

FEED AND WATER CONSUMPTION PATTERNS OF RABBITS DURING THE DAY AND
AT NIGHT

BY

Uchechukwu Emmanuel CHIOMA

AGR1800095

DEPARTMENT OF ANIMAL SCIENCE
FACULTY OF AGRICULTURE
UNIVERSITY OF BENIN
BENIN CITY.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Rabbits have a distinctive feeding behaviour that sets them apart from other mammals. This is due to their unusual digestive physiology, which falls between that of monozastric and herbivorous animals. Being herbivores, their eating technique differs significantly from that of ruminants. Rabbits are classified within the Lagomorpha order, specifically the Leporidae family, which encompasses both rabbits and hares (Grassé & Dekeuser, 2015). Although rabbits exhibit certain behaviours similar to rodents, such as chewing, they are not categorised as rodents. The majority of our comprehension on rabbit feeding behaviour is derived from research conducted on domestic rabbits, who are commonly bred for meat, fur, or as subjects in laboratory experiments. These trials frequently entail rabbits being provided with some well-balanced, complete pelleted feed ad libitum, occasionally supplemented with dry forages or straw, but typically without a genuine unrestricted selection of food. A distinctive characteristic of rabbit eating behaviour is caecotrophy, a process in which rabbits excrete and promptly consume specialised soft faeces known as "caecotrophes". As a consequence, rabbits consume two distinct forms of food: feeds and caecotrophes. Caecotrophes are produced by holding food particles in the fermentative section (caecum and proximal colon) until they become sufficiently tiny in size. Contrary to ruminants, rabbits employ a different approach by prioritising a

1.3 OBJECTIVE OF STUDY

1. To Investigate Water Consumption Patterns: Determine how different factors such as environment, diet, and age affect daily water intake in rabbits.

2. To Analyze Feed Consumption Patterns: Examine feeding behavior in rabbits, including frequency, duration, and type of feed consumed.
3. To Explore the Relationship Between Water and Feed Intake: Investigate the correlation between water consumption and feed intake in rabbits under various conditions.
4. To Determine Optimal Feeding and Watering Practices: Provide recommendations for optimal feeding and watering practices to ensure the health and productivity of rabbits in various production systems.

CHAPTER TWO

LITERATURE REVIEW

2.1 ANATOMY OF THE ALIMENTARY TRACT, BASES OF DIGESTIVE PHYSIOLOGY AND CAECOTROPHY.

The rabbit is an herbivorous mammal that 'belongs to the Lagomorpha order, specifically the Leporidae family, which includes rabbits and hares (Grassé and Dekeuser, 2015).

Therefore, despite its inclination to gnaw, it is not classified as a rodent. The data on feeding behaviour has primarily been gathered from domestic rabbits, which are commonly bred for meat or fur production, or used as laboratory animals. The study primarily focused on rabbits being provided with a balanced and full pelleted diet, with the option of being supplemented with dry forages or straw. However, in most cases, the rabbits did not have the opportunity to freely choose their own food. A distinctive characteristic of rabbit eating activity is caecotrophy, which entails the excretion and prompt consumption of specialised excrement known as soft faeces or "caecotrophes".

Therefore, the rabbit's daily eating habits consist of two types of meals: feeds and caecotrophes. The rabbit's digestive tract is specialised for a diet consisting of plants. It has specialised adaptations, such as modified teeth and an enlarged hindgut for fermentation. Additionally, it is capable of separating caecal digesta particles, which enables a process called caecotrophy.

2.1.1 ANATOMY

In an adult rabbit (4 to 4.5 kg) or semi-adult (2.5 to 3 kg), the total length of the alimentary tract is 4.5 to 5 m. The general organization of the digestive tract is presented in the figure

I together sixth the main characteristics of each segment.

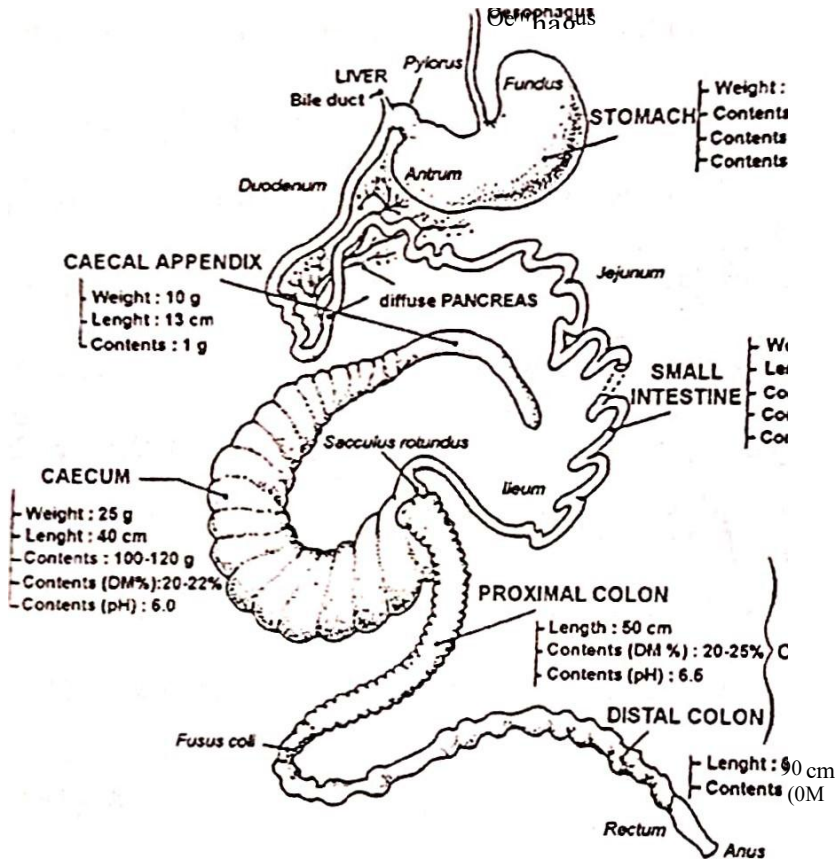


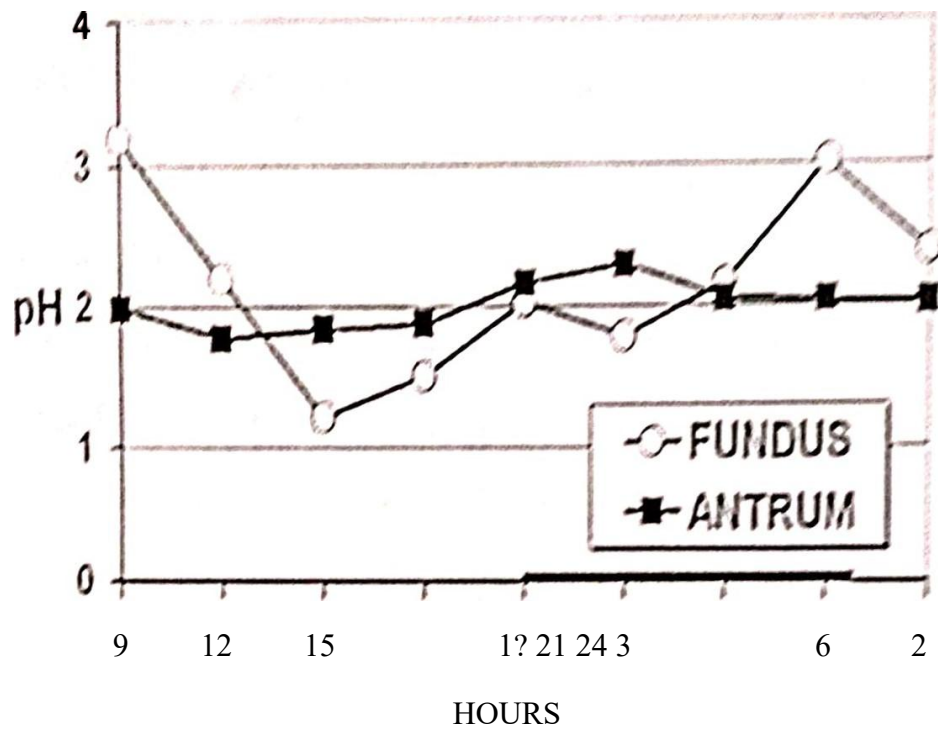
Figure 1: The digestive tract of a rabbit. Numerical values are those observed in a 2.5 kg New Zealand White rabbit, fed ad-libitum a pelleted balanced diet (according to Lebas *et al.*, 1997).

Mouth and Oesophagus

The rabbit's dental formula is $2/1 \ 0/0 \ 3/2 \ 3/3$. The 28 teeth grow continuously throughout life (1 to 2.4 mm/week) (Gyarmati *et al.*, 2000). The teeth in the upper jaw and lower jaw experience wear mostly from each other, regardless of the hardness of the food they consume (Gyarmati *et al.*, 2000; Cheeke, 1974). Incisors are responsible for cutting raw feeds, while molars shred them into coarse pieces. However, overall mastication efficiency is low (Cheeke, 1974). Mastication is less significant when a rabbit consumes pelleted diets, but becomes more significant when consuming raw forages, with an average of 120 mastication movements per minute (Cheeke, 1974). The salivary glands generate saliva with a relatively low concentration of amylase, which is approximately 10-20 times less than the concentration seen in pancreatic juice (Cheeke *et al.*, 1977). The duration between when food is consumed to when it is swallowed is quite brief, typically lasting only a few seconds (Cheeke *et al.*, 1977). The oesophagus is a brief structure that solely functions to convey food from the mouth to the stomach. According to Cheeke *et al.* (1977), regurgitation or vomiting is not feasible.

Stomach

Following a rapid passage down the oesophagus, the feeds enter the uncomplicated stomach, where they are stored in a quantity of around 90 to 120 g of a somewhat thick mixture of feedstuffs. The dry matter content ranges from 16% to 23%. The blind portion of the stomach is referred to as the fundus, while the opposite portion is known as the antrum. The antrum serves as the entry to the small intestine through the pylorus (Gidenne



Small intestine

The length of the small intestine is around 3 metres, while its width ranges from 0.8 to 1 centimetre. The structure is traditionally categorised into three sections: duodenum, jejunum, and ileum (Jamkhandi, 2019). The biliary duct opens directly after the pylorus, but the pancreatic duct opens 40 cm further down in the duodenum. The components of

the upper section have a high liquid composition, with a dry matter percentage of less than 10%. The pH in the upper section is somewhat alkaline (pH 7.2-7.5), whereas it becomes more acidic towards the end of the ileum (pH 6.2-6.5) (Cheeke *et al.*, 1977). Typically, there are short parts, approximately 10 cm in length, that are devoid of any content. The small intestine terminates at the caecum base through the ileo-caecal valve or sacculus rotondus, which primarily consists of lymphoid tissue.

Caecum

The second storage segment comprises approximately 40% of the total digestive material.

It has a length of around 40 to 45 cm and an average diameter of 3 to 4 cm (Cheeke *et al.*, 1977). The mixture is homogeneous and pasty, weighing between 100 and 120 grammes. It has a dry matter percentage of approximately 20-24%. The pH fluctuates around 6.0, with a minimum of 5.6 during the night and a maximum of 6.4 in the morning (see figure 3). The organ wall partially extends into the caecum lumen in a spiral pattern (with 2225 spires), hence enhancing the chances of interaction between the inner surface and the contents of the caecum (Jamkhandi, 2019). The caecal appendix, located at the distal end of the caecum, measures approximately 10 to 12 cm in length and has a significantly smaller diameter. The wall is made up of lymphoid tissues,

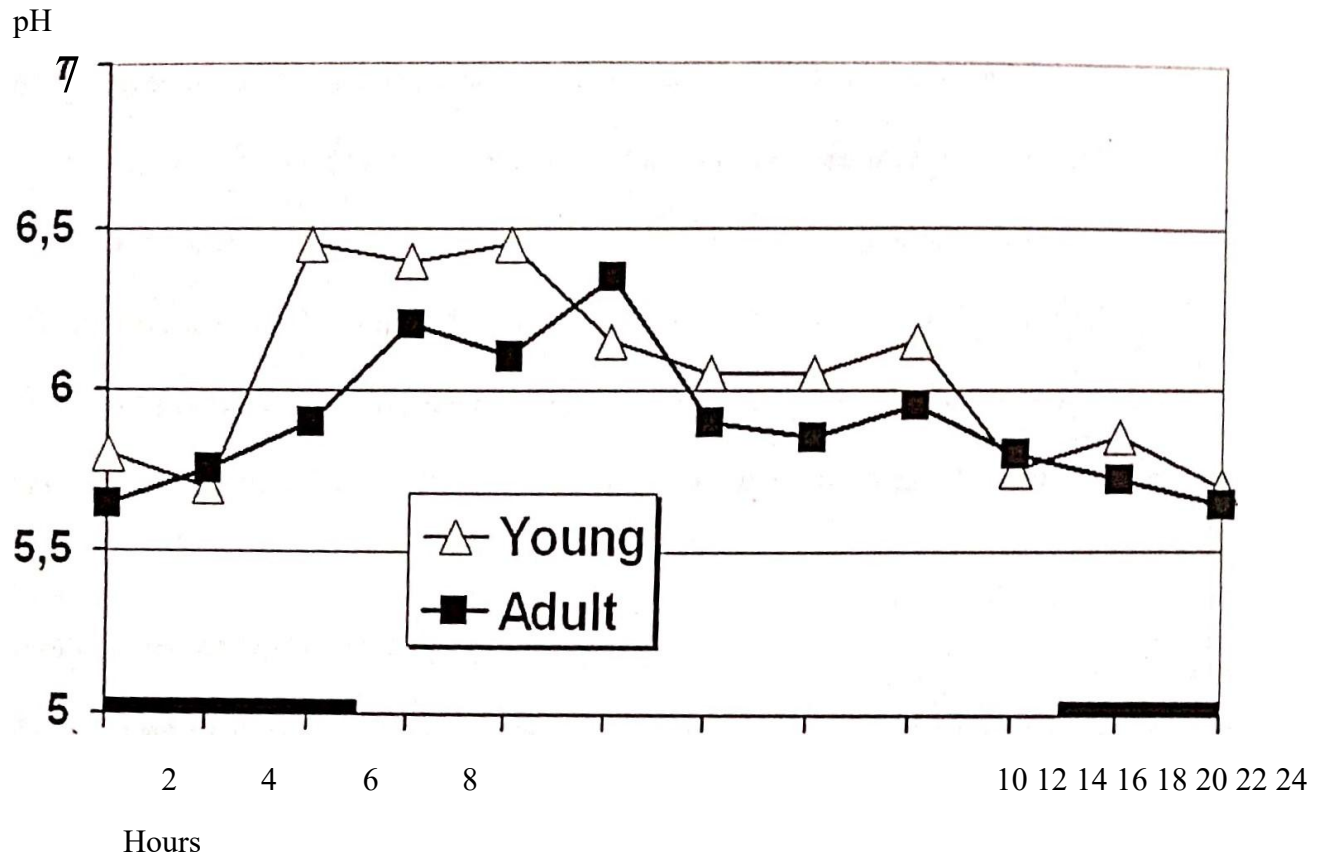


Figure 3: Nycthemeral variations of pH of the caecal contents, in 6 weeks old and adults' rabbits (18 weeks old), according to Bellier *et al.* (2019).

