WEEK TWO

RABBIT NUTRITION

They are not rodents, but are included in a family called Lagomorphs. They are strict herbivores and have continually growing incisors and molars that are designed to tear and macerate very tough leafy foods. The teeth rub against each other and are worn down by the action of eating. Rabbits require a large percentage of fiber in their diet to maintain normal gastrointestinal motility. Rabbits are monogastric animals with enlarged caeca. They are medium sized hopping mammals with long legs, long ears and short tails. Rabbits are mainly reared fort their meat and fur. Rabbit meat is normally regarded as a white meat. Rabbits kept as a source of meat and/or a source of income. The nutrition of rabbit is an important aspect of production. Rabbit is also a small non-ruminant herbivore with an enlarged hind gut. It is a monogastric or single stomachs animal.

The digestive system consist of :

- Mouth & teeth.
- stomach & small intestine
- Caeca & large intenstine

The Mouth and rabbit's teeth.

Digestion begins in the mouth, where food is mashed up by the teeth and mixed with saliva. Enzymes in the saliva begin the process of breaking down food into pieces small enough to move into the blood. When food is broken up and moist, the rabbit swallows and the food enters the stomach.

Dental formula	1 :2/1	C 0/0	pm 3/2	m 3/3
	Incisors	canine	premolar	molars.

Total number of teeth is 28.

The mouth part of rabbit is adapted for cutting and chewing.

The incisors are for cutting. The front surface of the incisors has a thick layer of enamel which formes a sharp edge at the cutting point of the teeth.
The incisors are open rooted, meaning that they continue to grow thrughout the rabbit's life as they worn down by chewing. Premolars and molars are for grinding.

Stomach and Small intestine

The stomach of rabbit weights about 20g and the contents weight about 90 – 100g. The pH is between 1.5 and 2.0. The food in the stomach is exposed to acidity and some enzyme digestion begins. The weak muscular contractions in the stomach push the ingested feed into the first loop of the small intestine. The small intestine is about 310 – 350 am long and has a weight of about 60+ 3 g. The contents of small intestine ranges between 18-42 g depend of on diet density and bulkiness. The pH of small intestine is 7.2 or slight alkaline. The first loop of the small intestine is called duodenum, Here the ingesta is bath in bile which is released into the GIT via bile duct. The bile is produced in the liner and is stored in the gall bladder. Next to the duodenum is the pancreatic loop which produces pancreas via the pancreatic duct. In the stomach the food is mixed with stomach acid and different enzymes continue the process of digestion. Once food has been broken into even smaller pieces by the stomach, it moves into the small intestine. Small water-soluble nutrients such as sugars, amino and nucleic acids, and non water soluble fats are absorbed in this region. Larger indigestible molecules such as fiber are passed into the large intestine. Once in the large intestine the material is sorted by size. Smaller fragments are moved backwards into the caecum for use by the cecal bacteria. Larger fiber fragments are passed to the large intestine and then excreted as fecal pellets.

Caecum and large intestine

Rabbits are referred to as hind – gut fermenter that is feed is broken down by bacteria at the end of the digestive system. The major site of breakdown in the caecum. The ceacum is between small and large intensives and is about 45cm long, 25-30g in weight while the content vary between 120-140g. The pH is 6.0. The caecum has absorbing and secretory cell. Its end there is a small closed sac called appendix. A rabbit's cecum maintains a delicate mix of protozoa, yeast and *good bacteria*, which is crucial to keeping your rabbit healthy. If something upsets the delicate bacterial balance (such as stress; some oral antibiotics such as penicillin & related drugs; a high fat, low fiber diet; too many carbohydrates, etc.), *bad bacteria* will begin to grow. These bad bacteria produce toxins that can be harmful or fatal to your rabbit. On the other hand, the products of *good* cecal fermentation are crucial to healthy gut flora, because they break down, or "ferment" the fiber the rabbit cannot digest, through coprophagy, the oral re-ingestion of the cecal pellets produced by this fermentation process, the rabbit can absorb by normal digestion the special nutrients and vitamins contained in the cecal pellets.

