The Study of Different Feed on Growth and Behaviour of Hamster, *Phodopus sungorus*

By

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DECLARATION

I hereby declare that the work embodied in this Report is the result of the original research and has not been submitted for a higher degree to any universities or institutions.

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I certify that the Report of this final year project entitled "The Study of Different Feed on Growth and Behaviour of Hamster, *Phodopus sungorus*" by Lee Shall Ting, matric number F14A0114 has been examined and all the correction recommended by examiners have been done for the degree Bachelor of Applied Science (Husbandry Science) with Honours，Faculty of Agro-Based Industry, Universiti Malaysia Kelantan.

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Abstract

Nowadays as there are many pet owners prefer to feed their hamster with commercial hamster food mix (processed feed) with the reason of convenient, yet it is not 100% proven that it is really a healthy diet for hamster. Hence, this project was carry out with the aims of determine does processed feed brings benefit to the growth of hamster if compare with fresh vegetables, fruits and legumes (fresh feed), and by using different feed will it affect the behaviour of hamster. Eight Djungarian hamsters (Phodopus sungorus) are divided equally into two groups, one group is feed with processed feed while another group is feed with fresh feed. Furthermore each group of the hamster are divide again into two pair of hamster which consist of one male and one female only living in a cage to test their fertility, thus total up there are four cages of hamster in this project. Result shown hamsters that eat processed feed had gained weight significantly which is 19.616g for male and 16.029g for female. While for hamster that consuming fresh feed, they showed slighter increase of body weight which is 6.406g for male and 4.538g for female. Thus by only feeding hamster with processed feed can cause obesity to the hamster and feeding hamster with fresh feed will not stimulate obesity problem for the hamster. The mortality rate of the hamsters are 0% and the fertility of hamster is also 0% in fresh feed group of hamster meantime in processed feed group is 50%. The active behaviour are obviously shown in hamsters that eat fresh feed compared with processed feed meanwhile the reasons for the hamster has such behavioural responses in the cage are because they tend to escape from the cage and wanted to explore the environment around. Besides, the hamster that feed with fresh feed are believe to be more content and happy when compared with processed feed hamster by showing more grooming behaviour. Broadly the result also demonstrate the relation between body weight and activeness of hamster, it is believe that the body weight of hamster could influence the activeness of hamster.

Keywords: hamster, healthy diet, processed feed, fresh feed, behaviour

Kajian terhadap makanan yang berbeza mempengaruhi pertumbuhan dan tingkah laku hamster, *Phodopus sungorus*

Abstrak

Pada masa kini terdapat banyak pemilik haiwan kesayangan lebih suka memberi makanan komersial campuran hamster (makanan diproses) dengan sebabnya ia memudahkan pemilik, tetapi bukannya makanan komersial ini 100% dibukti bahawa ia benar-benar diet yang sihat untuk hamster. Oleh itu, projek ini dijalankan dengan matlamat untuk menentukan sama ada makanan diproses membawa manfaat kepada pertumbuhan hamster jika dibandingkan dengan sayur-sayuran, buah-buahan dan kekacang yang segar (makanan segar), dan dengan menggunakan makanan yang berbeza adakan ia akan mempengaruhi kelakuan hamster. Lapan ekor hamster Djungarian (Phodopus sungorus) dibahagikan kepada dua kumpulan, satu kumpulan makan makanan yang diproses manakala kumpulan lain makan makanan segar. Manakala setiap kumpulan hamster akan dibahagikan lagi kepada dua pasangan hamster yang terdiri daripada seekor lelaki dan seekor wanita untuk menguji kesuburan mereka, jadi akan ada empat sangkar hamster dalam projek ini. Hasil kajian untuk hamster yang memakan makanan yang diproses telah memperoleh berat badan dengan ketara iaitu 19.616g bagi lelaki dan 16.029g untuk wanita. Sementara untuk hamster yang menggunakan makanan segar, mereka menunjukkan peningkatan berat badan yang lebih rendah iaitu 6.406g untuk lelaki dan 4.538g untuk wanita. Oleh itu dengan hanya memberi makan hamster dengan makanan yang diproses dapat menyebabkan obesitas pada hamster dan memberi makan hamster dengan makanan segar tidak akan merangsang masalah haid untuk hamster. Kadar mortalitas hamster adalah 0% dan kesuburan hamster rendah dalam kumpulan hamster yang makan makanan segar sementara dalam kelompok hamster yang makan makanan diproses adalah 50%. Tingkah laku aktif hamster jelas ditunjukkan dalam kumpulan yang makan makanan segar berbanding dengan makanan yang diproses sementara sebab untuk hamster mempunyai tindak balas dan kelakuan yang aktif dalam sangkar adalah kerana mereka mempunyai kecenderungan untuk melarikan diri dari sangkar dan mereka ingin menjelajahi persekitarannya. Selain itu, hamster yang makan makanan segar dipercayai akan lebih gembira apabila dibandingkan dengan hamster yang diberi makan proses dengan menunjukkan lebih banyak tingkah laku membersihkan bulu sendiri. Akhirnya, hasil kajian ini juga menunjukkan terdapat kaitannya berat badan dengan keaktifan hamster, berat badan hamster akan menjejaskan tahap keaktifan hamster.