Colon .The colon, which is 1.5 metres long, starts at the base of the caecum. The initial 50 cm of the colon is referred to as the proximal or castrated colon, characterised by three castrations lines at the beginning and one at the end (Jamkhandi, 2019). The gut concludes with the compact fusus coli, measuring 1-2 cm in length, which is the sole section of the intestine containing red muscle. The distal colon, which is 1.0 metre in length, follows this zone and terminates at the rectum and anus. The diameter of the proximal colon is around 2-3 cm, while the distal colon has a diameter of 1 cm (Bellier *et al.*, 2019).

General development of the digestive tract

The digestive tract of a young rabbit is more developed compared to that of an adult rabbit. The New Zealand White breed, which is frequently examined, exhibits the definitive size of its digestive tract when the rabbits are 12-14 weeks old and weigh 2.62.7 kg while alive, which corresponds to just 60-70% of their maximum weight. Furthermore, the maturation of the lower portion of the digestive system, including the caecum and colon, occurs at a later stage compared to the top portion, which includes the stomach and small intestine (Bellier *et al.*, 2019).

2.1.2 DIGESTIVE PHYSIOLOGY

A classical digestion process in the upper part of the digestive tract

The rabbit rapidly digests the feed, which promptly enters the stomach. Upon reaching the stomach, it encounters an acidic environment and stays there for a duration of 2 to 4 hours, exhibiting minimal chemical alteration (Faure, 2013). Therefore, the rabbit's stomach can be regarded as a temporary storage unit. The stomach contents are progressively transferred into the small intestine through intermittent bursts, facilitated by forceful contractions of the stomach (Beilier *et al.*, 2019; Carabaño *et al.*, 2010). Upon entering the small intestine, the contents are diluted by the flow of bile, the initial intestinal secretions, and ultimately by the pancreatic juice. Following enzymatic activity from these latter two secretions, the components of the feed that can be readily broken down are released and traverse the intestinal wall to be transported by the bloodstream to the cells, after being collected by the portal vein system and passing via the liver (Björnhag, 2012). Particles that remain undigested after approximately 1-2 hours in the small intestine go to the caecum. The duration of their stay ranges from 2 to 18 hours, with an average of 6 to 12 hours, as reported by Carabaño *et al.* (2010). During this time, they are subjected to attack by bacterial enzymes. The caecum is the second storage compartment of the digestive tract, serving as a long-term storage area (Björnhag, 2012). The new attack breaks down certain elements, resulting in the production of

volatile fatty acids and ammonia. These broken-down elements either enter the bloodstream through the wall of the digestive system or are metabolised by other bacteria. The contents of the caecum are subsequently expelled into the colon (Carabaño *et al.*, 2010). Approximately 50% of the content is composed of undigested food particles, both large and small, together with partially decomposed intestinal secretions. The remaining 50% is made up of bacteria that have grown in the caecum and have been nourished by the material coming from the small intestine.

The dual functioning of the colon and the caecotrophy

Currently, the operation of the rabbit's digestive system is essentially identical to that of other monogastric mammals. The distinctive characteristic of rabbit species (as well as Lagomorpha in general) is the dual role of the proximal colon (Carabaño *et al.*, 2010). If the contents of the caecum enter the colon during the early morning, they experience few metabolic alterations. The colon wall releases mucus that progressively covers the pellets produced by the contractions of the wall. These elongated clusters of pellets are referred to as soft pellets, or more precisely, caecotrophes. If the contents of the caecum enter the colon at a different time of day, the functioning of the proximal colon is completely altered. Consecutive waves of contractions in opposite directions initiate (Morot, 2016); the first to expel the contents in a regular manner and the second to push them back into the caecum. The contents are compressed, similar to a sponge, due to the fluctuating pressure and rhythm of these contractions. The majority of the liquid component, which consists of soluble substances and minute particles measuring less than 0.1 mm, gathers along the wall of the colon in the haustrae and is subsequently pushed back into the caecum (Björnhag, 2012). The solid portion, consisting primarily of particles larger than

0.3 mm in length, remains in the centre of the colon's lumen and is propelled towards the rectum in the form of firm pellets. The latter are promptly evacuated (Carabaño *et al.*, 2010). Due to its dual activity, the colon generates two distinct types of excrement:
solid

and liquid. Table 1 presents the chemical makeup of these pellets, as documented by Björnhag in 2012. Upon production, solid faeces are promptly evacuated, but loose pellets are momentarily retained in the distal colon. The rabbit retrieves the ejected faeces immediately through grooming in the early morning, as described by Faure (2013). In order to accomplish this, the rabbit coils its body around, ingests the tender excrement as it is expelled from the rectum, and thereafter consumes them without mastication. The rabbit is able to effortlessly acquire the tender pellets, even when they are on a mesh floor. At the conclusion of the morning, a significant quantity of these pellets accumulate in the stomach, potentially accounting for over 75% of the overall contents (Gidenne, 2017 — figure 4). The presence of these soft pellets in the stomach led to the initial accurate definition of caecotrophy by Morot in (2016). Caecotrophy refers to the creation of two forms of excrement and the deliberate absorption of one of the two types, specifically the soft ones. Caecotrophy differs from the coprophagy commonly observed in rats or pigs, as it involves the production and partial consumption of only one type of excrement. Following a period of 4-6 hours in the stomach, which is longer than the typical digestion time for regular food, the soft pellet contents undergo the same digestive process as normal feed after breaking down the external aggregative structure. The rabbit's digestive process typically lasts from 18 to 30 hours, with an average duration of 20 hours. This duration may vary depending on the type of diet and the number of times certain sections of the initial intake are recycled. The soft pellets are composed of partially digested food remnants, including incompletely broken-down food leftovers, digestive fluids, and

consists of a small number of large particles and/or is easily digestible, the majority of the contents in the caecum are returned to the caecum itself. This results in the loss of essential nutrients that provide nourishment to the "normal" bacteria residing in the caecum. This could potentially elevate the likelihood of the growth of harmful bacteria in an imbalanced environment that has a scarcity of carbohydrates but is abundant in nitrogenous substances (Carabaño *et al.*, 2010). Certain unforeseen germs may provide a potential threat. Therefore, it is recommended to add a little amount of indigestible

material in the rabbit's diet to ensure the presence of undigested particles in the colon during the formation of solid faeces. This will facilitate the rabbit's digestion process to occur quickly and efficiently (Morot *et al.*, 2016). The regulation of caecotrophy is contingent upon the integrity of the flora and the rhythm of feed intake. The consumption of soft pellets is often detected 8-12 hours after the feed is distributed in cases of feed limitation, or after the major period of ingestion in rabbits that are fed ad libitum (Laplace, 2018). The intake rhythm of the latter is directly influenced by lighting, which in turn affects the caecotrophy rhythm as well (Carabaño *et al.*, 2010). The regulation of caecotrophy is also subject to internal regulation. For instance, the removal of the adrenal glands inhibits the dual functioning of the colon, while infusions of cortisol in rabbits that have had their adrenal glands removed can reinstate it. The caecotrophy behaviour emerges in young animals (whether domesticated or wild) when they start consuming solid food, often between 22 and 26 days of age (Orengo and Gidenne, 2005).

Table 1 : Average composition of rabbit's hard and soft pellets (according to Proto, 1980). Means and dispersion correspond to a study with 10 feedstuffs including complete pelleted feeds, green and dry forages.

Hard pellets

Caecotrophes

	Average	Extremes	Average	Extremes
• Dry matter (%)	53.3	48-66	27.1	18-37
<i>as % DM</i>				
• Proteins	13.1	9-25	29.5	21-37
• Crude fiber	37.8	22-54	22.0	14-33
• Lipids	2.6	1.3-5.3	2.4	1.0-4.6
• Minerals	8.9	3-14	10.8	6-18

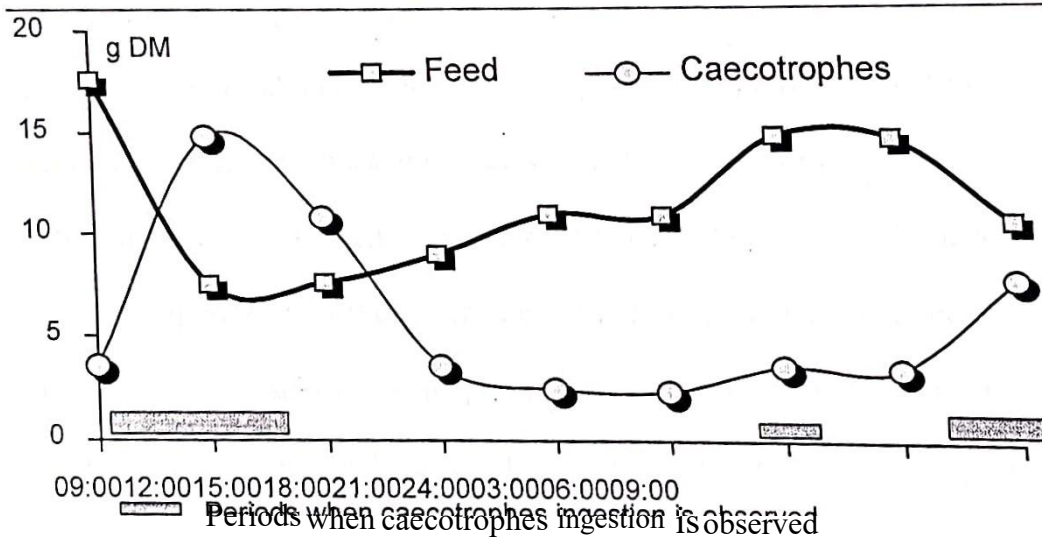


Figure 4: Daily variation of the stomach content (9weeks old rabbits, daily feed intake

2.2 FEEDING BEHAVIOUR IN THE DOMESTIC RABBIT

The feeding behaviour of the newborn rabbits is determined by the mother. Indeed, a female deer nourishes her offspring solely once every 24 hours (Cross, 2012; Zarrow *et al.*, 2015). Recent research has indicated that a portion of does (10-15%) engage in nursing their young twice a day. This occurs more frequently during the second week of lactation, with an average of 1.3 nursing sessions per 24 hours (Hoy and Selzer, 2012). The duration of suckling for a litter of 8 to 11 kits is typically limited to 2-3 minutes. The initial suckling, as colostrum, typically took place during

the birthing process for the first offspring, and within the initial hour following birth for the remaining offspring. The initial consumption of milk is crucial for the survival of the kits (Coureaud *et al.*, 2010). Newborn rabbits do not exclusively use one nipple (unlike piglets), but they are capable of switching between nipples frequently even within a single feeding session (Hudson *et al.*, 2010). Kits that are between five to six days old have the capacity to consume up to 25% of their body weight in milk during a single breastfeeding session. The behaviour of seeking for nipples is highly stereotyped and regulated by a pheromonal signal (Schaal *et al.*, 2013). When there is insufficient milk, the offspring attempt to eat each time the female enters the nest box, but she will withhold her milk. However, if two suckling does are offered daily, with one every 12 hours, the young are capable of suckling twice, resulting in an increased growth rate (Gyarmati *et al.*, 2010). During the initial week after birth (specifically between 4 and 6 days old), the offspring also ingest solid waste left by the female rabbit in the nest. This process helps to promote the development of the bacteria in the cecum (Kovacs *et al.*, 2014). Between one and three weeks of age, the young offspring gradually increase their daily milk consumption from 10 to 30g through suckling (as shown in figure 5). After this period, the milk production of the mother goat starts to decline, especially if she is pregnant. A juvenile rabbit, raised in a group of 7-9 offspring, typically eats approximately 360 to 450 grammes of milk from birth until 25 days old. This amount decreases to 100 to 150 grammes from 26 to 32 . days old. The milk intake patterns of individuals exhibit considerable variability and are somewhat dependent on the live-weight of the kit (Fortun-Lamothe and Gidenne, 2010). The consumption of dry feed increases dramatically after the young animal is capable of moving freely to reach a feeder containing pelleted feed and a drinker. This typically occurs when the animal is around 17-20 days old (see to figure 5). According to Gidenne and Fortun-Lamothe (2012), the amount of food consumed per day increases by a factor of 25 between the ages of 20 and 35 days. Nevertheless, significant disparities in the timing of when young animals start consuming solid food have been noted within a litter. For instance, when there is more competition for milk, the amount of dry feed consumed by the young is influenced by the size of the litter (Fortun-

Lamothe and Gidenne, 2010). In contrast, providing a second milking to the young using a second doe resulted in a delay in their consumption of dry feed (Gyarmati *et al.*, 2010). In addition, the juvenile rabbits exhibit a preference for consuming food from the mother feeder rather than a feeder specifically designed for young bunnies (Fortun-Lamothe and Gidenne, 2013).