The bacteria use the energy generated during fermentation to grow. By products of fermentation include VFA like acetic acid of monophonic butyric acid, bacteria, B. vitamins, gas like methane, bacteria protein and essential amino acids, all of which can be used by the rabbit. Volatile fatty acids are absorbed directly into the bloodstream through the lining of the cecum and provide approximately 30% of the energy required by the animal. Nutrients that cannot be absorbed directly into the bloodstream pass through the large intestine and are excreted as "cecal pellets" Cecal pellets are different from the round rabbit droppings that are left in the litter boxes; they are soft, grapelike clusters that have a distinctive smell

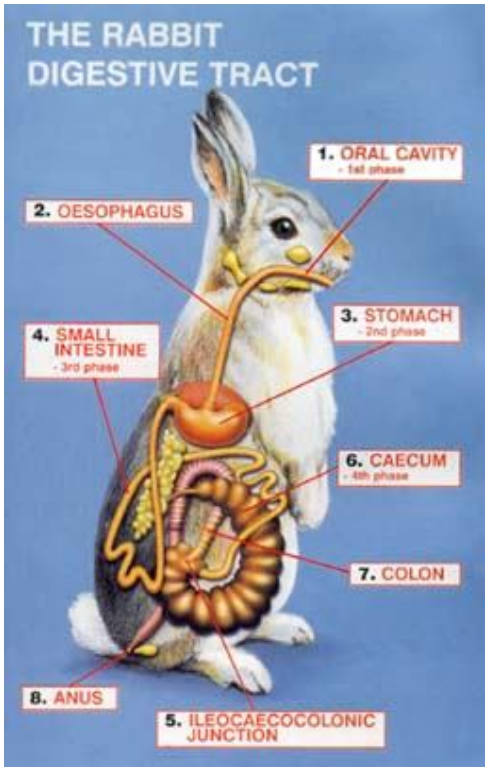
The content of the caecum are digest a, VFA like acetic acid of monophonic butyric acid, bacteria, B. vitamins, gas like methane. Bacteria in the caecum cause fermentation are digesta to produce B-vits, e.g. thiamine, bacteria protein and gases.
Note: That when a rabbit is treated with antibiotic for bacterial diseases, the cecal bacteria may also be killed. This often led to disturbances in the digestive system. Water is

reabsorbed throughout the caecum of large intensive. This results in relatively hard, dry facial pellets.

Digestive tract and caecotrophy

Feed eaten by the rabbit quickly reaches the stomach. There it finds an acid environment. It remains in the stomach for a few hours (three to six), undergoing little chemical change. The contents of the stomach are gradually "injected" into the small intestine in short bursts, by strong stomach contractions. As the contents enter the small intestine they are diluted by the flow of bile, the first intestinal secretions and finally the pancreatic juice.

After enzymatic action from these last two secretions the elements that can easily be broken down are freed and pass through the intestinal wall to be carried by the blood to the cells. The particles that are not broken down after a total stay of about one and a half hours in the small intestine enter the caecum. There they have to stay for a certain time, from two to 12 hours, while they are attacked by bacterial enzymes. Elements which can be broken down by this new attack (mainly volatile fatty acids) are freed and in turn pass through the wall of the digestive tract and into the bloodstream.



The digestive system of the rabbit

The contents of the caecum are then evacuated into the colon. Approximately half consists of both large and small food particles not already broken down, while the other half consists of bacteria that have developed in the caecum, fed on matter from the small intestine.

So far, the functioning of the rabbit's digestive tract is virtually the same as that of other monogastric animals. Its uniqueness lies in the dual function of the proximal colon. If the caecum contents enter the colon in the early part of the morning they undergo few biochemical changes. The colon wall secretes a mucus which gradually envelops the pellets formed by the wall contractions. These pellets gather in elongated clusters and are called soft or night pellets (more scientifically, caecotrophes). If the caecal contents enter the colon at another time of day the reaction of the proximal colon is entirely different.