Kata kunci: hamster, diet sihat, makanan diproses, makanan segar, kelakuan

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LIST OF ABBREVIATIONS AND SYMBOLS

g	Grams
mm	Millimeters
cm	Centimeter
%	Percentage
I.U.	International Unit
kg	Kilogram
mg	Milligram
/	Per
pm	Post meridiem

CHAPTER 1

INTRODUCTION

1.1 Research Background

Hamster is famous as a companion animal and we can see that small animals have become the second most common type of pet that children take care of (Media, 2015). However, like other companion animal, attention, love and care are also needed to give to hamster although it is easy to take care of.

One of the main consideration that will be given when having a pet is to provide the pet with healthy diet. Animal are not suitable to eat human food and so do hamster. By feeding hamster commercial hamster food mix or what we call as commercial feed is very common for pet owner and some of them believe that by feeding commercial feed is good for their hamster plus it is also due to convenient purpose.

The feed intake will determine the nutrient obtained by the hamster. Besides that, the growth and behaviour of the hamster will also be affected by the feed intake. This is proven by (Hasdai & Liener, 1983) where Golden Syrian hamsters were fed raw soy flour grew much more poorly than those fed heated soy flour, an effect which was reflected in a lower food efficiency as well. In the other hand, a diet of corn is turning wild hamsters in north-eastern France in to deranged cannibals that devour their offspring(Tissier, Handrich, Dallongeville, Robin, & Habold, 2017). Both the experiment clearly show that growth and behaviour of hamster are related with feed that was given

to them. Thus, in this project, we are giving main focus on the diet of hamster, *Phodopus sungorus*.

1.2 Problem Statement

Commercial feed may bring benefits to hamster but it may also does not good for the hamster. Thus by figuring out what kind of feed will bring benefits to hamster this study is carry out. There are always have some pet owner will feed their hamster with processed feed which are pallet and muesli due to convenient purpose. Today, there are also many processed feed we can found on the market and emphasize that processed feed is good to hamster. In the other way, as we know that fresh vegetables, fruits and legumes that have not been processed is always better than processed feed, because some chemical content may be added to the food. So, by giving fresh vegetables, fruits and legumes only to the pet may also be a good choice to pet owner. Thus this research is going to study of different feed on hamster *Phodopus sungorus*.

1.3 Research Objectives

The specific objectives of the project are:

1) To determine the body weight, mortality and fertility of hamster by using different feed.

2) To determine the behaviour of hamster by using different feed.

1.4 Scope of Study

This study involved three female and three male mature hamster and divided them into two groups which one group will consist of two pairs of hamster, while one female and male are group as a pair. Feeding, collecting data and observation technique are important in this study. One group are feed with commercial mix hamster feed (processed feed) and another group are feed with fresh vegetables, fruits and legumes (fresh feed). The body weight, mortality and fertility are recorded weekly and the data collected determined their growth during this experiment. Besides that, the behaviour of the hamster which indicates the level of activeness are also observed and recorded daily.

1.5 Significance of Study

Providing a diet that is suitable for owns pet is very important because once we feed our pet with food that does suitable for them, it may lead to retard of growth, low fertility and even death to the pet. Especially nowadays, some article claims that majority processed feed does not bring any benefits to pet, because some contaminations like food colouring and preservations are added inside the processed feed. Besides that, some of the processed feed not even provide the adequate nutrient to the animal for example percentage of protein contains in the processed is not enough for the animal and it has high lipid content. Lastly, what should not be neglected is that the behaviour of hamster will also get affected due to what they had been fed. To this point, determine which type of feed are suitable for pet is important and giving our pet a healthy diet is vital for every pet owner.

1.6 Limitation of Study

The main needed sample for this research will be the three female and three male mature *Phodopus sungorus* hamster, but there are hard to find them at Jeli area, even a proper pet shop is hard to find at Jeli town. The condition become worse when it comes to even though at Tanah Merah is also difficult to find pet shop that selling hamster. Thus we need to travel until Kota Bharu to get the sample. This also shows that the processed feed which will be given to the hamster is not available at Jeli area. On the other hand, financial issue is another limitation for this study because there total up 8 hamster are needed in this research and money is needed to buy those hamster. Besides that, processed feed and fresh feed are also the important materials in this research, petrol fees and money to buy those feed also cost some amount of money.

Besides that, there are not much of suitable journal for references. Lack of numbers of journal that can be refer in terms of the suitable titles.

CHAPTER 2

LITERATURE REVIEW

2.1 Hamster

This research is main on study of hamster. Hamster is well known as companion animal and it is the fifth most commonly used lab animal in US behind mice, rats, rabbits and guinea pig (Canadian Council on Animal Care, 1984) .The taxonomy of hamster shows that it is from the order of *Rodentia*, its suborder is *Myomoorpha*. Hamster is classified from *Cricetidae* family and the sub family is *cricetinae*, so the scientific name for hamster would be (*Cricetinae*) and it also has many genus species. In fact, there are 26 species of wild hamster that run free in parts of Europe, Asia, and the Middle East (Dell'Amore, 2014) and the commonly known species now are Syrian hamster and dwarf hamsters.

The first documented hamster is Syrian species when physician Alexander Russell came across them in the wild and described the rodents (though didn't give them a name) in a publication called The Natural History of Aleppo (Dell'Amore, 2014). The *Cricetidae* family is characterized by having large cheek pouches, thick bodies, short tails, excess of loose skin, continuously growing incisors and cupidate molars that do not continue to grow (Canadian Council on Animal Care, 1984).