This behaviour is likely a result of imitating their mother's feeding habits. The age at which an animal is weaned is a significant influence in controlling the amount of dry feed it consumes. For example, in its natural habitat, the juvenile rabbit can be separated from its mother and start eating solid food at around 3 1/2 weeks of age (Carabaño *et al.*, 2010). This occurs when the mother rabbit is pregnant and getting ready to build a new nest for her next litter, which compels her to quickly switch to consuming dry food. The period between 25 and 30 days of age is significant because the consumption of solid food and water will surpass the consumption of milk. During this period, the feeding behaviour of the juvenile rabbit undergoes significant changes. It transitions from consuming only one milk meal per day to consuming a high number of solid and liquid meals, which are dispersed sporadically throughout the day. The number of meals can range from 25 to 30 per 24 hours (Gyarmati *et al.*, 2010). Furthermore, as previously stated, the caecotrophy behaviour begins between 22 and 26 days of age, coinciding with a substantial intake of dry feed. This intake results in the filling of both the caecum and colon, and triggers the dual motility pattern in the proximal colon. During the weaning process, kits have four different types of intake: milk, solid food, caecotrophes, and water (Gyarmati *et al.*, 2010). Nevertheless, the specific feeding patterns of the young are not well understood, including elements that regulate their feeding behaviour and the frequency of their meals. This lack of knowledge is due to the absence of a current way to accurately measure the amount of food consumed by young individuals kept together until they are weaned.

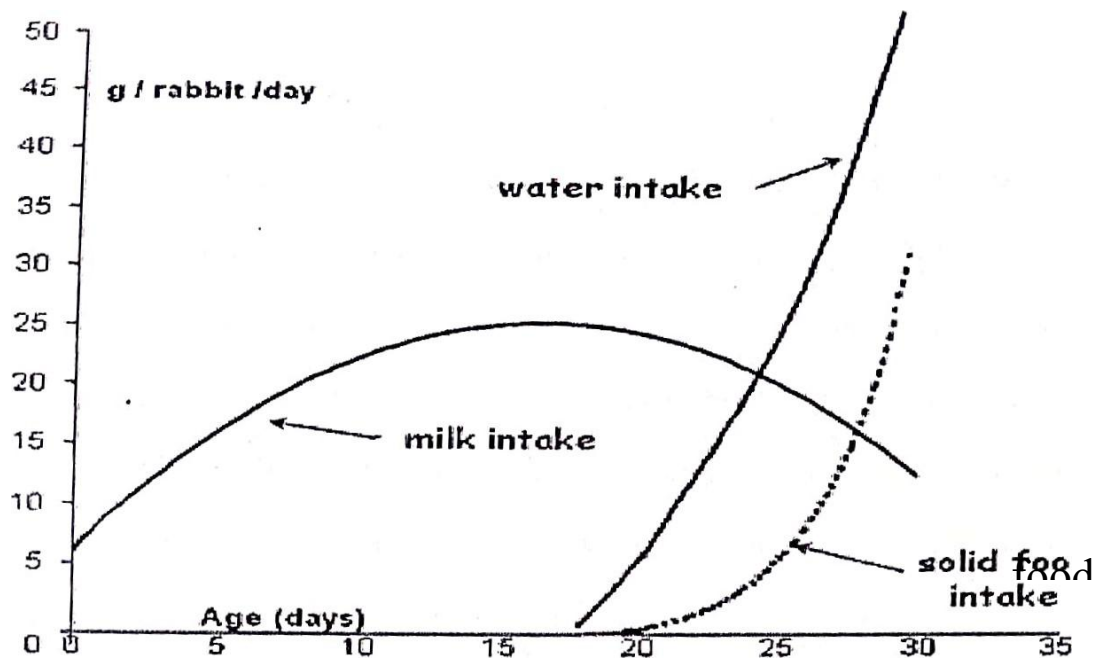


Figure 5: Milk, water and dry feed intake of the young rabbit (adapted from Szendrő *et al.*, 1999; and Fortun-Lamothe & Gidenne, 2000) Mean values, for a kit in a litters of 79 , with pelleted dry feed, nipple drinker, and weaned at 30d (doe remated 1 Id after kindling). Feeding behaviour of the growing and adult rabbit.

Starting with the weaning stage, often between 4 and 5 weeks old, the domestic rabbit's daily intake of food, namely a complete pelleted feed, grows in proportion to its metabolic live-weight (as shown in figure 6). This increase continues until the rabbit reaches about 4-5 months of age, at which point the intake levels out (Gyarmati *et al.*, 2010). Using an adult New Zealand White rabbit weighing 4 kg as a benchmark, a young rabbit at 4 weeks of age consumes only a quarter of the amount of food that an adult bunny consumes. However, the young rabbit's body weight is only 14% of the adult's weight. At 8 weeks, the relative proportions are 62% and 42%. At 16 weeks, they are 100% to 1 and 87% (Gyarmati *et al.*, 2010). During the period between weaning (4-5 weeks) and 8 weeks of age, the weight increase reached its peak (as shown in table 2), while the feed conversion was at its most efficient. Subsequently, the rate at which feed intake increases is slower compared to the rate of growth, reaching its peak at approximately 12-14 weeks of age for modern commercial hybrid lines of domestic rabbits. The level decreases somewhat after reaching this age and then remains stable in adulthood (Fortun-Lamothe and Gidenne, 2010). A rabbit adjusts its food consumption based on its energy requirements, similar to other animals. The chemostatic mechanisms are activated through the nervous system and the concentration of chemicals involved in energy metabolism in the bloodstream. Nevertheless, glycemia is a crucial factor in regulating food intake in monogastric animals, as stated by Fortun-Lamothe and Gidenne (2010). Conversely, in ruminants, the levels of volatile fatty acids in the bloodstream have a significant impact. As a monogastric herbivore, the rabbit's main blood component that regulates feed intake is believed to be the blood glucose level (Parigi-Bini and Xiccato, 2018). The amount of food consumed voluntarily is directly proportional to the metabolic live-weight raised to the power of

0.75. This intake is approximately 900-1000 kJ of digestible energy per day per kilogramme of metabolic live-weight raised to the power of 0.75. The regulation of food intake by chemostatic mechanisms only occurs when the dietary concentration of digestible energy exceeds 9-9.5 MJ per kilogramme. (Parigi-Bini & Xiccato, 2018). Below this threshold, there is a dominant control mechanism that is physical in nature and is associated with the level of gut fullness. The consumption of soft faeces reaches its peak at 2 months of age and thereafter remains constant (figure 6). The consumption of soft faeces, measured in terms of fresh weight, increased from 10 g/day at 1 month old to 55 g/day at 2 months old. This accounted for 15 to 35% of the total food intake (Gidenne and Lebas, 2017). The rabbit divides its voluntary solid intake into multiple meals, around 40 at 6 weeks of age and a somewhat smaller amount when it reaches adulthood (as shown in table 3). The division of meals is likely associated with the stomach's comparatively limited storage capacity, especially when compared to ruminants or even carnivorous or omnivorous animals such as dogs or pigs (see to section 1.1.2). In a study conducted by Parigi-Bini and Xiccato in 2018, it was shown that 6week-old rabbits fed with a pelleted diet spend slightly over 3 hours on eating over a 24hour period. Subsequently, it plummets steeply to under 2 hours. According to Lebas (2013), when rabbits are given a ground non-pelleted diet, the amount of time they spend eating is twice as long. The quantity of liquid meals developed simultaneously with that

of solid food, and the duration of drinking is less than the duration of eating. In addition, rabbits of any age can obtain adequate hydration from feed that has a water content over 70%, such as green forage, when the temperature is below 20°C. In such circumstances, rabbits may not consume water separately (Parigi-Bini and Xiccato, 2018). The typical

water-to-dry matter ratio for rabbits being fed pellets is approximately 1.6-1.8. In the adult or breeding doe, the value is elevated to 2.0-2.1. The amount of solid intake per hour fluctuates throughout a 24-hour period, as depicted in Figure 7. A domestic rabbit following a 12L/12D light schedule consumes more than 60% of its solid feed (excluding soft faeces meals) during the dark period. The diurnal fluctuations in liquid meals closely mirror those of solid meals in domestic rabbits fed pellets (Prudh'on *et al.*, 2015). However, there is no association between the timing or intervals of solid and water meals. The nocturnal eating behaviour grows more prominent with ageing (Hirawaka 2016).

Wild rabbits have much greater nocturnal feeding patterns compared to tamed rabbits. Contrary to popular belief, domestic rabbits do not go without food. They consume around 20 servings of dry feed each day, and also get caecotroph meals in the early morning. In addition, Hirakawa (2016) observed that leporids, which include rabbits, also ingest a portion of their own solid excrement that have been chewed, as opposed to the soft poo that are ingested. The frequency of soft faecal meals, and occasionally hard ones, increases proportionally when rabbits have low food availability. The feed intake level is influenced by the physiological condition of the animal. For example, the amount of food a female deer consumes on her own accord fluctuates significantly throughout her

reproductive cycle (Figure 8) (Parigi-Bini and Xiccato, 2018). The consumption during the last days of pregnancy decreases significantly. Some individuals abstain from consuming solid food immediately prior to giving birth. Water use, on the other hand, never ceases entirely. Following ignition, the consumption of feed experiences a significant and quick surge, reaching levels that can surpass 100 grammes of dry matter per kilogramme of body weight every day. During this period, the amount of water consumed is similarly elevated, reaching up to 200-250 grammes per day per kilogramme of body weight. When a female deer is both pregnant and producing milk, she consumes quantities of food that are comparable to those observed in a female deer that is simply producing milk.

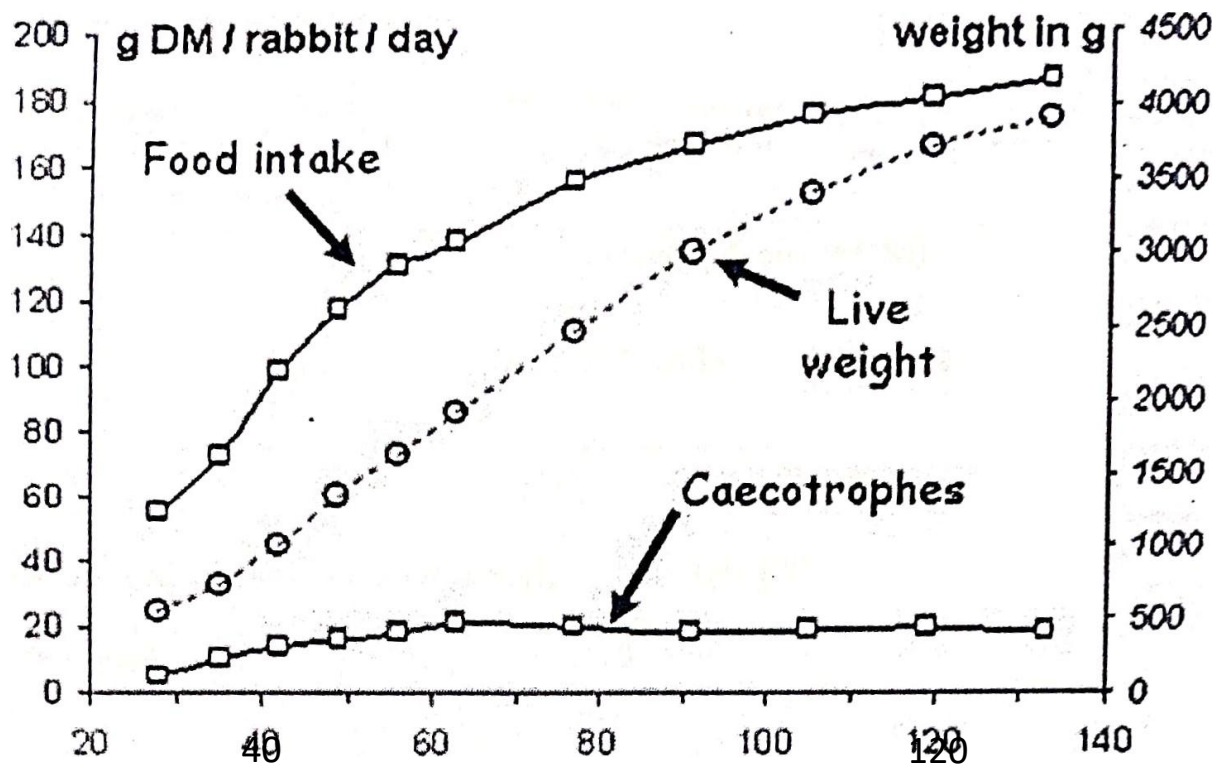


Figure 6: Dry matter intake from pelleted feed, caecotrophes, and live-weight from weaning (28d) till adulthood. Data from domestic rabbit, fed ad-lib. a pelleted feed (Gidenne and Lebas, 1987), data of caecotrophes excretion obtained on rabbits wearing a collar.

Table 2: Feeding behaviour of the domestic rabbit after weaning. Average feed intake and growth rate of rabbits (current commercial lines), fed ad-libitum a pelleted diet (89% DM), and having free access to drinkable water.

