capable of being deficient in indispensable amino-acids**. That is to say his organism cannot synthesise them. The proteins that intervene in the maintenance of cellular structures, for growth, gestation and lactation will only be synthesised to the level of the dietary supply of these essential amino-acids, and notably the **limiting amino acid, lysine** (see the diagram) then followed by the others knowing that research led at the University of Florida suggests that the second limiting amino-acid is **threonine**.

ALL AMINO ACIDS SUPPLIED BY THE HORSES RATION

(Source: Wolter, 1999)

The bucket = the entirety of amino acids / 1 amino acid = 1 board of the bucket



"Limiting factor" = The most lacking essential amino acid in the ration **= LYSINE** *= The smallest board of the bucket*

The quantity of **amino acids of no value** to the organism = Fraction eliminated (urines, sweat etc.) = Overloading the organism

THE WATER LEVEL = The quantity of proteins able to be synthesised by the organism
= The fraction fixed by the organism (maintenance of cellular structures, growth, gestation, lactation etc.)

Lysine requirements have firstly been quantified in the foal. It has been shown that **actively growing youngsters** receiving **lysine deficient rations** had a **slower growth rate** than those nourished with a sufficient quantity of the amino acid, even if the crude protein content of the two rations was identical.
It is **therefore important to use quality protein sources that are able to fulfill the lysine requirements of the horse**. Detailed below are the recommendations depending on the physiological stage:

SOURCE: INRA, 2012		LYSINE REQUIREMENTS (g/day)	REVERDY RATIONS = LYSINE SUPPLY (g/day)
Adult	At rest	24	8 kg of hay* = **26 g**
	Working	31 - 54	5.6 kg (8 L) of ADULT ENERGY + 8 kg of hay* = **55 g**
Mares	Gestation 1 - 8 months	27 - 35	1.4 kg (2 L) of BREEDING + 7 kg of hay* = **34 g**
	Gestation 9 - 11 months	38 - 48	2.8 kg (4 L) of BREEDING + 7 kg of hay* = **45 g**
	Lactation 1 - 3 months	77 - 82	5.6 kg (8 L) of BREEDING + 10 kg of hay* = **77 g**
	Lactation 4 - 6 months	60 - 75	4.2 kg (6 L) of BREEDING + 8.5 kg of hay* = **61 g**
Youngster	6 - 18 months	37 - 49	2.8 kg (4 L) of FOAL + 5 kg of hay* = **43 g**
			2.8 kg (4 L) of BREEDING + 5 kg of hay* = **38 g**

*Normandy meadow hay:
Crude protein = 8%, Lysine = 4.1% of crude protein (INRA 2004)

EXCESS PROTEIN

There is a fairly wide tolerance; however excesses are pointless and even dangerous. **Even if the surplus nitrogen is transformed into good quality microbial proteins by the flora of the large intestine, they will be principally absorbed as ammoniac** which has the principal consequence of overloading the emunctories (liver, kidneys etc.) and could also be accompanied by risks of auto-poisoning.

Consequently, supplying **excess protein** must be **avoided** in the athletic horse as it can be at the origin of:

- **Dehydration**: Urea will notably be excreted in sweat and in the urine; this will create an important call for water. It is responsible for an abundant sudation (white foamy sweat) and high urine excretion.
- **Intestinal upsets**: Diarrhoea, enterotoxaemia etc.
- **Behavioural problems**: Nervousness, Irritability.
- **Perturbations in metabolism of carbohydrates.**
- **An increase in the respiratory frequency during exertion.**
- **Irritation of the respiratory tract** due to ammonia volatilisation from urine in the stable atmosphere.

In the same way, distribution of non-protein nitrogen sources such as **young spring grass** must be limited in order to only to not overload the emunctories, they can be at the origin of diarrhoeas at turn-out (see in the section dedicated to “fibres”).

WHICH PROTEIN SOURCES TO CHOOSE?

Numerous protein sources are used in horse nutrition, such as lucerne (alfalfa), milk proteins, oil cakes (soya, oil seed rape, etc.), or even mediocre by-products (millings, corn gluten feed, brewer's grains etc.).

To compensate for cereals being relatively poor in lysine, protein sources employed must be of top quality. Furthermore, proteins that have a high nutritional value, that is to say, with high levels of digestible protein and Lysine compared to the crude protein content, allow limitation of nitrogenous waste that is prejudicial to the organism.

Thus we have made the choice to incorporate the **best protein sources on the market: milk proteins, potato protein, and non-genetically modified soya bean meal** (See table).

	CRUDE PROTEIN	DIGESTIBLE PROTEIN		LYSINE
	%	g/kg	% CRUDE PROTEIN	% CRUDE PROTEIN
Common wheat	10.5	74	70.3	**2.9**
Sunflower meal	33.5	245	73.2	**3.5**
Barley	10.1	71	70.7	**3.8**
Common wheat bran	14.8	106	71.7	**3.9**
Linseed	22.6	170	75.2	**3.9**
1st cut Normandy meadow hay	2.3	13	57	**4.1**
Oats	9.8	69	70.2	**4.2**
Lucerne (alfalfa) 17-18% dry matter	15.9	94	59.4	**4.5**
Oil seed rape meal	33.7	254	75.3	**5.3**
Soya-bean meal 48	45.3	383	84.5	**6.1**
Skimmed milk powder	34.3	NP	NP	**7.9**

NP = Not provided.
Crude protein, digestible protein and lysine levels for different raw ingredients (source: inra 2004 and inra 2012)

TO SUM UP

CRUDE PROTEIN = DIGESTIBLE PROTEIN + METABOLIC WASTE
The quality of a protein source is provided by the **ratio Digestible/Crude protein** and the quantity of essential amino-acids, notably lysine, for a given quantity of crude protein.
Therefore these two parameters are objective indicators of protein quality, upon which we must rely to judge the quality of a protein source.