Successive waves of contractions in alternating directions begin to act; the first to evacuate the contents normally and the second to push them back into the caecum. Under the varying pressure and rhythm of these contractions the contents are squeezed like a sponge. Most of the liquid part, containing soluble products and small particles of less than 0.1 mm, is forced back into the caecum. The solid part, containing mainly large particles over 0.3 mm long, forms hard pellets

which are then expelled. In fact, as a result of this dual action, the colon produces two types of excrement: hard and soft. Table 14 shows the chemical composition of these pellets.

The hard pellets are expelled, but the soft pellets are recovered by the rabbit directly upon being expelled from the anus. To do this the rabbit twists itself round, sucks in the soft faeces as they emerge from the anus, then swallows without chewing them. The rabbit can retrieve the soft pellets easily, even from a mesh floor. By the end of the morning there are large numbers of these pellets inside the stomach, where they may comprise three quarters of the total contents.

From then on the soft pellets follow the same digestive process as normal feed. Considering the fact that some parts of the intake may be recycled once, twice and even three or four times, and depending on the type of feed, the rabbit's digestive process lasts from 18 to 30 hours in all, averaging 20 hours.

The soft pellets consist half of imperfectly broken-down food residues and what is left of the gastric secretions and half of bacteria. The latter contain an appreciable amount of high-value proteins and water-soluble vitamins. The practice of caecotrophy therefore has a certain nutritional value.

The composition of the soft pellets and the quantity expelled daily are relatively independent of the type of feed ingested, since the bacteria remain constant. In particular, the amount of dry matter recycled daily through caecotrophy is independent of the fibre content of the feed (Table 7-15). The higher the crude content of the feed and/or the coarser the particles, the sooner it passes through the digestive tract.

On the other hand, this particular function requires roughage. If the feed contains few large particles and/or it is highly digestible, most of the caecal contents are pushed back to the caecum and lose elements which nourish the "normal" bacteria living in the caecum. This would appear to increase the risk of undesirable bacteria developing in this impoverished environment, some of which might be harmful.

It is thus advisable to include a minimum of roughage in the feed, enabling the rabbit's digestive process to be completed fairly rapidly. In theory, roughage is provided by the crude-fibre content of the feed, as this is normally rather hard to digest. However, certain fibre sources (beetroot pulp, fruit pulp in general) are highly digestible (digestibility of crude fibre varies from 60 to 80 percent). Recommendations now made on quantities of indigestible crude fibre to be fed are

therefore given below. Table 16 gives the chemical composition of various raw materials which can be fed to rabbits.

Caecotrophy regulation depends on the integrity of the digestive flora and is governed by intake rate. Experiments have shown that caecotrophy starts eight to 12 hours after the feeding of rationed animals, or after the intake peak of animals fed ad lib. In the latter case, the intake rate and hence the function of caecotrophy are governed by the light regime to which the animals are subjected.

Caecotrophy also depends on internal regulatory processes as yet not understood. In particular, the removal of the adrenals halts caecotrophy. Cortisone injections of animals without adrenals causes the resumption of normal behaviour. The digestive process of the rabbit appears to be highly dependent on adrenalin secretions. Hypersecretion associated with stress slows down digestive activity and entails a high risk of digestive ailments.

Composition of hard and soft faeces: averages and range for ten different feeds

Components	**Hard pellets**		**Soft pellets**	
	Average	**Range**	**Average**	**Range**
	(Percentage)			
Moisture	41.7	34-52	72.9	63-82
Dry matter	58.3	48-66	27.1	18-37
	(Percentage of dry matter)			
Proteins	13.1	9-25	29.5	21-37
Crude fibre	37.8	22-54	22.0	14-33
Fats	2.6	1.3-5.3	2.4	1.0-4.6
Minerals	8.9	3.1-14.4	10.8	6.4-10.8
Nitrogen-free extract	37.7	28-49	35.1	29-43

Source: Proto, 1980.