	Periods of age (weeks)	
	5-7 weeks	7-10 weeks
Solid feed (pellets, DM) solid 100-120 140feed intake (g/d)		
	170	
Weight gain (g/d)	45-50	35-45
Feed conversion ratio	2.2-2.4	3.4-
3.8		

Table 3: Feeding and drinking behaviour of the domestic rabbit from 6 to 18 weeks old
 Mean values from 9 New Zealand White rabbits, fed ad-libitum a pelleted diet (89% DM)
 and having a free access to drinkable water (Prud'hon *et al.*, 1975).

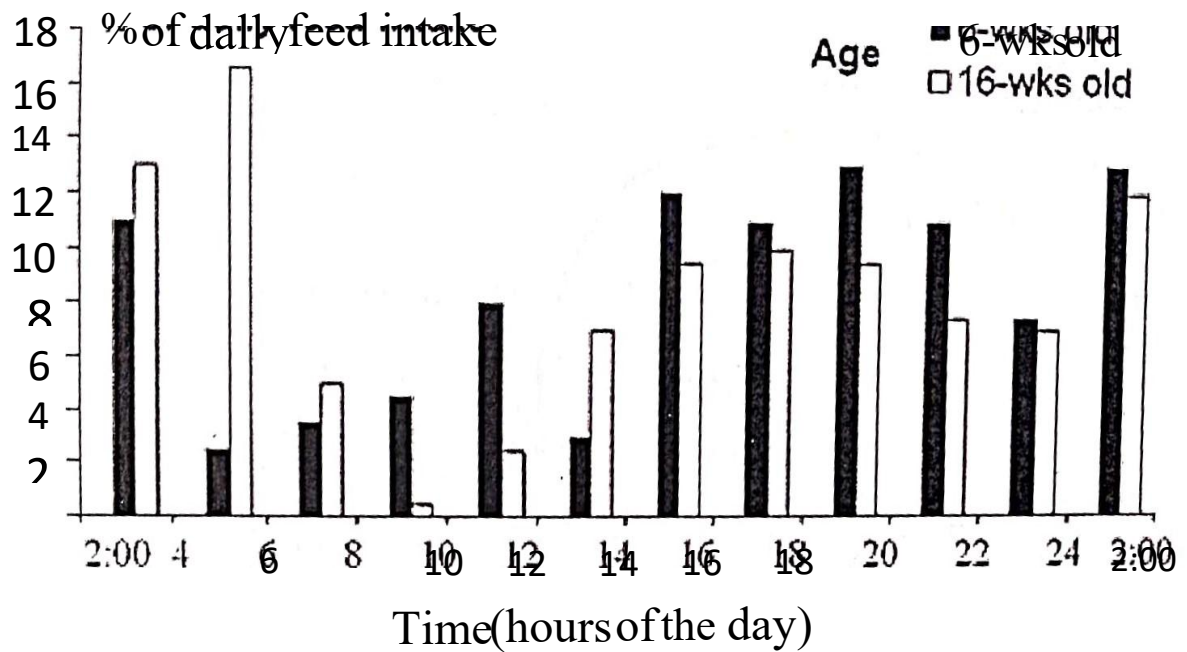


Figure 7: Circadian pattern of feed intake in growing or adult rabbit. Mean values of 2 hours feed intake for domestic (Bellier *et al.*, 2015).

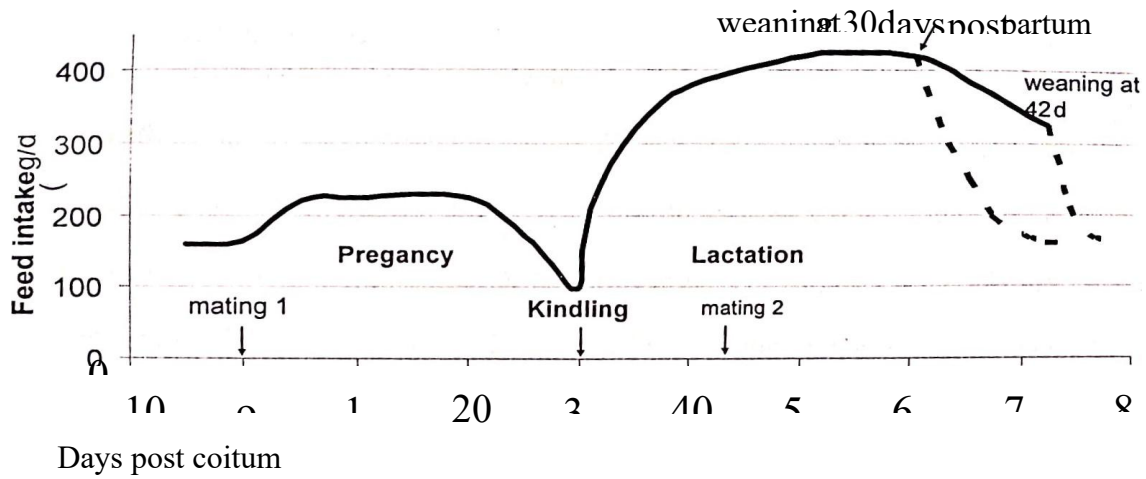


Figure 8: Average daily feed intake of a rabbit doe during gestation and lactation . Data from Lebas (2015), domestic rabbit fed a balanced pelleted feed (89% DM)

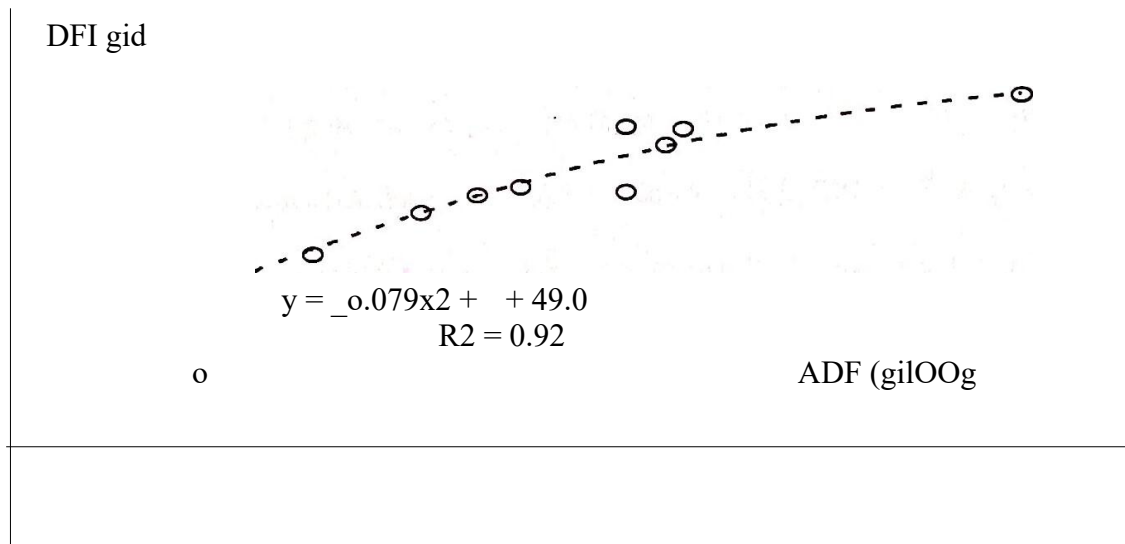
2.3 EXTERNAL FACTORS MODULATING THE FEEDING BEHAVIOUR OF THE DOMESTIC RABBIT

Feed composition and presentation form

The digestible energy (DE) content is a key dietary factor that plays a role in regulating feed intake, particularly after weaning (Parigi-Bini and Xiccato, 2018). The domestic rabbit can control its energy intake (and therefore its growth) when the dietary energy concentration is between 9 and 12 MJ/kg, or when the dietary fibre level is between 10 and 25% ADF (Acid Detergent Fibre), while being provided a balanced diet in pellet form. Figure 9 shows a strong correlation between the consumption level and the dietary fibre level, as opposed to the dietary DE content. Nevertheless, including fat in the diets, while keeping the dietary fibre level same, elevates the dietary DE level but results in a minor decrease in intake. Prior to weaning, the young did not appear to adjust their food intake based on the DE level (Gidenne and Fortun-Lamothe, 2012). Instead, the litters showed a preference for consuming a diet with a greater DE concentration. Additional nutrients in the diets have the capacity to alter food consumption, such as protein and amino acids (Tomé, 2014). For instance, an overabundance of methionine resulted in a decrease of at least 10% in the amount of food consumed by the developing rabbit (Colin *et al.*, 2013; Gidenne *et al.*, 2012). The meal presentation plays a crucial role in influencing the feeding habit of rabbits. When given the option, pelleted feeds are chosen over meals by 97% of individuals, according to Harris *et al.* (2013). In addition, meals appeared to disrupt the circadian rhythm of food consumption (Lebas and Laplace, 2017).

The size and quality of pellets can also impact eating behaviour, including factors such as hardness and durability (Maertens and Villamide, 2018). A decrease in

pellet diameter, which simultaneously enhances hardness, results in a decrease in feed intake among young (Gidenne *et al.*, 2013) or growing rabbits (Maertens, 2014), despite an increase in the time allocated for feeding.



120

100 80 60 5 10 15 20 25 30

Figure 9: Feed intake in weaned domestic rabbit, in relation with diet's digestible energy and ADF content.

Environmental factors affecting the feeding behaviour of the rabbit

The rabbit's energy use is influenced by the surrounding temperature. Feed consumption in order to meet energy requirements is thus associated with temperature

(Colin *et al.*, 2013; Gidenne *et al.*, 2012). Research conducted on rabbits in the growing stage revealed that when exposed to temperatures ranging from 5°C to 30°C, their consumption of pelleted feed decreased from 180 to 120 g per day, but their water intake increased from 330 to 390 g per day (as shown in Table 4). Upon deeper examination of feeding behaviour, it becomes evident that an increase in temperature leads to a decrease in the quantity of solid meals consumed over a 24-hour period. The number of solid feeds decreases from 37 to 27 when the temperature increases from 10°C to 30°C in young New Zealand White rabbits (Colin *et al.*, 2013; Gidenne *et al.*, 2012). The quantity of food consumed per meal decreases as the temperature increases, namely from 10°C to 20°C, dropping from 5.7 grammes per meal to 4.4 grammes at 30°C. However, the amount of water consumed per meal increases, rising from 11.4 grammes to 16.2 grammes between 10°C and 30°C. The feeding and drinking behaviour of the doe and their litters were examined in relation to the prevailing meteorological circumstances, as documented by Cervera and Fernandez-Carmona (2018). In the absence of drinking water and with only dry feed containing less than 14% moisture available, the intake of dry matter decreases to zero within 24 hours. In the absence of water, an adult rabbit can endure for a period of 4 to 8 days without suffering any permanent harm, taking into account factors such as temperature and humidity. However, during this time, the rabbit's

weight may decrease by 20-30% in less than a week (Cizek, 2011). Rabbits provided water but no solid food can sustain themselves for a period of 3 to 4 weeks. During this time, their water consumption will increase to 4-6 times their usual intake a few days. The presence of sodium chloride in the water at a concentration of 0.45% the amount of intake. This has been demonstrated by Colin *et al.* (2013) and Gidenne *et al.* (2012). However,

potassium chloride does not have any impact on sodium loss by urination. The rabbit exhibits a high level of resistance to hunger and a moderate level of resistance to thirst. However, any decrease in the availability of water, based on water requirements (Colin *et al.*, 2013), leads to a corresponding decrease in the consumption of dry matter, resulting in a decline in performance. Additional environmental elements, such as the light schedule or housing systems, have also been examined in residential settings. When rabbits are kept in constant darkness for 24 hours a day, their apparent:

feed intake increases compared to rabbits exposed to either 8 hours or 16 hours of light per day, according to studies by Colin *et al.* (2013) and Gidenne *et al.* (2012). However, their feed efficiency decreases, as reported by Lebas (2017). Under conditions of complete darkness, rabbits established a consistent feeding schedule lasting 23.5 hours. Approximately 5-6 hours were dedicated to consuming soft faeces, while the rest of the cycle was dedicated to food intake. The feeding pattern in continuous lighting is structured according to a roughly 25-hour programme (Rey and Goussopoulos, 2014). For breeding does, reducing the total amount of time they are exposed to light to only 4 hours out of a 24-hour cycle by adding 4-hour periods of darkness during the normal 12 hours of light in a 12L/12D programme (intermittent

lighting) does not change the average amount of food they eat each day. However, it does increase milk production and improve the efficiency of using food for milk production (Virag *et al.*, 2010). The style of caging has an impact on the daily feed intake and feeding pattern of rabbits, as stated earlier (Colin *et al.*, 2013). For example, the amount of food consumed is influenced by the population density of rabbits in the enclosure. Raising the density above the conventional 16-18 rabbits per square metre, which appears to result in increased competition

for food among the animals, leads to a decrease in the amount of food consumed (Aubret and Duperray, 2013). However, this phenomenon is not solely attributed to a rivalry for food sources, since it has also been found in rabbits housed individually in cages (Xiccato et al., 2019). Compared to housing groups of 4 rabbits in cages, housing groups of 30 rabbits in pens (with the same density of 15.5 animals per square metre) allows for increased activity for the rabbits and reduces their daily feed intake (Maertens et Van J lerck, 2010). However, when rabbits are kept in cages of either 2 or 6, they consume the same amount of food each day, regardless of the cage density,

However, rabbits in cages of 2 spend less time eating compared to rabbits in cages of 6. Specifically, rabbits in cages of 2 spend 5.8 % of the observed 12-hour lighting period consuming while rabbits in cages of 6 spend 9.9% of the same period eating (Mirabito et al., 2019). According to Lebas (2015), the number of locations at the feeder

(ranging from 1 to 6) did not affect the daily feed consumption of individual rabbits in a group of 10 rabbits who are fed freely. However, the length of the feeder becomes significant when rabbits are subjected to feed restriction (Rashwan and Soad, 2016).