2.1.1 Djungarian Hamster

For this study, the genus species using is *Phodopus sungorus* which is commonly called as Djungarian hamster. The generic name Phodopus was introduced by (Miller, 1910) which is derived from phodos, the genitive case of the Greek phos, meaning blister, and the Greek pous, meaning foot. There are three species in the genus Phodopus: *Phodopus sungorus*, *Phodopus campbelli*, and *Phodopus roborovski* (Bauer & Besch-Williford, 2012). *Phodopus campbelli*, that is also well known as Campbell's hamster, having plenty of common names as *P. sungorus* and has brought confusion in the life sciences literature.

The most obvious phenotypic feature that distinguishes *P. campbelli* from *P. sungorus* is the lack of dramatic coat color change in response to a short photoperiod. *P. sungorus* molts to pure white hair coat, while *P. campbelli* retains a grey hair coat(Bauer & Besch-Williford, 2012) . According to Stephan Steinlechner (1998) who gave the species name Sungorus based on the region "Sungaria" (different spellings exist: Dsungaria or Djungaria or Zungaria), which is the south of the Altai mountains. The literal translation of the nominate form therefore is the blister-footed (D) Sungarian (hamster) (Stephan Steinlechner, 1998).

2.2 Characteristic and Behaviour

Phodopus sungorus is a small hamster with a unique characteristic of dense fur on the footpads, which accounts for the common name of "hairy-footed hamster" and the adult males are about 11 cm long while mature females are about 9 cm long (Bauer & Besch-Williford, 2012). Their body weights will be different with length of photoperiod,

Djungarian hamster species having characteristic of reduces its body weight by 30% during winter to reduce its energy requirements while their body weight increased slightly 7% in long photoperiod (St. Steinlechner, Heldmaier, & Becker, 1983). At peak body mass, males weigh from 40–50 grams while females weigh about 30 grams (Bauer & Besch-Williford, 2012).

Besides that, male Djungarian hamsters were raised from birth in long photoperiods, reached their final size at about 60 days of age; while in short photoperiod they needed about 130 days developed to reach normal size. Hamsters have short tails, 5-15mm in length, which are partially covered with white hair (Ross, 1998). The dorsal pelage is dense and grey with a wide, black-brown mid-dorsal stripe that extends from a dark black-brown patch on the crown of the head to the base of the tail. Black patches on the shoulders and flanks are connected with a line of black hairs that demarcate the dorsal from the ventral fur. The ventral pelage is white with a few black hairs (Bauer & Besch-Williford, 2012).

P. sungorus has lateral and mid ventral sebaceous marking glands. The glands are responsive to testosterone, vitamin D, and possibly estradiol and so are larger in males, especially in the breeding season (Stumpf, 1993). Djungarian hamsters are similar with other hamsters, has cheek pouches that are huge for food storing purpose. In contrast to other hamsters, *Phodopus* has an epidermal pocket between the skin of the cheek and the opening of the cheek pouch (Bauer & Besch-Williford, 2012). This pouch is lined by stratified squamous epithelium that exfoliates into the center of the pouch, forming a whitish material with a pungent odor (Sokolov, 1994). *Phodopus* are reported to be more docile and less aggressive than Syrian hamsters (Hoffmann, 1981). By having this nature, thus these hamsters can be housed in same-sex groups, and breeding pairs can stay together for the duration of their breeding life (Lerchl, 1995). *P. sungorus* is nocturnal, crepuscular, and active year round in the wild (Ross, 1995).

Hamsters, mostly are describe as animal that active at the night and sleep during day time. However, there is at least one author that is Kontschinz (1956) suggests that although they are most active at night, they are also active during the day. Within a day hamster can suddenly become very active and this is common in dwarf hamsters (Russian Dwarf Hamster Organization, n.d.). This issue can be due to the food intake by the hamsters had digested into energy form and they need to burn their energy. Thus when they are lazy, maybe it is a sign that they are sick.

There are many body language that we can observe from hamsters, when they are grooming, it shows that they are feeling content. When a hamster grooms itself, it will start washing its feet, hands and fur while grooming means that the hamster is feeling secure and happy (Saliba, 2010). While when they are stretching their limbs, it means that they are feeling good and relaxed about their current situation. We also can get to know the hamsters is sick when they are unresponsive during the approach of owner. When it is standing on hind legs with their dukes up, it shows that they feels threatened or also can be said that they feel curios towards the environment. When they are insecure, they will empty its cheek pouches quickly.

Based on Snodgrass-Belt, Gilbert, and Davis (2005) active behaviours including wheel running, grooming and eating. An estimated 50% of all laboratory mice reliably develop stereotypies in standard laboratory cages and the like stereotypies in other species caged rodents' stereotypies do not appear suddenly in full form, as a substitute they develop, originating mainly from behavioural responses to thwarting or motivational conflict such as intention movements, displacement activities or redirected behaviours (Wurbel, 2006).