Intake and excretion of dry matter by growing rabbits eating is nitrogenous feeds containing two levels of straw in place of maize starch

	Experimental feeds	
	Low fibre content	**High fibre content**
Straw content *(%)*	5	20
Crude-fibre content *(%)*	10.8	16.8
Daily dry-matter intake *(g)*	60±28	67±28
Dry matter excreted each day in:		
hard pellets *(g)*	20±5	33±8
soft pellets *(g)*	10±4	10±5

Source: C. Dehalle, personal communication, 1979.

Caecotrophy first starts to function in young rabbits (domesticated or wild) at the age of about three weeks, when they start eating solid feed in addition to mother's milk.

Feeding behaviour

Feeding behaviour studies have basically involved rabbits receiving balanced concentrates or fed ad lib on dry feed (cereals, straw, dry forage).

The feeding pattern of newborn rabbits is imposed by the dam. A doe feeds her young only once every 24 hours (although some does will nurse their young twice). Suckling lasts only two or three minutes. If there is not enough milk the young try to feed every time the doe enters the nest-box, but she will hold back her milk. This behaviour signals insufficient milk production in the doe.

From the third week of life the young rabbits begin to move about, taking a few grams of mother's milk and a little drinking water if available. In a few days the intake of solid feed and

water will exceed the milk intake. During this period the changes in feeding behaviour are remarkable: the young rabbit goes from a single milk feed a day to a large number of alternating solid and liquid feeds distributed irregularly throughout the day: 25 to 30 solid or liquid meals every 24 hours.

The number of feeds during light periods drops and the morning "feeding rest" tends to lengthen. The feeding habits of wild rabbits are even more nocturnal than those of domesticated rabbits.

The Importance of Fiber in rabbit nutrition

Many different types of microorganisms (bacteria and protozoa) normally live in the rabbit intestine and cecum and aid tremendously in fermentation and digestion of foods. Fiber is required for these microorganisms to function properly and stay in balance. Fiber also stimulates motility of the gastrointestinal tract and helps keep food moving properly so that normal digestion and absorption of nutrients can take place. Without fiber, gut motility slows down, the normal bacterial population is disrupted, and changes in gut pH and fermentation occur. This dangerous cascade of events can lead to indigestion or gut stasis, and can make a rabbit very ill. Rabbits experiencing this type of illness, called ileus, may show a decreased appetite, decreased fecal production, decreased size of fecal balls, softer feces, weight loss, increased gas production, and possibly diarrhea or other life-threatening disease. Ileus is frequently misdiagnosed as a “hairball” stomach obstruction.

High fiber is also necessary to keep the teeth in normal wear. A rabbit’s teeth grow continuously throughout its lifetime. In the absence of a high fiber diet, the teeth tend to overgrow, and complications can result including incisor or molar malocclusion, molar points, or tooth root and facial abscesses. When your rabbit is fed an improper diet that is, one that does not contain an adequate amount of [indigestible] fiber or one that is too high in carbohydrates the Gastro-Intestinal (GI) tract cannot function properly and it begins to shut down, causing various degrees of what is called GI stasis.

What is GI stasis?

When the speed with which material moves through the GIT is altered it can affect how quickly the stomach and cecum empty. When this happens we often see a dramatic decrease in the rabbit's appetite for both food and water, which only furthers the problem: The body still needs water to function so it takes it from the stomach and cecum, causing the contents of the entire GI tract (food, hair from grooming, etc.) to become further dehydrated and impacted. The bunny is then unable to pass the mass of food/hair in the stomach, feels full, uncomfortable and often gassy (due to the build-up of the bad bacteria in the cecum), which only adds to his "I don't want to eat" mentality! A rabbit in GI stasis will often stop eating, become anorexic and die. When a rabbit dies from GI stasis and its related problems it is most often due to hepatic *lipidosis* or Fatty Liver Disease, which is caused by the toxins produced by the bad bacteria in the cecum.