Table 4: Feeding behaviour of growing rabbits according to ambient temperatures. Data from Eberhart (1980)

Relative humidity			
Pelleted feed eaten (g/day)	182	158	123
Water drunk(g/day)	1.80	1.71	3.14
Water/feed ratio	35.1	37.4	25.4
Average weight gain (g/day)	328		
	271	386	

Feeding behaviour in situation of choice

All studies at basis of the above explained results were conducted with domestic rabbits generally fed with complete and more or less balanced diets. In the wild or in situation of free choice for caged rabbits, another dimension must be added to the feeding low rabbits select the feeds?

- Feeding behaviour of wild rabbits in open situation (grazing rabbits)

Primarily, the feed resources accessible to wild rabbits consist predominantly of a diverse assortment of plant material. Rabbits exhibit a definite preference for graminaceous plants such as *Festuca* sp., *Brachypodium* sp., or *Digitaria* sp. They only consume a small number of dicotyledons if there is an ample supply of grasses (Williams *et al.*, 2014). Among dicotyledonous plants, rabbits selectively graze on some leguminous plants and compositae. However, it is important to note that rabbits have a low preference for grazing on carrots (*Daucus carotta*), resulting in minimal grazing pressure on this plant (CTGREF,

1978). The abundance of dicotyledonous species and even mosses may vary seasonally, influenced by the availability of plants (Bhadresa, 2017). During the winter and early spring seasons, rabbits feeding on cultivated cereals can significantly damage the crop, particularly within a range of 30-100 metres from their burrows (Biadi and Guenezan, 2012). Rabbits have a definite preference for winter cereals that are farmed without chemical fertilisation (phosphorus and/or nitrogen) when given the alternative, as demonstrated by Spence and Smith (2015). Rabbits that graze have a tendency to be highly selective, often choosing specific parts of a plant or specific types of plants that the maximum concentration of (2010). In a study, it was observed that wild rabbits exhibited more intense grazing on particular types of spring barley compared to other varieties. This behaviour is likely related to the content of the plants. However, the variation in sugar content between different types was not sufficient to completely account for the preference of grazing rabbits for specific varieties (Bell and Watson, 2013). It is important to recognise the strong winter appetite that rabbits have for the buds and young stems of certain woody plants. The grazing of young trees shoots can have a detrimental impact on the next generation of certain forests, such as the growth of shrubs like juniper or common .

During the winter season, rabbits have a preference for consuming the bark of some planted trees, including apple trees, and to a lesser extent, cherry and peach trees.

This includes not only the young stems, but also other parts of the tree. The barks of pear, plum, or apricot trees are typically less susceptible to attacks, as stated by CTGREF in 1980. Rabbits in forests exhibit a definite preference for broadleaved trees, but they may also target the bark of conifers, particularly spruce and some types of pines. However, when very young trees are present, rabbits tend to prioritise consuming the apical or lateral sprouts of spruces or firs instead of those of oaks (CTGREF, 1978). The fundamental rationales for the selections remain ambiguous, notwithstanding their consistency. The regulation of rabbits' decision pattern is clearly influenced by the hypothalamus, as evidenced by the significant modifications observed in

rabbits with hypothalamic lesions (Balinska, 2016). The researchers Sanderson *et al.* (2015) have also

discovered a changed feeding habit in rabbits who have undergone vagotomy. A multitude of tests were carried out, particularly in Australia and New Zealand, to investigate the behaviour of wild rabbits when exposed to various types of bait, ranging from natural to artificially produced substances. The ultimate aim of these investigations was to achieve the complete elimination of imported wild rabbits. Significant changes were found based on the type of bait used, as well as the season in which the observations were made. As an illustration, pollard+bran pellets, which have a weight ratio of 5/1, are consumed consistently throughout the entire year. Conversely, the level of acceptance for carrots or oats fluctuates depending on the season. The inclusion of either 1% or 5% NaCl (salt) or 15% lucerne meal in the pollard+bran pellets results in a considerable decrease in bait consumption, as reported by Ross and Bell in 2019.

- **Free choice for domestic caged rabbit**

Rabbits typically exhibit a preference for a diet that includes an appetiser, as opposed to a control diet without an appetiser, according to studies conducted by Colin *et al.* (2013) and Gidenne *et al.* (2012). However, when rabbits are given the same two diets individually, their daily feed intake and growth performance are identical (Fekete and Lebas, 2013). It signifies that the enjoyable aroma of the suggested dish is not necessary for the regulation of food consumption. This was also demonstrated through the use ^{Of a} repellent diet (with the addition of formalin), which was obviously refused in the free choice test but consumed in the same amount in the long-term single food test (Lebas, 2012). Cheeke *et al.* (2017) have shown that rabbits exhibit a preference for a specific

level of bitterness in their food. As an illustration, they have a preference for lucerne containing saponin, a bitter compound, in amounts of up to 3 mg/g of their diet. In contrast, rats consistently prefer the control diet without saponin,

which falls within the **range** of 0.4 to 5 mg/g (see figure 10). However, when rabbits are given individual feeds containing varying amounts of saponin (ranging from 1.8 to 6.4 mg/g of the COmplete diet), their intake of feed and pace of growth are not affected by the degree of saponin present (Auxilia *et al.*, 2013). In contrast, when a hazardous substance like aflatoxins is present, rabbits exhibit complete refusal to ingest the food or consume it in significantly reduced amounts (Morand-Fehr *et al.*, 2018; Morisse *et al.*, 2011; Saubois and Nepote, 2014). This legislation is relevant for safeguarding animals from food-related harm. When given the option between a low-fiber diet component and a fibrous substance, rabbits show a preference for the concentrate. The consumption of the fibrous material is limited to tiny amounts, which can potentially lead to a decrease in the growth rate (Lebas *et al.*, 2017). The lack of fibre in the diet of rabbits with digestive difficulties leads to an instant increase in the risk of health problems, as stated by Gidenne in 2013. This is the result of rabbits specifically searching for sources of energy (which are limited in the environment), as it is the primary regulatory system for their food intake. When two energetic concentrates are offered to individuals with free choice, as demonstrated by Gidenne (2015) using a complete diet and fresh green bananas, the growth rate is found to be equal to that of the control group, and the daily consumption of digestible energy remains the same. However, it is important to note that in this study, the percentage of bananas is: the overall intake of dry matter declined from during weaning (5 to 28% at the conclusion of the experiment 7 weeks later. Rabbits that are fed a lacking in a certain necessary amino acid, such as lysine or sulphur amino acids, given the choice between drinking water with or without the missing amino acid in solution, consistently show a preference for the solution containing the missing amino

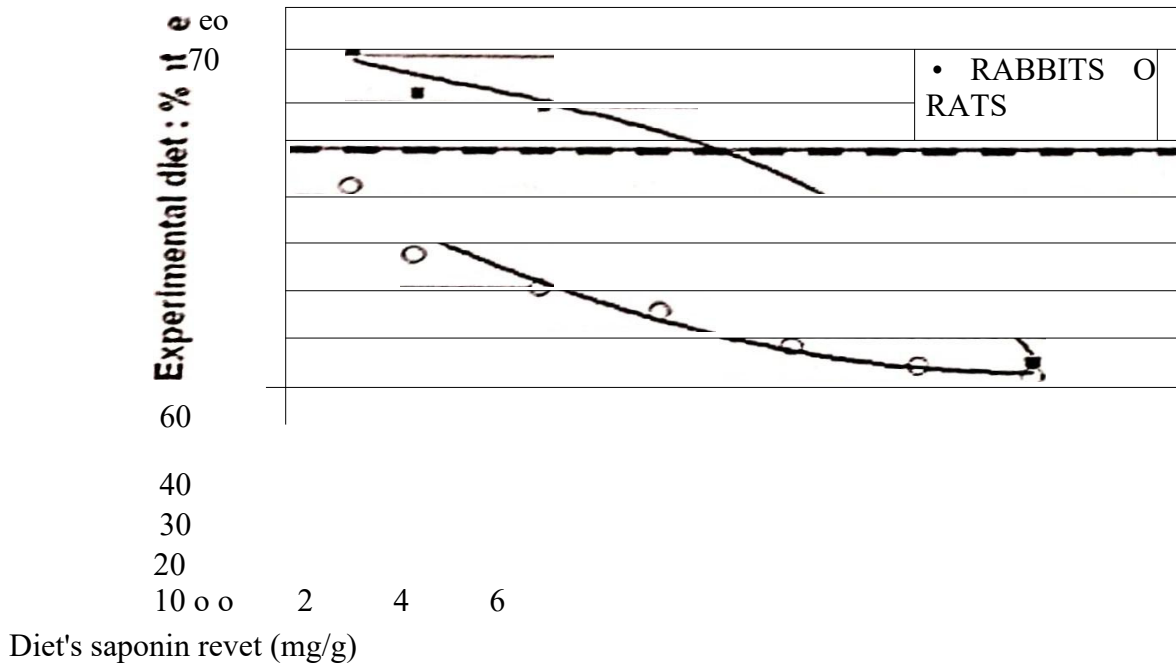


Figure 10: Relative feed intake of a lucerne based diet with various levels of saponin in rats and rabbits in situation of free choice between this diet and a control diet without saponin (according to Cheeke *et al.*, 2017)

2.5 WATER CONSUMPTION PATTERNS IN RABBITS

Water is the essential nutrient for rabbits. Although they can endure without food for a maximum of 60 days, their ability to withstand thirst is comparatively weaker (Colin *et al.*, 2013; Gidenne *et al.*, 2012). Rabbits have the ability to withstand thirst for varying durations, which can range from 2 days to 3 weeks, depending on the species. A rabbit's mortality can occur within a span of 3 days if it experiences a 12% reduction in its bodily fluids. Water is a major component of the body, comprising 83% of the blood, 22% of the bones, and 75% of the brain and muscles. It has crucial functions in regulating body temperature, stimulating metabolic reactions, carrying nutrients, and removing waste (Gidenne *et al.*, 2012). Rabbits

obtain the water they require from three sources: water consumed directly, water included in their food, and water produced as a result of metabolic processes. They generally acquire water from natural sources or water dispensers, with water consumption typically being 2-3 times their intake of dry matter.

Water quality is a crucial factor (Cheeke *et al.*, 2017); it must include cleanliness, clarity, absence of hazardous microorganisms, a pH level within the range of 7.0-7.2, and should not have excessive amounts of iron or sulphur compounds. The optimal water temperature should range from 10 to 15 degrees Celsius, while maintaining low levels of hardness and salinity. Rabbits obtain water not just by drinking it directly, but also via consuming feed that contains water (Colin *et al.*, 2013; Gidenne *et al.*, 2012). The water content of the feed might vary from 10% to 90% depending on its composition. Dry grass and straw typically have a water content of approximately 10-12%, however green feeds and food

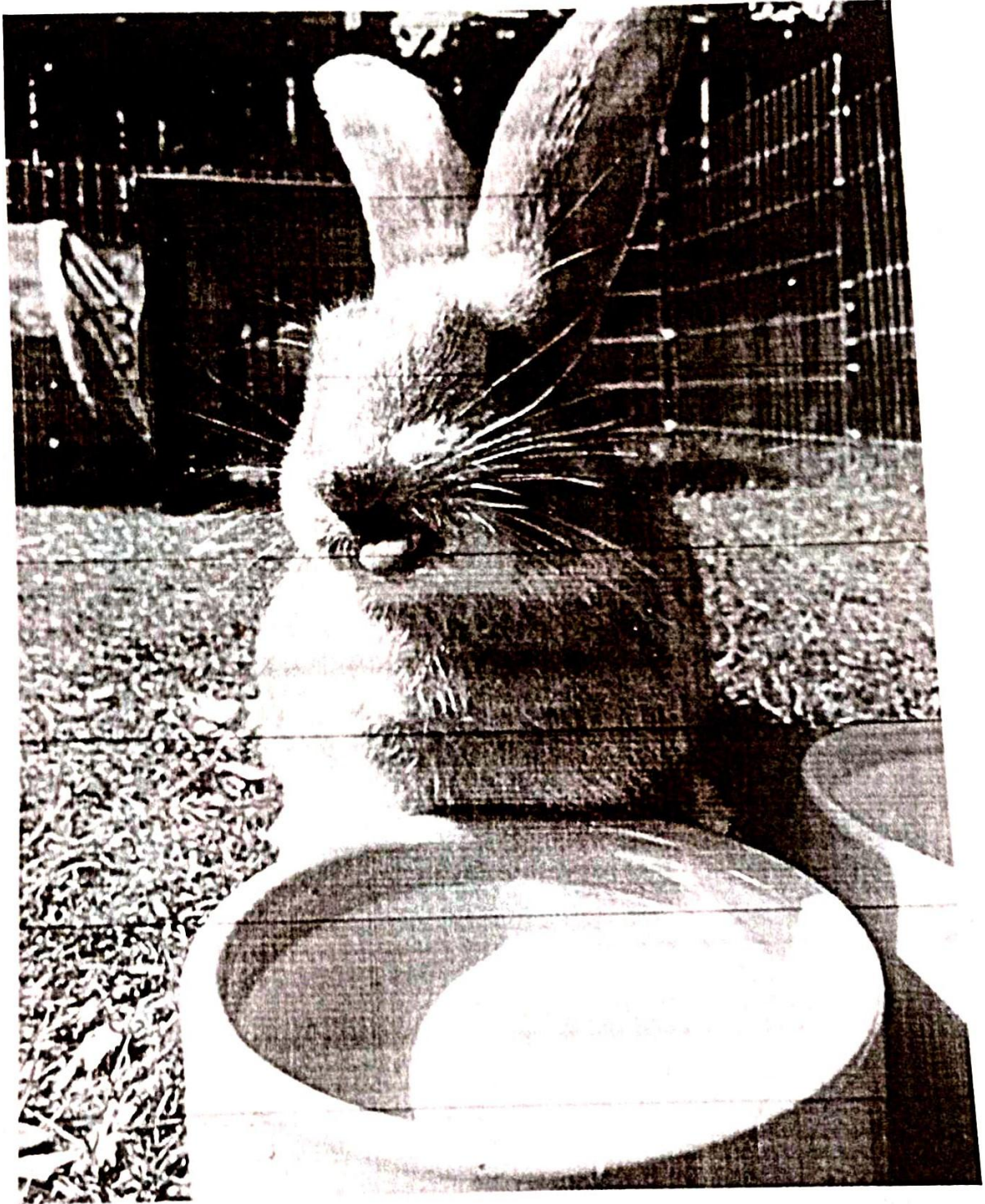
residues contain as During the process of digestion, 113% of lipids are released- Specifically, of carbohydrates, of proteins, 113% of lipids are Broken in the food are released as metabolic