Hence, the personality and pattern of the behaviour from which a stereotypy develops, for example its 'source behaviour pattern', might indicate us something about the underlying motivation. According to Wurbel (2006), caged rodents will have

behaviour like jumping or also known as jack-hammering, which it is define as jumping up-and-down (on all four legs or on the hind legs only) at a cage wall or, more commonly in a cage corner and it will also have behaviour like backflipping or also known as somersaulting which it is define as backward flip from one cage wall or the food rack towards the opposite cage wall, with or without touching the cage lid and/ or the opposite cage wall during the flip.

2.3 Breeding

Gestation length for the first litter is around 18-19 days (Figala, 1973; Scribner, 1994) to 12 weeks after pairing litters are typically born so females generally produce their first litter at about four or five months of age (Lerchl, 1995). According to Lerchl (1995), female Djungarian hamsters have a postpartum estrus, and the inter-birth interval is from 18-25 days. The interbirth interval delay of over 19 days may be the result of post-implantation embryonic diapause (Newkirk, 1997). The male Djungarian hamster do not take part in the rearing of offspring. The breeding life of a pair of hamsters is about one year, and up to 13 litters can be produced (Lerchl, 1995).

The newly born litters are hairless except for vibrissae and they weigh 1-2 grams (Suckow, Stevens, & Wilson, 2012). When day eight, the pups will be fully covered by fur, their eyes will be open by day ten then they will have the ability to move on the nest and chew the food. Young can be weaned at 16-18 days, but commonly are weaned at 21-23 days of age (Lerchl, 1995). Weaned young can stay together with each other as long as they are same-sex. Weaned weight at 20 days averages 17.4 grams (range of 11.7-21.5 grams) (Jordan, 1971). Djungarian hamster will grow and reach their adult weight by 4 weeks of age.

2.4 Nutrition Requirement

Trainor (2014) reported that hamster is a vegetarian or grain eaters or we also can call them as herbivores. On the other hand, (Canadian Council on Animal Care, 1984) categorised hamster as omnivore and stated that detailed information on the nutritional requirements for these omnivorous rodents have not been properly determined, although commercial rations developed for other rodent species have commonly been used and appear to have been quite satisfactory.

In spite of those facts, hamster still need protein, carbohydrates, lipids, minerals, vitamins all these basic nutrient to survive. A minimum of 16% protein may be adequate in maintenance rations for mature animals; however, a level of 24% protein or more is required to ensure proper growth and for pregnancy (Harkness, 1983; Stoliker, 1981). The diet of hamster should contain 18% of crude protein to support the growth rates around 2grams per day in weanling hamsters (Washington, 1995). While for the study of carbohydrates in hamsters, with purified, fiber-free diets containing 64% carbohydrate, cornstarch was superior to glucose or sucrose in supporting survival of hamster (Ershoff, 1956). Rice starch supported higher growth rates than lactose(Dam, 1961). Rogers (1974) obtained satisfactory growth in a long-term study when animals were fed a gel diet containing 40% cornstarch and 21.9% sucrose.

Washington (1995) concluded that lipid requirement for maximal growth of hamsters is slightly higher than 5%, it brings higher mortality, but greater weight gain occurred with higher fat diets. In the other hand, fiber-free diets containing high concentrations of purified sugars result in high mortality. Basal diets containing starch or lactose may not require fiber additions because these ingredients support favourable microflora in the colon (Snog-Kjaer, 1963). Micro-organisms present in the cecum and colon seem to be capable of degrading fiber sources (Banta, 1957; Vorontsov, 1979).

Besides that, growth curves for supplemented ascorbic acid animals were slightly above those of controls, which were fed diets containing no ascorbic acid(Washington, 1995).

2.5 Diet

Food consumption of standard laboratory feeds that given to hamster will be from 7-15 g/day and water consumption will be up to 20 ml/day for animals on dry feeds (Canadian Council on Animal Care, 1984).

While the feed intake for Dwarf hamsters is about a tablespoon of typical pet-shop hamster food each day.

2.5.1 Commercial Hamster Food Mix

Commercial hamster food mix provide a good, balanced diet, but offer hamsters no variety thus many hamsters will refuse them; mixes can be a sound alternative, but many are high in fatty foods (The Ottawa Humane Society, 2011).

The Ottawa Humane Society (2011) claims that plain pellet diets are best, as they offer a complete balanced diet. Diets that include seeds and treats seem to be nicer for your pet, but many hamsters will only pick out the treats and not eat the pellets. This may lead to malnutrition and obesity of the animal. Besides that, pelleted diets are fortified with optimal levels of vitamins and minerals like calcium and vitamin D3 for the health of your pet. Pelleted diets may also have additives to support digestive health.

The commercial feed that given to the hamster is Delikate Super Premium Mix brand which can feed to hamster, dwarf hamster and gerbil. This is one of the most common brand that is available in mostly all of Malaysia's pet store. Based on the analysis list of this feed, the crude protein content is 12.5%, 9% of crude fiber, 7% of crude fat, vitamin A content is 5050.00 I.U./kg, vitamin E content is 160.00I.U./kg, vitamin D content is 1600.00 I.U/kg, iodine content is 0.5mg/kg, folic acid content is 0,20mg/kg, iron content is 60mg/kg and lastly zine content is 50mg/kg.