In most cases, especially those caught early-on by observant owners, GI stasis can be reversed with time, *patience* and good advice from your rabbit vet. But our goal is to prevent it from happening at all.

What Causes GI Stasis?

A rabbit's intestine can become static for a variety of reasons, including

(1) stress (2) dehydration (3) pain from another underlying disorder or illness (such as gas, dental problems, infections, or urinary tract disorders)

(4) an intestinal blockage or (5) insufficient dietary crude fiber. Left untreated, the slowdown or complete cessation of normal intestinal movement (peristalsis) can result in a painful death, in a relatively short period of time.

An intestinal slowdown can cause ingested hair and food to lodge anywhere along the GI tract, creating a potential blockage. Also, because the cecum is not emptying quickly enough, harmful bacteria such as *Clostridium* species (related to the ones that cause botulism and tetanus) can proliferate, their numbers overwhelming those of the normal, beneficial bacteria and fungi in the cecum. Once this overgrowth occurs, gas emitted by the bacteria can cause extreme pain. Some

Clostridium species also produce potentially deadly toxins. It is the liver's job to detoxify these poisons, at a high cost to that all-important organ. Damage to the liver can be a serious--even life-threatening--side effect of GI stasis.

Rabbits can be fed on four major types of feed

1) Grass 2) Weeds

3) Leaves 4) Agro- industrial by products

5) Concentrates

GRASSES

1) Elephant grass 2) Spear grass

3) Guinea grass

WEEDS

- ***Tridax procumbens*** - ***Asphilia africana*** - ***Syndrella nodiflora***

- ***Milk weed*** - ***Talinum triangulare***

LEAVES

1) Sweet patoto leaf 2) Pawpaw leaf 3) Cowpea leaf 4) Plantain leaf

AGRO-INDUSTRIAL BY PRODUCT

- **Maize milling waste** - **Ground nut haulms**
- **Maize chaff** - **Rice milling waste**

TYPICAL RABBIT CONCENTRATE

Ingredients	**%composition**
Maize	**45.00**
Soya bean meal	**10.00**
Ground nut cake	**10.00**
Palm kernel cake	**10.00**
Wheat offal	**19.50**
Bone meal	**2.00**

Oyster Shell	**1.50**
Premix	**0.25**
Salt	**0.25**
	100.00

M.E=2.55 KCAL/G

CP= 18%

CF = 15%

CONCENTRATE FEEDING IS THE MANAGEMENT OF CHOICE

Because - Concentrate feed is in form of mash

-It is easy to serve.

- Left over does not stink

- It supplied the necessary nutrients

- It encourage and maintain sanitation and cleanliness in farm

A recommended level of 50-100g concentrates daily depending on age and physiological status Concentrates are supplied in concrete feeders of varying height

-Clean water is supplied in drinkers daily

-Wash feeders every other day to prevent mouldiness

Adaptation of Rabbits to forage based- diets

The caecum is the major site of microbial growth and fermentation. So small herbivores like rabbit have evolved a unique digestive strategy that allows them to utilize a forage- based diets. The followings are noted in rabbit:

(i) The digestive system involves selective separation of fibre particles from non- fibre components (stomach) for fermentation in the caecum.

(ii) The selective separation and excretion of fibre is accomplished by muscular activities of the portioned colon. Fibre particles are less dense than other components of a forage, so they tend to segregate out in solution. The separated fibre particles are moved rapidly by peristaltic action to the colon, forming the faecal pellet (hard feces)

(iii) Reverse peristalsis moves the non- fibre components (starch, granules, proteins, hides) from the proximal colon to the caecum whore they undergo microbial fermentation. Colon is emptied completely every 24hrs of hard faeces and the soft faeces or chemotropism are excreted. In this process, the caecum contracts to move the caecal content into the proximal colon. Mucus is separated by goblets cells into the lining of proximal colon, covered or coated the cecotropes, which resembles grapes in appearance. These are moved true the colon by peristaltic action and are consumed directly from the anus by the animal.