Rabbits excrete by urine, faeces, perspiration, and breathing- The loss of through feces is substantial in rabbits, as their excreted faeces typically contain approximately 75-85% (Cheeke *et al.*, 2017). The amount of water lost by respiration varies according on the temperature and humidity levels, with greater losses periods of heat stress- Rabbits primarily regulate their body temperature by releasing heat through the evaporation of moisture from their skin and by the loss of water respiration- Rabbits have low levels of perspiration in comparison to other species such as horses or cattle. Rabbits require sufficient and suitable water based on their sex, size of production, and prevailing weather conditions (Colin *et al.*, 2013; Gideane *er al.*, 2012)- It is necessary to have a sufficient amount of clean water, which should be kept in a cool and shady location during hot weather. Various types and sizes of drinkers are available. When using automatic nipple drinkers, it is important to ensure they are equipped with a failsafe mechanism and set at the appropriate height for the size of rabbits being maintained. Water bowls can serve as a means of providing water, but it is necessary to clean them periodically and inspect them at least a day to ensure they have not been overturned or damaged. To prevent the bedding from getting it is to position the water container on a solid surface or a grassy area within the enclosure (Xlorand-Fehr *et al.*, 2013; Nforisse *et al.*, 2011 ; Saubois and Nepote,

2011), Ensure that newly introduced rabbits are utilising the designated receptacle for drinking, as rabbits accustomed to using a bowl may be unfamiliar with drinking from a bottle. Rabbits necessitate a water intake of 50-150mls per kilogram of body weight, which is contingent upon factors such as the sort of feed, climatic circumstances, and whether they are nursing or not (Auxilla 2013). Rabbits consuming

a diet consisting primarily of dry food such as hay and pellets will experience an elevated water consumption. Water consumption is notably elevated during periods of high temperatures and lactation. According to Saubois and Nepote (2014), lactating and pregnant does will have an increased water consumption. Water is essential, Rabbits require constant access to an ample supply of clean water. Rabbits that consume a substantial amount of fresh grass and greens will have a reduced water intake, but those primarily consuming hay would have an increased water intake. According to Morisse et al. (2011), rabbits find it more natural to drink from a bowl rather than a bottle, making bowls a preferable option.

The nozzle of bottles can often become obstructed and will solidify during winter if your rabbit is outdoors. Bowls are unlikely to become obstructed, but there is a possibility of their being spilled or tipped over. Therefore, it is advisable to offer both a bowl and a bottle if feasible. Replace the water in both containers on a daily basis, routinely clean them, and ensure they are free from any slime or debris.



2.5 WHY IS WATER IMPORTANT?

It has four main functions, all of them absolutely essential.

- It keeps every cell and organ of the body alive
- It is a major part of blood, and your rabbit wouldn't be able to live without that

- It keeps everything moving in the gut

- It flushes out excess calcium

Keeping everything moving in the gut

Optimal functioning of the digestive tract relies on enough hydration. Food that is consumed must be adequately hydrated in order to facilitate unhindered movement throughout the digestive tract. Excessive dryness can cause an obstruction in the gut, resulting in a severe condition known as Gastro-Intestinal Stasis or Ileus (Morand-Fehr *et al.*, 2018). As the eaten contents remain in the large intestine (colon) for a longer period of time, more water will be absorbed from the intestines into the bloodstream. Delay in therapy can exacerbate the situation by further dehydrating the contents and contributing to the obstruction (Saubois and Nepote, 2014). If this occurs, your rabbit will exhibit a lack of faecal production or only make extremely little, compact droppings, and will also have a loss of appetite. The condition is potentially fatal, and it is imperative to promptly seek the assistance of a veterinarian with expertise in treating rabbits.

- Flushing out excess calcium

Rabbits have a unique ability to fully absorb all the calcium present in their meal, which is unlike humans. While it is true that bones require a significant amount of nutrients to maintain their strength and teeth to continue developing, the amount they actually absorb is not as substantial. Rabbits excrete any excess substances in their urine, resulting in a chalky appearance (Morand-Fehr *et al.*, 2018; Morisse *et al.*, 2011; Saubois and Nepote, 2014). An imbalance in calcium levels, either excessive or insufficient, can lead to several issues. Inadequate calcium intake is associated with tooth disease, whereas excessive calcium consumption can lead to urinary stones and bladder difficulties. Water is crucial to ensuring the

elimination of unnecessary substances through the kidneys and bladder. Accumulation of substances can lead to the formation of bladder sludge (Morisse *et al.*, 2011), bladder stones, or kidney stones. These conditions are highly consequential, and it is more effective and successful to prevent them rather than attempting to address them after they have already happened. The urinary calcium concentration is subject to variation based on the rabbits' overall dietary intake.

CHAPTER THREE

MATERIALS AND METHOD

3.1 EXPERIMENTAL LOCATION

The study was conducted at the University of Benin Farm Project, Ugbowo Campus, Benin City, Nigeria. The location of the farm is between Latitude 6°30"N and Longitude 5°40' to 6°E. It is situated in the rain forest zone with an average temperature of 27.6°C. The average annual rainfall is 2126mm and the relative humidity is 72.5%. These details were obtained from NAA (2014) and Google Earth (2024).

3.2 EXPERIMENTAL ANIMALS AND MANAGEMENT

Rabbits, aged roughly 6-8 weeks, were acquired from a reputable supplier. Upon arrival, they received stress prophylactics along with medications for coccidiosis and were then given a two-week chance to acclimatise to the new habitat. A total of twenty-eight rabbits, consisting of both males and females, were individually weighed and then randomly divided into individual cages, with each rabbit serving as a repeat. The hutch and feeder were positioned inside a small structure with open sides made of low walls. This structure is covered with wire mesh, which ensures adequate airflow and upkeep. During the experiment, the rabbits were provided with water and feed according to the following procedures, During the first two weeks, 50g of rabbit mash feed was prepared

using a weighing scale. 400ml of water was administered twice from a 500ml graduated plastic measuring cylinder to the rabbits' water containers. The rabbits were given access to the water throughout the day. Additionally, 50g of mash feed was placed into feeding bowls or troughs each morning to ensure all rabbits had access to the feed. The feeders were refilled as needed to ensure each rabbit

received the allocated amount of feed. Recording involved noting the amount of water consumed by each rabbit in the morning and evening, recording any leftover feed to estimate feed consumption, and noting observations regarding rabbit behavior during feeding and water consumption. During weeks 3-4, the procedure continued with the preparation of 80g of rabbit mash feed using a weighing scale, same amount of water was given to the rabbits. The rabbits were ensured access to the water throughout the day. Additionally, 80g of mash feed was placed into feeding bowls or troughs each morning, and the rabbits were observed to ensure all had access to the feed. Water consumption of each rabbit in the morning and evening was recorded, along with any leftover feed to estimate feed consumption. Observations were noted regarding rabbit behavior during feeding and water consumption

Table 3.1: Composition and cost of diet fed to the experimental rabbits

Maize	40.00	616	246.40
*Soybean meal	20.00	700	140.00
Wheat offal	20.00	130	19.50
Palm kernel cake	15.00	300	60.00
Palm oil	1.00	1500	1.500
Bone meal	2.40	90	2.16
Limestone	1.00	60	0.60
Growers premix *	0.25	1000	3.50
Salt	0.35	1000	2.50
Total	100		490.00

vitamin -mineral premix per Kg of diet-Vit A, 5000ui; Vit D3, 800 ICJ, Vit E, 12mg, Vit. B6, 1.5mg; Vit B12 0.01mg, Folic acid, 0.3mg pantothenic acid 5mg, Choline Chloride, 150mg; Maganese, 60mg; Iron, 10mg; Zinc, 15mg; Biotin 15mg;

Copper,0.8mg iodine 0.4mg; Cobalt 0.07mg Selenium, 0.04 mg, anti-oxidant, 40mg.

3.3 EXPERIMENTAL TREATMENT

Twenty-eight rabbits were singly weighed and randomly assigned to four different treatments, with seven replicates per treatment. The experimental treatments were as follows:

WFHO (Control): Wooden hutch with earthen feeder placed at floor level (0 inch): The hutch was made using wood and wire mesh. The hutch dimension was 60 cm breadth by 60 cm height by 120 cm length. The hutch was partitioned into cells to house the rabbits singly. The body of the hutch was covered using wire mesh. Inside the hutch was placed an earthen feeder made of clay with an average diameter of 20cm. The feeder was placed at the floor level (0 inch).

MFHO: Metallic hutch with aluminium feeder at floor level (0 inch)

The hutch was constructed entirely from wire gauze, specifically measured at 16mm, to ensure it had sufficient strength to support the rabbits' weight. The hutch was divided into individual cells using identical wire mesh, with each cell accommodating a single rabbit.

Each cell featured an aperture through which the feeders were inserted. The feeders were positioned outside the hutch at ground level (0 inch). The feeders were securely fastened to prevent them from detaching and slipping off due to the rabbit's movements. The dimensions of the hutch were 180cm in length, 22cm in breadth, and 30cm in height. The metallic hutch's floor was fortified with wire mesh to avert the entrapment of the rabbits' legs. The hutch was additionally strengthened with poles on both sides, secured to it with

binding wire. A faecal dish was positioned beneath each cubicle to gather excrement and urine for convenient upkeep.

MF112: Metallic hutch with aluminium feeder at 2 inch above the floor Level

The hutch was constructed entirely from wire gauze with a gauge of 16mm, providing sufficient strength to support the rabbits' weight. The hutch was divided into individual compartments using identical wire mesh, with each compartment containing a single rabbit. Each cell contained an aperture through which the feeders were inserted. The feeders were positioned externally, with a distance of 2 inches above the hutch's floor. The feeders were securely fastened to prevent the rabbit from dislodging them. The dimensions of the hutch were 180cm in length, 22cm in breadth, and 30cm in height. The metallic hutch's floor was fortified with wire mesh to avoid entrapment of the rabbits' legs. The hutch was additionally strengthened by attaching poles on both sides, secured with binding wire. A faecal dish was positioned beneath each cubicle to gather excrement and urine for convenient upkeep.

MF114: Metallic hutch with aluminium feeder placed at 4 inch above the floor level The hutch was constructed entirely from wire gauze with a gauge of 16mm, providing sufficient strength to support the rabbits' weight. The hutch was divided into individual cells using identical wire mesh, with each cell accommodating a single rabbit. Each cell featured an aperture through which the feeders were inserted. The feeders were positioned

externally, with a distance of 4 inches above the hutch's floor. The feeders were additionally secured to ensure their appropriate fixation and prevent them from detaching .due to the rabbit's movements. The dimensions of the hutch were 180cm in length, 22cm in breadth, and 30cm in height. The iron hutch's floor was fortified with wire mesh to avert the rabbits' legs from becoming ensnared. The hutch was additionally strengthened by attaching poles on both sides, secured with binding wire. A faecal dish was positioned beneath each cell to gather excrement and urine, facilitating upkeep. The expense associated with each experimental treatment (hutch and feeder) was calculated and displayed in Table 3.2,

Table 3.2: Cost of experimental treatments

Treatment	Cost	Description
Wooden hutch (IS cells)	144000	Experimental unit
Metallic 1 luteh cells)	38000	WFI 10 = Wooden hutch
conventional feeder	1500	MFI 10 = Metallic hutch with aluminium feeder installed at floor level (0 inch)
Aluminium feeder	2500	
Wooden cell Conventional feeder	11300	MFI 12 = Metallic hutch with aluminium feeder installed at two inches above floor level
Metallic cell + Aluminium feeder	10500	
Cost of feeder	490	

3.4 EXPERIMENTAL DESIGN

The experiment was laid out using Completely Randomized Design (CRD). There were four experimental treatments with seven replicates per treatment all summed up to twenty-eight rabbits.

The linear additive model for the CRD is expressed as follows:

$$Y_{ij} = \mu + \tau_i + e_{ij}$$

Where:

Y_{ij} = the effect of the j th observation in the i th treatment

μ = the general mean of the population τ_i = effect of the i th treatment where $i = 1, 2, 3, \dots$ e_{ij} =

the random error associated with the j th observation in the i th treatment

Aluminium (fabricated) Feeder

The feeder was constructed using aluminium sheets. The feeder was constructed to ensure that the welfare of the rabbits were met while feeding. They were specially designed to have two openings from which feeds are supplied from the outside of the hutch and feeds are eaten by rabbits inside the hutch in the other opening.

Earthen Feeder

Earthen feeders were purchased from a nearby market. It is made of clay with slightly smooth texture and cylindrical in shape. They were made such that rabbits can obtain feed easily from it (not too deep) and not too shallow so it could contain a sizable amount of feed for the rabbit.

Faecal Tray

This is a rectangular tray placed under the metallic hutches to collect faeces and urine from the rabbits. It was made from aluminium sheets having edges folded upward to ensure it could hold both the faeces and urine. Edges were properly sealed to ensure that there was no leakage.