2.5.2 Fresh Vegetables, Fruits and Legumes

In this study, fresh feed like broccoli, pumpkin, carrot, baby corn, green beans, apple, black soybeans, mung beans and pumpkin seed are given to the hamsters. It has been reported that some fruits, particularly apples, play an important part in the hamster diet, and that the removal of these items from their diet will often result in a decrease in the implantation rate and an increase in cannibalism (Poiley, 1950). But based on Veterinary Medical Teaching Hospital (2015) hamsters have a sensitive digestive tract and cannot tolerate high-sugar items such as fruits.

On the other hand, there are several benefits for animal to consume apple. Aprikian O (2001) found that when cholesterol fed rats were supplemented with lyophilized apples, there was a significant drop in plasma cholesterol and liver cholesterols and an increase in high-density lipoproteins (HDL). Furthermore, they found that cholesterol excretion increased in the feces of rats fed apples, suggesting reduced cholesterol absorption. A second study, a similar cholesterol lowering effect was seen in cholesterol fed rats when rats were fed apples, pears, and peaches. Apples had a greater cholesterol lowering affect than the other two fruit (Leontowicz et al., 2002).

Besides that, dehydrated whole carrot could be considered as good source of nutrients for the growing rabbit (Goby J.P., 2008). This shows that carrot may also be a good source for the growing of hamsters. Carrots produce a diversity of phytochemicals including α-tocopherol, carotenoids, phenolics, and polyacetylenes, many of which have antioxidant and other health promoting effects (Metzger, 2009). They are highly nutritious and rich in provitamin A, vitamins C, D, E, K, B1, B6, and biotin, minerals such as magnesium, calcium, potassium, phosphorus, organic sodium, and many other trace minerals (Ng et al., 2016) .According to traditional Chinese medicine, carrots are good for some of organs including the eyes, ears, lungs, stomach, liver, pancreas, intestine, and skin. They have been referred to as tiny ginseng. Carrot meal supplementation improved metabolisable energy intake and nitrogen retention of unsexed Arbor acre broiler chickens (Mokgope, 2014).

As we know that green beans or the other common name is cowpea are good source of protein. Cowpea exhibited maximum protein content followed by mungbean, peas and pigeon pea (Butt & Batool, 2010). There is also journal that suggest cowpea meals are good sources of nutrient and can be used as ingredients in diets for white shrimp, the digestibility of dry matter, protein and carbohydrate of the diet containing whole raw cowpea meal was similar to the control diet (Rivas-Vega et al., 2006). Beans also are an abundant source of inositol, specifically inositol hexaphosphate, an antioxidant compound that can help prevent cancer and control the growth, progression, and spread of tumors in animals.

There is one animal study showed that mice consuming diets consisting of 20% black beans experienced a reduced incidence of DNA damage, which may be linked to cancers. Animal studies show that the resistant starch in beans also may help lower blood cholesterol (Winham.D, 2008). A cardio research on green beans involves animal studies on rats and nice, improvement in levels of blood fats and better

protection of these fats from oxygen damage has been shown to result from green bean intake (The World's Healthiest Foods, 2017).

Pumpkin is always the natural feed that was recommended to feed pet animals especially dogs and cats. Pumpkin flesh contains soluble fiber, which helps slows digestion, and can help manage diarrhea by absorbing water. Alternatively, pumpkin also helps with constipation due to its high fiber and water content Pumpkin flesh contains vitamin A, which is important for vision health contains vitamin C, which boosts the immune system. The zinc in pumpkin will help improve skin and coat. When this protein-bound polysaccharide from pumpkin fruits (PBPP) can increase the levels of serum insulin, reduce the blood glucose levels and improve tolerance of glucose in alloxan-induced diabetic animals(Yadav.M, 2010)

Broccoli (*Brassica Oleracea Var. Italica*), which is one of the *Brassicaceae* vegetables is a powerhouse of nutrient. As we know that this verdant vegetables is now popular in many places all over the world and over the past three decades, *Brassica* production has grown steadily becoming an important source of oil and protein of plant origin for animal and human nutrition respectively (Jahangir, Kim, Choi, & Verpoorte, 2009). *Brassica* vegetables contain high levels of vitamins (Heimler, Vignolini, Dini, Vincieri, & Romani, 2006), including carotenes, tocopherols, and folic acid according to Jahangir et al. (2009) and besides that, numerous of vitamin C can be detected in broccoli. S-methylcysteine sulfoxide, a naturally occurring S-containing amino acid, is contained at high concentrations in Brassica vegetables such as broccoli (Jahangir et al., 2009).

Its cholesterol-lowering effects have been demonstrated in animals, observing a significant decrease of the serum level of LDL-C (14% decrease) following the oral administration of broccoli (*B. oleracea L. var. botrytis L*.) and cabbage (*B. oleracea L. var. capitate L*.)(Suido et al., 2002). On the other hand, there is research using broccoli

to treat type 2 diabetic Sprague-Dawley (SD) rats and at the end the results shows that effect of *Brassica oleracea var. Italica* extract on mean body weight, food and water intake of rat has increase 9%, 14 % and 2% respectively when compared to the day 0 values (Shah, Sarker, & Gousuddin, 2016). Hence this shows that broccoli have high content of protein which are enough to animal to increase their body weight.

Black soybeans (*Glycine max (L.) Merr*.) are merely a black variety of the soybean, it's appearance is a black seed coated outside the bean while inside is the same colour as yellow soybeans and as with the yellow soybean, the black variety is considered an inexpensive source of protein (Verywell Editor, 2017). A study of Fafioye, Fagade, Adebisi, Jenyo-Oni, and Omoyinmi (2005) used heat treated and raw soybeans to feed African Catfish fingerlings. At the end of this study, results shows that heat treated and raw soybeans might enhance better growth performance and feed utilisation by Catfish fingerlings while the high digestibility of the diets suggests that soybeans have the potential of replacing or competing with animal protein in fish feed formulation (Fafioye et al., 2005). Lastly, this study also shows that protein synthesis occur inside the fish body when soybean are given to the fish.

A type of small, green legume in the same plant family as peas and lentils which is mung beans (*Vigna radiata (L.) Wilczek*), is a high source of protein, fiber, antioxidants and phytonutrients (Dr.Axe, 2016). A journal shows that mung beans can act as feed to provide protein to rat. Feeding experiments on albino rat (*Mus norvegicus albinus*), have shown that with the intake at about 18 per cent of the ration, and representing not less than 20 per cent of the total calories, the proteins of the Chinese mung bean are biologically complete (Tso, 1926) to the rat.

With a wide variety of nutrients ranging from magnesium and manganese to copper, protein and zinc, pumpkin seeds are nutritional powerhouses wrapped up in a very small package (Mercola, 2013). Pumpkin seeds consists of antioxidants which are

carotenoids and vitamin E. The function of antioxidants can use to reduce inflammation and look after our cells from damaging free radicals. Due to this reason, by eating foods that rich in antioxidants can aid the body against disease. In one study, inflammation was reduced when rats with arthritis were given pumpkin seed oil. Rats given an anti-inflammatory drug experienced negative side effects, whereas rats given pumpkin seed oil had no side effects (Brown, 2016).

Pumpkin is not treated with pesticides, thus pumpkin is good for animal nutrition in organic production as well. Pumpkin seeds can be used, as well as pumpkin seed cake, pulp, oil and peel of pumpkin in animal nutrition. Ruminants like the taste of pumpkin seed cake and it can increase the palatability of feed mixture. Seeds, as well as pumpkin seed cake, are rich in crude protein and crude fat with adequate concentrations of unsaturated fatty acids, particularly oleic (C18:1 n-9) and linoleic (C18:2 n-6), moreover pumpkin seed cake contains higher metabolisable energy and higher crude proteins content compared to soybean meal (Klir, Novoselec, & Antunović, 2017).

Baby corn has a nutritional makeup closer to a non-starchy vegetable and it has a lower carb count than regular corn yet it is still a good source of fiber (Corleone, 2017). From Hooda and Kawatra (2013) stated that ascorbic acid and b-carotene content of baby corn was 5.43mg/100 g and 670.00 mg/100 g, which are greater than carrot, colocasia stem, pumpkin and ridge gourd which supply 3.00, 3.00, 2.00 and 5.00mg ascorbic acid/100 g, respectively. Next, the calcium content of baby corn was 95.00 mg/100 g and contained 6.91 mg/100g of iron which was observed to be higher than a number of common vegetables (Hooda & Kawatra, 2013). After analysis, study shows that baby corn contained 898.62 mg/100 g phosphorus which was found to be several times higher than the phosphorus content of cabbage, lettuce, spinach, bitter gourd, brinjal, cauliflower, french beans and ladies finger (Hooda & Kawatra, 2013).

Nevertheless, there is precaution that should be take note when feeding hamsters with fresh fruits and vegetables, those feed should be remove after a day to prevent rotten and spoilage feed is given to hamster.

CHAPTER 3

METHODOLOGY

3.1 Materials

Six mature female and six mature male of hamster are bought from pet shop and continue raise in this experiment. In this experiment, the sources of getting the two main manipulated variables which are the commercial hamster food mix of Delikate Brand and fresh vegetables, fruits and legumes, are bought from pet shop and hypermarket nearby Jeli town. During this experiment, fish tank in the aqua lab are make as their living cage and since their health care will be consider, a hamster running ball toy will be from pet shop to let them exercise regularly. Weighing balance are needed to weight the body weight of hamster.

3.2 Method

3.2.1 Experimental Design

Four female and four male of hamster are involve in this experiment. All of them are divided into four cages which each cage consist of one male and one female only, while the four pairs of hamster are divided into two groups which are commercial hamster food mix group and fresh vegetables, fruits and legumes group. During the

experiment, water is provided to both group of hamster, but one group of hamsters are fed with of process feed which is Delikate Super Premium Mix brand and and each of them are feed with 6g of processed feed every day. Another group of hamsters are fed with fresh vegetables, fruits and legumes and each of them are feed with 16g of fresh feed every day. The two groups of hamsters are provided with similar of living cage and live under same environment temperature. The experiment was carry out for three months to get more accurate data.