Drinkers

The drinkers were used to supply adequate water to the rabbits. They were also fabricated from aluminium sheets. It measured 10cm³ in dimension.

3.5 GROWTH PERFORMANCE PARAMETERS

Parameters measured included initial weight, final weight, weight gained, feed intake, and feed conversion ratio.

Live Weight and Weight Gain

The rabbits' initial live weight was measured at the beginning of the experiment and then weekly until the study concluded. The weight acquired per rabbit each week was calculated by subtracting the initial live weight of the rabbit at the start of the experiment from its final live weight at the end of the experiment. The average daily weight gain was calculated by dividing the weekly weight gain by seven.

Feed Intake

Daily feed intake determined by subtracting the left-over feed from the quantity of known experimental diet supplied daily. The weekly as well as the total feed intake was also determined.

Feed Conversion Ratio

This is an expression of weight gain per unit of feed consumed.

Feed Conversion Ratio (FCR) = feed intake/weight gain

Economy of Feed Conversion **The** economy of feed conversion of the experimental rabbits was determined using economic parameters such as feed cost, cost of feed consumed, cost conversion ratio, and cost differential from the prevailing prices of ingredients/feed (April, 2024) the experimental period (Ogunsipe *et al.*, 2011 ; Agbonghae and Nwokoro, 2023).

Feed cost (S) = Cost of formulating 1 kg dietary Treatment

- Cost of feed consumed (¥/kg) = Feed cost (¥/kg) x Average Feed Intake (kg) -
Cost per weight gain = Cost of feed consumed (¥kg) / weight gain (kg)
- Cost differential (CD) = Cost per weight gain in Treatment — Cost per weight gain in Control

STATISTICAL ANALYSIS

The data obtained were subjected to analysis of variance (ANOVA) using CRD. The significant difference between the dietary treatments was determined at 5% confidence level while means were separated using Duncan's multiple range test (Duncan, 1995) where significant exists. All analysis was done using SAS (SAS,2013)

CHAPTER FOUR

RESULTS

Table 4.1 represents the performance of rabbits when they are fed at day and night. Rabbits of statistically similar weights ($p > 0.05$) were used at the beginning of the experiment. Day and night time feed intake ranged from 33.98-35.45 g and 24.52 — 30.39 g, respectively. Although, day-time did not show any significant difference ($p > 0.05$), night time did. Night-time water-feed ratio had significant difference ($p < 0.05$). intakes were significantly affected by the rabbit hutch. Rabbits in WFHO had a significantly lower water-feed ratio that of MFHO, MFI-12 and MFH4, respectively. The highest feed conversion was recorded for rabbits in WFH4 (59.35). Water and feed intake were significantly higher at day-time compared to night-time ($p < 0.001$)

Table 4.1 : Day and night feed and water intake of rabbits reared in four different hutches in UNJBEN farm

Variables	WFH0(Control)	MFH0	MFH2	MFH4	SEM
Initial weight (g)/rabbit	965.0	973.0	975.0	982.0	70.30
Final weight (g)/rabbit	1387.00	1534.00	1435.00	1504.00	99.40
Day time feed intake	34.10	35.45	33.98	34.83	1.12
Night time feed intake	30.29a	26.91 ab	27.45ab	24.52b	1.38
Feed Intake	64.39	62.35	61.43	59.35	2.01
Daytime water intake	104.45	102.66	102.81	97.80	3.45
Nighttime water intake	85.80	93.28	86.30	84.66	4.11
Water Intake	190.25	195.94	189.11	182.46	7.03
Daytime Water-feed ratio	3.08	2.90	3.03	2.83	0.12

Nighttime ratio	Water-feed	2.84a	3.53ab	3.21b	3.50b	0.20
Average water to feed ratio		2.96	3.16	3.09	3.10	0.13

ab = Means in a row followed by a different letter are significantly different at 0.05 level of probability,

SEM means standard error of mean.

WFI 10 (control) = Wooden hutch with earthen feeder placed at floor level (0 inch)

MFI 10 = Metallic hutch with aluminium feeder installed at floor level (0 inch)

MI•112 = Metallic hutch with aluminium feeder installed at two inches above floor level

MI] 14 = Metallic hutch with aluminium feeder installed at four inches above floor level
 Table 4.2: Comparison between day and night time feed and water intake in UNIBEN farms

Feed intake	968.56	764.17	52.44	<.001
	34.59	27.29	1.87	<.001
Feed intake per day				
Water intake	2854.08	2450.28	149.35	<.001
C E A P T E R Water intake per day	101.93	87.51	5.334	<.001
Water-feed	2.96	3.27	0.25	<.001

FIVE

DISCUSSION

Table presents the performance of rabbits when they are fed at day and night. A comparable pattern was noted for the daily increase in weight. The weight range recorded in this study, ranging from 1387 g to 1534 g, exceeds the weight range reported by Onimisi *et al.* (2006), which was between 1120 g and 1415.00 g. The final weight can be influenced by factors such as inheritance, environment, and nutrition. From the results, it was observed that there was an increase in the amount of feed consumed in the day when compared to that of the night, with day-time having a value of 968.56 g and night-time a value of 764.17 g, which was significantly different ($p < 0.001$) which is in contrast to Lebas *et al.* (1986), which had reduced daily feed consumption of rabbits under ad lib feeding. It attributed it to the comparatively higher daytime temperatures in contrast to the nighttime temperatures. He went on to say that high temperature has a detrimental impact on growing rabbits, leading to a decrease in the rate of weight gain due to a drop in feed intake. In addition, he asserted that rabbits raised at a temperature range of 18-20°C can achieve a live weight of 3kg within 112 days, whereas those raised at a temperature range of 30-31 °c only attain a weight of 2.5 kg. This might be enhanced by implementing nocturnal feeding, as it would allow rabbits to access food during the cooler hours of the day and align with their natural feeding patterns. The study found that rabbits on a night feeding schedule did not exhibit feed wastage, unlike the rabbits in the other treatment groups. This observation can be explained to the nocturnal behaviour of rabbits and the lower nighttime temperatures compared to daytime. It is however worthy of note that the temperature was not recorded in the current study. For water consumption, a similarly higher amount of water was consumed amounting to 2854.08 ml during the day and 2450.28 ml at night. This can be a result of higher temperatures in the day or wastage owing to their

nocturnal nature of which There is increased activity, less stress and boredom unlike the experience during the day. When rabbits are bored, they express this by playing and scratching the cage and equipment therein and at times it can result in tipping off of the feeders thus leading to wastage.

The water-feed ratio was observed at day and night were significantly different ($p < 0.001$), having a ratio 2.96 at day-time and 3.27 ratio at night. Peter (1999) stated that rabbits consume nearly twice the amount of water compared to feed when their rectal temperature is within the usual range (comfort temperature). This pertains to the rabbits fed during day and night-time. This argument aligns with the conclusions drawn by Reddy (1999), who observed that a consistent provision of fresh, cool, and uncontaminated water can effectively alleviate heat stress. Reddy also found that offering drinking water at a temperature of approximately 15 °C resulted in a 5-10% increase in feed intake, compared to providing warm water at around 29°C during periods of heat stress.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

A total of twenty-eight rabbits were divided into four treatment groups, with each group having seven replicates. The assignment of rabbits to treatments was done in a completely randomised manner, ensuring that each rabbit acted as a replicate. The treatments consisted of a wooden hutch equipped with an earthy feeder and a metallic hutch equipped with an aluminium feeder. These were positioned at varying heights, specifically 0, 2, and 4 inches. The outcomes were as follows:

- I. There was a higher consumption of feed in the day than at night
- II. There was a higher consumption of water in the day than at night
- III. WFHO had the highest feed consumption
- IV. IMFHO had the highest water consumption
- V. The highest ratio of water-feed intake was at night-time

6.2 RECOMMENDATION

Based on this study, the following are recommended:

- I. Reduced feed and water should be given to rabbits at night in order to reduce wastage

- II. Metallic hutch with aluminium feeder should be used to raise rabbit in tropical environment.
- 111. To save money on feed, metallic hutch with the aluminium feeder place at 2 inch above the floor level should be used, owing to the high cost differential.
- IV. Further research is needed to investigate the durability of the metallic hutch and aluminium feeder.
- V. Further research is needed to investigate the effect of temperature on water and feed consumption,

REFERENCES

- Aubret J.M., Dupperay J., 1993. Effets d'une trop forte densité dans les cages d'engraissement. *Cuniculture*, 109, 3-6.
- Auxilia M.T., Bergoglio G., Masoero G., Mazzocco P., Ponsetto PD., Terramocchia S., 1983. Feeding meat rabbits. Use of lucerne with different saponin content. *Coniglicoltura* 20, 51-58.
- Balinska H., 1966. Food preference in rabbits with hypothalamic lesions. *Revue Roumaine de Biologie* 11, 243-247.
- Bell A.C., Watson S., 1993. Preferential grazing of five varieties of spring barley by wild rabbits (*Oryctolagus cuniculus*). *Ann. Appl. Biol.* 122, 637-641.
- Bellier R., Gidenne T., Vernay M., Colin Nf., 1995. In vivo study of circadian variations of the cecal fermentation pattern in postweaned and adult rabbits. *J. Anim. Sci.* 73, 128-135.
- Bhadresa R., 1977. Food preferences of rabbits *Oryctolagus Cuniculus* (L.). At Holkham Sand Dunes, Norfolk. *Journal of Applied Ecology* 14, 287-291.
- Biadl E, Guenezan M., 1992. Le lapin de garenne. *Bull. Tech. d'Information* 3, 89-95.
- Björnhag G., 1972. Separation and delay of contents in the rabbit colon. *Swedish. J. Agric. Res.* 2, 125-136.
- Carabaño R., Garcia A.I., Blas E., Falcao E Cunha L., Gidenne T., Pinheiro V., 2000. Collaborative studies on cæcotrophy in adult rabbits: effect of feed intake and methodology. In: A. Blasco (Ed), 7th World Rabbit Congress, 5-7 July 2000, Valence, Spain *World Rabbit Sci.*, 8, suppl.1, vol. C, p153-159.
- Cheeke P.R., 1974. Feed preferences of adult male dutch rabbits. *Lab. anim. Sci.*, 24(4), 601-604.
- Cizek L.J., 1961. Relationship between food and water ingestion in the rabbit. *Am. J. Physiol.*, 201 557-566.
- Cross B.A., 1952. Nursing behaviour and the milk, ejection reflex in rabbits. *J. Endocrinol.*, 8, XIIIIV
- Cervera C., Fernandez-Carmona J., 1998. Climatic environment. In: C. De Blas and J. Wiseman (ed.) *The nutrition of the rabbit*. CABI Publishing, Wallingford, UK, Chapter 15, pp. 273-295

- Cheeke P.R., Kinzell J.H., Pedersen M.W., 1977. Influence of saponins on alfalfa utilisation by rats, rabbits and swine. *J. Anim. Sci.* 46, 476-481. III International Rabbit Production Symposium, Villareal (Portugal); 2 Novembre 2005 Feeding behaviour in rabbits
- Colin M., Arkhurst G. , Lebas F. 1973. Effet de l'adition de methionine au régime alimentaire sur les performances de croissance chez le lapin. *Ann. Zootech.* 22, 485-491.
- Coureaud G., Schaal B., COUDERT P., RIDEAUD P., FORTUN-LAMOTHE L., HUDSON R., ORGEUR P., 2000. Immediate postnatal suckling in the rabbit: its influence on pup survival and growth. *Reprod. Nutr. Develop.* 40, 19-32.
- CTGREF, 1978. Observations sur les préférences alimentaires du lapin de garenne et les dégâts causés aux plantations forestières. *Le SaintHubert*, Fév. 1978, 74-76.
- CTGREF, 1980. Protection des cultures agricoles et des régénérations forestières contre le lapin de garenne. *CTGREF Informations Techniques*, cahier 39 note 4, pp5.
- Eberhart S., 1980. The influence of environmental temperatures on meat rabbits of different breeds.
- In: *Proceedings of the II World Rabbit Congress, Barcelona, April 1980*, vol. 1, 399-409.
- Faure J. , 1963. Le sommeil 'paradoxal' du lapin dans ses aspects anatomo-fonctionnels et hormonaux.
- Colloque intern. du CNRS , Lyon 9-11 sept. 1963, N^o 127, 241-283
- Fekete S. , Lebas, F., 1983. Effect of a natural flavour (thyme extract) on the spontaneous feed ingestion, digestion coefficients and fattening parameters. *Magyar allatow. lapja* 38, 121125.
- Fortun-Lamothe L., Gidenne T., 2000. The effect of size of suckled litter on intake behaviour, performance and health status of young and reproducing rabbits. *Ann. Zootech.* 49, 517-529.