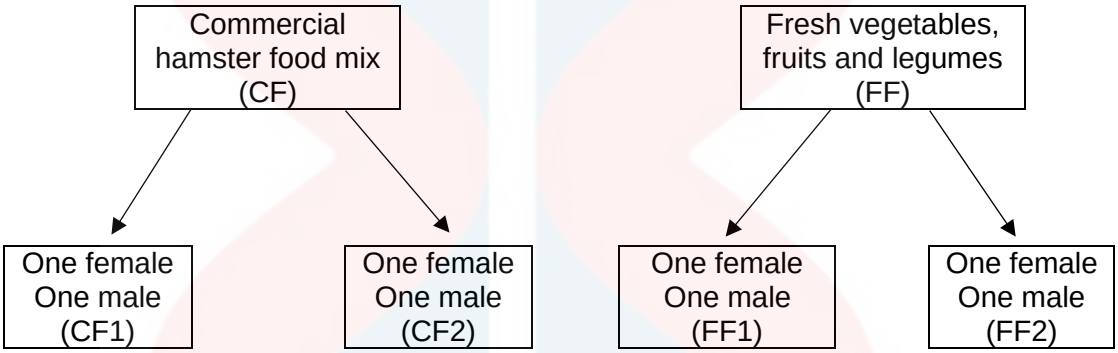
Based on Canadian Council on Animal Care (1984) food consumption of standard laboratory feeds that given to hamster will be from minimum 7g/day and water consumption will be up to 20 ml/day for animals on dry feeds. While for this experiment, it is modified to 6g of commercial feed was given to each dwarf hamster in commercial feed group because they does not eat much and to prevent wastage of feed as the feed left over are throw away on the second day.

Fresh vegetables, fruits and legumes like broccoli, pumpkin, carrot, baby corn, green beans, apple, black soybeans, mung beans and pumpkin seed was given to another group of hamster. Each of them are feed with 16g of combination of fresh feed every day.

The body weight of the two groups hamsters are recorded weekly and the mortality of the hamsters are also recorded. The fertility of hamster are recorded based on number of mating during this experiment, number of times female hamster conceive and number of pups produced. The behaviour will be record daily for four times (2.30pm, 4.00pm, 5.30pm, 7.00pm) each time will be 30 minutes. This is based on K Fischer, SG Gebhardt-Henrich, and A Steiger (2007) the highest level of activity of hamster occurred during 2.30pm to 5.30pm. Based on Snodgrass-Belt, Gilbert, and Davis (2005) active behaviours including wheel running, grooming and eating. But in

this experiment, only grooming and jumping are included in active behaviour and they are observed and recorded.

3.2.2 Experimental Layout



CHAPTER 4

RESULTS

4.1 Body Weight of Hamster

The body weight of every hamster are recorded during the first day of this experiment and is followed by every week of the experiment. From Table 4.1, we compared the initial weight and final weight of hamsters that involved in this experiment and we can see that all hamsters that eat processed feed had gained weight significantly which is 19.616g for male and 16.029g for female. While for hamster that consuming fresh feed, they showed slighter increase of body weight which is 6.406g for male and 4.538g for female.

From Table A.1 we can see that male and female hamster in CF1 group shows continuous weight gained in every week while for CF2 male hamster, during week 5 there is a slightly obvious weight gained if compare with previous week but after a week the body weight lost and weight become almost same as week 4 again. CF2 female show a significant weight gained for week 2 and 3 because it is pregnant during that time and same goes for week 7 and 8. There are no body weight recorded during week 4, 5, 9 and 10 because she needs to take care of the pups and it is not suitable to disturb the mother during lactation period. On the other hand, from the Table A.1, we can see that all fresh feeding hamster lost their weight during week 2 and increasing back immediately at week 3. The body weight of FF1 cage male has the most uncertain body weight which it started to loss its weight for week 6 and 7 and only keep to gain weight after week 7. The male hamster in cage FF2 also lost some weight during week

6 but it slowly increasing back its weight after that. Female hamster in cage FF1 and FF2 only show weight gained in every week.

Table 4.1: Body weight gain of hamster.

Group of hamster	Initial weight (g)	Final weight (g)	Weight gain (g)
CF Male	36.752	56.368	19.616
CF Female	25.041	41.070	16.029
FF Male	30.186	36.592	6.406
FF Female	26.087	30.625	4.538

CF: Commercial hamster food mix
FF: Fresh vegetables, fruits and legumes

4.2 Mortality

In this experiment, the mortality rate in both of the group are zero. The result shown that all hamster survived during this experiment.

4.3 Fertility

During this 12 weeks of time, there are no hamster that produced litters except for one pair of CF group hamster that feed by commercial hamster food mix. Thus the fertility rate is 50% for processed feed since there is one cage of processed feed gave birth and another one does not gave birth while the fertility rate is 0% in fresh feed group. The CF group female hamster gave birth two times within this 12 weeks and for the first pregnancy she produced six litters but at the end just five of the litters survived because she ate one of them. While for the second time of pregnancy, the same female hamster from the same control group produced 6 litters and all of them survived.