- Cervera C. , Fernandez-Carmona J., 1998. Climatic environment. In: C. De Blas and J. Wiseman (ed.) The nutrition of the rabbit. CABI Publishing, Wallingford, UK, Chapter 15, pp. 273-295
- Cheeke P.R., Kinzell J.H., Pedersen M.W., 1977. Influence of saponins on alfalfa utilisation by rats, rabbits and swine. J. Anim. Sci. 46, 476-481. III International Rabbit Production Symposium, Villareal (Portugal); 2 Novembre 2005 Feeding behaviour in rabbits
- Colin M., Arkhurst G., Lebas F. 1973. Effet de l'addition de methionine au régime alimentaire sur les performances de croissance chez le lapin. Ann. Zootech. 22, 485-491.
- Coureaud G., Schaal B., COUDERT P., RIDEAUD P., FORTUN-LAMOTHE L., HUDSON R., ORGEUR P., 2000. Immediate postnatal suckling in the rabbit: its influence on pup survival and growth. Reprod. Nutr. Develop. 40, 19-32.
- CTGREF, 1978. Observations sur les préférences alimentaires du lapin de garenne et les dégâts causés aux plantations forestières. Le SaintHubert, Fév. 1978, 74-76.
- CTGREF, 1980. Protection des cultures agricoles et des régénérations forestières contre le lapin de garenne. CTGREF Informations Techniques, cahier 39 note 4, pp5.
- Eberhart S., 1980. The influence of environmental temperatures on meat rabbits of different breeds.
- In: Proceedings of the II World Rabbit Congress, Barcelona, April 1980, vol. 1, 399-409.
- Faure J., 1963. Le sommeil 'paradoxal' du lapin dans ses aspects anatomo-fonctionnels et hormonaux.
- Colloque intern. du CNRS , Lyon 9-11 sept. 1963, N^o 127, 241-283
- Fekete S., Lebas, E, 1983. Effect of a natural flavour (thyme extract) on the spontaneous feed ingestion, digestion coefficients and fattening parameters. Magyar allatow. lapja 38, 121125.

- Fortun-Lamothe L, Gidenne T., 2000. The effect of size of suckled litter on intake behaviour, performance and health status of young and reproducing rabbits. *Ann. Zootech.* 49, 517-529.
- Fortun-Lamothe L., Gidenne T., 2003. Les lapereaux préfèrent manger dans la même mangeoire que leur mère. In: Bolet, G. (ed.) Proceedings of the IOème J. Rech. Cunicoles Fr., 19 & 20 nov. 2003, Paris, France, ITAVI publ., pp. 111-114.
- Gidenne T. , 1985. Effet d'un apport de banane en complément d'un aliment concentré sur la digestion des lapereaux à l'engraissement. *CuniSciences*, 3, 1-6.
- Gidenne T. , 1987a. Influence de la teneur en lignine des aliments sur la composition des digesta et la production de cæcotrophes par le lapereau. *Ann. Zootech.* 36, 85-90.
- Gidenne T., 1987b. Utilisation digestive des constituants pariétaux chez le lapin. Méthodes d'études du transit et des flux, dans différents segments digestifs. Thèse de doctorat, Inst.Nat.Polytech. Toulouse, pp93
- Gidenne T. , 2003. Fibres in rabbit feeding for digestive troubles prevention: respective role of low-digested and digestible fibre. *Livest. Prod. Sci.* 81, 105-117.
- Gidenne T., Fortun-Lamothe L., 2002. Feeding strategy for young rabbit around weaning: a review of digestive capacity and nutritional needs. *Anim. Sci.* 75, 169-184.
- Gidenne T., Lebas F., 1987. Estimation quantitative de la cæcotrophie chez le lapin en croissance : variations en fonctions de l'âge. *Ann. Zootech.* 36, 225-236.
- Gidenne T. , JehL N., Segura M., Michalet-doreau B., 2002. Microbial activity in the cæcum of the rabbit around weaning: impact of a dietary fibre deficiency and of intake level. *Anim. Feed Sci. Technol.* 99, 107-118.
- Gidenne T., Lapanouse, A., Fortun-lamothe, L. 2003. Comportement alimentaire du lapereau sevré précocement: effet du diamètre du granulé. In: Bolet, G. (ed.) Proceedings of the 10th "Journées de la Recherche Cunicole", 19 & 20 nov. 2003, Paris, France, ITAVI publ. Paris, pp. 17-19.
- Gyarmati T. , Szendrő Z, Maertens L., Biro-nemeth E., Radnal I., Milisits G., Matics, Z, .2000. Effect of suckling twice a day on the performance of suckling and growing rabbits. In Blasco, A. (ed.), Proceedings of the 7th NWorld Rabbit Congress, 5-7

july, Valence, Spain, Polytech. University of Valence publ., World Rabbit Sci., 8, suppl.1, vol. C, pp. 283-290.

Harris D.J., Cheeke P.R., Patton N.M., 1983. Feed preference and growth performance of rabbits fed pelleted versus unpelleted diets. *J. Appl. Rabbit Res.* 6, 15-17.

Iirikawa I., 2001. Coprophagy in lagomorphs and other mammalian herbivores. *Mammal Rev.* 31,61-80.

Hoy S., Selzer D, 2002. Frequency and time of nursing in wild and domestic rabbits housed outdoors in free range. *World Rabbit Sci.* 10, 77-84.

Hudson R., Schaal I., Martinez-Gomez M., Distel I., 2000. Mother-Young relations in the European rabbit : physiological and behavioral locks and keys. *World Rabbit Sci.* 8, 85-90.

Kovacs M., Szendrői Z., Csutoras I., Bota B., Bencsik K.Z., Orova Z., Radnai I., Birone N.E., Horn P., 2004. Development of the caecal microflora of newborn rabbits during the first ten days after birth. In: Becerril, C. and Pro, A (ed.) *Proceedings of the 8th World Rabbit Congress, 7-10 september, Puebla, Mexico, Colegio de Postgraduados for WRSA publ. vol. 5, pp. 1091-1096.*

Jilge B., 1982. Monophasic and diphasic patterns of the circadian caecotrophy rhythm of rabbits. *Laboratory Animals*, 16, 1-6.

Laplace J.P., 1978. Le transit digestif chez les monogastriques. III. Comportement (prise de nourriture - caecotrophie) motricité et transit III International Rabbit Production Symposium, Villareal (Portugal); 2 Novembre 2005 Feeding behaviour in rabbits digestif, et pathogénie des diarrhées chez le lapin. *Ann. Zootech.* 27, 225-265.

Lebas F., 2002. *Biologie du lapin.* 4.4 Comportement alimentaire. [http://www.cuniculture.info/1\)ocs/Biologie/biologie-04-4.htm](http://www.cuniculture.info/1)ocs/Biologie/biologie-04-4.htm) (accessed 14 Novembre 2004)

Lebas F., Laplace J.P., 1977. Le transit digestif chez le lapin. VI.-Influence de la granulation des aliments. *Ann. Zootech.* 26, 83-91.

Lebas F., Greppi G., 1980. Ingestion d'eau et d'aliment chez le jeune lapin disposant d'un aliment carencé en méthionine ou en lysine et pour boisson, en libre choix, d'une solution de cet acide aminé ou d'eau pure. *Reprod. Nutr. Develop.* 20, 1661-1665.

- Lebas I^g., Coudert R., Rouvicr., Rochambeau de Il., 1986. The Rabbit Husbandry, I
lealth and
Production.FAO, Animal Production Health Series No. 21, Rome.Pp 21-28.
- Lebas F., Coudert DE Rochambeau H., Thebault R.G., 1997. The Rabbit - Husbandry, Health
and Production (2d edition) FAO publ., Rome, 223 pp
- Maertens L., 1994. Influence du diamètre du granulé sur les performances des
lapereaux avant sevrage. In: Coudert, P. (ed.), Proceedings of the Vlèmes J.
Rech. Cunicole Fr., France, 6 & 7 dec., La Rochelle, France, ITAVI publ.
Paris. Vol. 2, pp.325-
- Maertens Ia., Villamide M.J., 1998. Feeding systems for intensive production. In: De
Blas C. and. Wiseman J. (ed.) The nutrition of the rabbit. CABI publishing,
Wallingford, UK. Chapter 14, pp. 255-271.
- Maertens L. , Van herck, A., 2000. Performances of weaned rabbits raised in pens or in
classical cages: first results. In: Blasco, A.(ed.) Proceedings of the 7th World
Rabbit Congress, 4-7 july, Valence, Spain, Univ. Polytec. publ., World Rabbit
Science, 8 supp 1B, pp. 435-440.
- Mirabito L., Galliot P., Souchet C., Pierre V., 1999. Logement des lapins en
engraissement en cages de 2 ou 6 individus : Etude du budget temps. In: Perez,
J.M. (ed.) Proceedings of the "8èmes Journées de la Recherche Cunicole", 9-10
june, Paris. ITAVI publ., pp. 55-58.
- Morand-fehr M., Delage J., Richir C, 1968. Répercussions de l'ingestion d'aflatoxine sur le
lapin en croissance. Cahiers de Nutrition et Diététique 5, 62-64.
- Morisse J.P., Wyers M., Drouin P., 1981. Aflatoxicose chronique chez le lapin. Essai de
reproduction expérimentale. Recueil de Médecine Vétérinaire 157, 363-368. .
- Morot C., 1882. Mémoire relatif aux pelotes stomacales des léporidés. Recueil de. Médecine
Vétérinaire 59, 635-646.
- Onimisi PA., Bawa GS., Oimage, JJ., 2006. Growth performance of growing rabbits fed
graded levels of poultry litter. Proceedings of the 3 1st annual conference of the
Nigerian Society for Animal Production (NSAP). March 12th-15th, Bayero
University Kano, Nigeria. Pp 328-330.
- Orengo J., Gldenne T., 2005. Comportement alimentaire et caecotrophie chez le lapereau
avant sevrage. In: Bolet, G. (ed.) Proceedings of the 11th "Journées de la

- Recherche Cunicole", 29 & 30 nov. 2005, Paris, France, ITAVI publ. Paris (in press)
- Parigi bini R. , Xiccato G., 1998. Energy metabolism and requirements. In: De Blas, C. and Wiseman, J. (ed.) The nutrition of the rabbit. CABI Publishing, Wallingford, UK, Chapter 7, pp. 103-131.
- Peter PH., 1999. Physiology of water and electrolyte balance. Poultry Journal 38 (11): 54.
- Pinheiro V., 2002. Contribution à l'étude de la digestion chez le lapin: effet du taux de fibre et de la nature de l'amidon alimentaires. Thèse de doctorat, Univ. Alto Duro, Vila-Real], pp253. .
- Proto V., Gargano D, Gianni Ia., 1968. La coprofagia del coniglio sottoposto a differenti diete. Prod Anim. 7, 157-171 .
- Proto V., 1980. Alimentazione del coniglio da carne. Coniglicoltura 17(7), 17-32.
- Prud'hon M., Cherubin M., Goussopoulos J., Carles Y, 1975. Evolution au cours de la croissance des caractéristiques de la consommation d'aliments solides et liquides du lapin domestique nourri ad libitum. Annales de Zootechnie 24, 289-298.
- Prud'hon M (1975). Le comportement alimentaire [du lapin] depend beaucoup de l'abreuvement. Elevage (special number): Une production d'avenir-Le Lapin:5559.
- Rashwan A. A. , Soad S. A., 1996. Growing rabbit management: housing system, reduction of eating time and feeder space. In Lebas F. (éd.) Proc. 6th World Rabbit Congress, Toulouse, France, 09-12/07/1996, vol. 3, 411-414.
- Reddy CV., 1999. Water supply, Production, Processing and Marketing Worldwide. Poultry international 39 (2): 40.
- Reyne Y. , Goussopoulos L, 1984. Caractéristiques du système endogène responsable des rythmes circadiens de la prise de nourriture et d'eau de boisson chez le lapin de garenne: étude en lumière permanente et en obscurité permanente. In: Proceedings of the 3rd World Rabbit Congress, Rome, Italy, vol.2, pp. 473-480.
- Ross W.D., Bell J., 1979. A field study on preference for pollard and bran pellets by wild rabbits. New Zealand Journal of Experimental Agriculture, 7, 95-97.
- RSPB (The Royal Society for the Protection of Birds), 2004. Salisbury plain project. III International Rabbit Production Symposium, Villareal (Portugal); 2 Novembre 2005 Feeding behaviour in rabbits

- Saboutxlv Nt.. t 9? t s ArtxÂt de la régénération des genêts dans une parcelle boisée de Sotogne en raison du sutvâturage par les lapins de garenne. Communication petsonnelle
- Sandetstotl 0.1). Vanderweele D.A., 1975. Analysis of feeding patterns in normal and vagotomised rabbits. *Physiol. Behav.*, 15, 357-364.
- Saubois Nepote MSG., 1994. Atlatoxins in mixed feeds for rabbits. *Bolletín Micología*, 9, 115-120.
- Schaal Coureaud G., Langlois D., Gillies C., Semon E., PERRIER G. 2003. Chemical and behavioural characterization of the rabbit mammary pheromone. *Nature* 424, 68-72s
- Seidenstücker S., 2000. Rabbit grazing and Nfertilization on high grass-encroachment in dry coastal grassland in 'Meijendel', The Netherlands.
- Spence T,B., Smith A.N., 1965. Selective grazing by rabbits. *Agriculture Gazette of N.S. Wales*, 76,614-615.
- Szendtò Z., Papp Z, Kustos K., 1999. Eftèct of environmental temperature and restricted feeding on production of rabbit does. *CIHEAM, Cahiers Options MéditeRInéennes* 41, I l-17.
- Tome D., 2004. Protein, amino acids and the control of food intake. *Brit. J. Nutr.* 92, S27S30.
- Virae G., Papp Z, Rafai P., Jakab L., Kennessy As, 2000. Effects of an intermittent lighting schedule on doe and suckling rabbit's performance. In: Blasco, A. (ed.) *Proceedings of the 7th World Rabbit Congress*, Polytech. Univ. of Valence publ., *World Rabbit Science*, vol. S, sup. 1B, pp. 477-481.
- Williams O.B., NVells T.C.E., Wells D.A., 1974. Grazing management of Woodwalton Fen : seasonal changes in the diet of cattle and rabbits. *J. Appl. Ecology* I l, 499-516.
- Xiccato G., Verga Nf., Trocino A., Ferrante V.,Queaque P.I., SARTORI A., 1999. Influence de l'eùèctif et de la densité par cage sur les performances productives, la qualité bouchère et le comportement chez le lapin. In: Perez, J.M. (ed.) *Proceedings of the 8th "Journées de la Recherche Cunicole"* ,9-10 june, Paris. ITAVI publ., pp. 59-62.