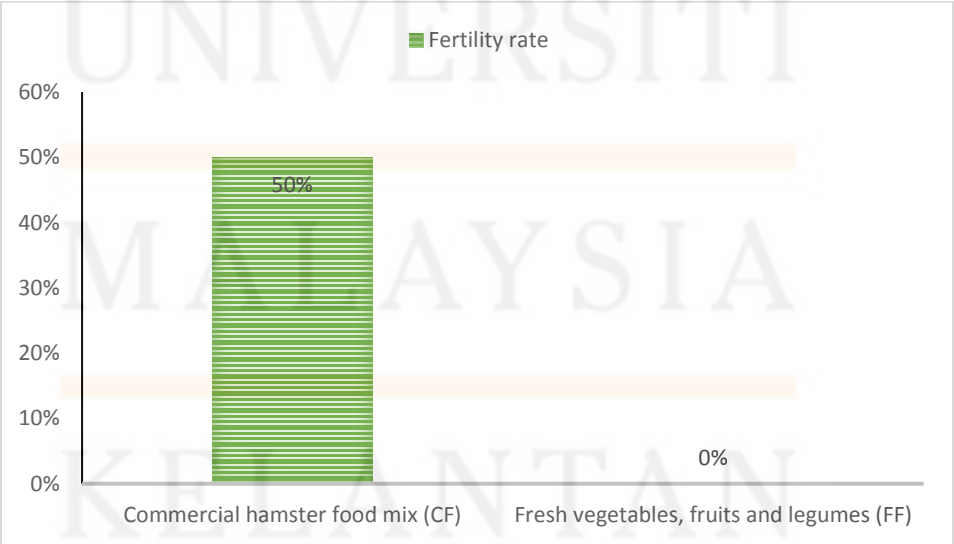


Figure 4.1: fertility rate of commercial hamster food mix group (CF) and fresh vegetables, fruits and legumes group (FF) of hamster.

4.4 Behaviour

The hamsters mainly spent their time in jumping and grooming for active behaviour. The result for the active behavioural is counted every day during the experiment and each jump and each grooming behaviour are being counted. The amount of jumping and grooming for four hamsters that ate the same feed are added together to concluded the result for its group. From table 4.2 we can see that hamster that are given fresh feed tend to have more jumping movement than processed feed hamster which it is 31661 times for fresh feed hamster and is 15921 times for processed feed hamster. The different amount in jumping can up to 15740 times and that is a huge number of different. Throughout the time, it is observed that fresh feed hamsters also show a total of 3743 times in grooming while processed feed hamsters show a total of 2550 times of grooming only. Somersaulting only demonstrated by FF cage male hamster only and he somersaulting for 80 times during this experiment. From the result, it indicates that hamsters in fresh feed group shown a very active behaviour.

Table 4.2: number of active behaviour of hamster.

Behaviour	Commercial hamster food mix (CF)	Fresh vegetables, fruits and legumes (FF)
Jumping	15921	31661
Grooming	2550	3743
Somersaulting	0	80

CHAPTER 5

DISCUSSION

5.1 Discussion

The goal of this study is to examine will the feed intake affect the body weight, mortality, fertility and behaviour of hamster thus to determine which feed is suitable to hamster as a pet. Based on Table 4.1, it shows that hamster gainned more weight after consuming commercial feed if compare with fresh feed. Thus it shows that commercial feed is effective in letting hamtser gain weight. But ganning too much of weight in hamster cause obesity to hamster which can cause health problem in hamster. In a journal, hamsters have served as models for studying obesity and study about obesity induction in hamster that mimics the human clinical condition (Silva et al., 2017). Thus, it is believe that hamstar that is obese does not bring benefits to hamster.

Based on Bauer and Besch-Williford (2012), at peak body mass of *Phodopus sungorus* hamster, males weigh from 40g to 50g while females weigh about 30g. From Table A.1, it clearly shows that male and female hamsters that was feed with processed feed are overweight which can also consider as obesity. Various metabolic syndromes such as nonalcoholic fatty liver disease (NAFLD), insulin resistance, and hypertension are known to be associated with obesity, yet obesity is most commonly accompanied by liver damage, as dietary obesity promotes liver inflammation (Huang, Chang, Kao, & Lin, 2015). In addition to this, according to (Dalboge et al., 2015) hamsters will quickly develop hypercholesterolemia and hypertriglyceridemia when fed a cholesterol-rich

diet. The fat content of commercial feed is too high which is 7% and it exceed the lipid requirement needed of a hamster that is 5%.

From Table A.1 all fresh feeding hamster lost their weight during week 2, this might due with hamster cannot adapt to fully fresh feeding immediately because previously they were feed with processed feed. Maybe it is too sudden for them to only eat fresh feed plus fresh feed is low in fat thus it is more hard for them to gain weight during the first week. Besides, it is also observed that the weight of male hamster in CF and FF group are not increasing continuously every week, this may be due to some experimental error happenned during recording the weight of hamster. Because the hamster is in a moving state when the body weight is recorded thus it may cause bias occur when recording the reading. Besides, the body weight of hamster will also be affected during measuring their weight if the hamster stored food in its huge cheek pouches.

In contrast with commercial feeding hamster, the body weight of fresh feeding hamster does not reach their peak body mass except for one female hamster. However, the weight of all the fresh feeding hamster are still in a normal range or can be said the body weight is in the nadir of normal body weight for dwarf hamster. For an adult dwarf hamster, their body weight is initially start from 28g which stated in Veterinary Medical Teaching Hospital (2015). This result shows that the fresh feed given has provided the minimum requirement of nutrient to the hamsters.

In such a way, different feed used are proven can effect the growth of hamster which is also stated by Hasdai and Liener (1983), Golden Syrian hamsters were fed raw soy flour grew much more poorly than those fed heated soy flour, an effect which was reflected in a lower food efficiency as well. So it is very vital for pet owner to decide which type of feed should be given to their hamster.

As it is know that processed feed is very common in feeding hamster but hamster that are feed fully using fresh vegetables, fruits and legumes is not that common. The 0% of mortality rate shows that hamster is safe to consume processed feed or fresh feed only. Trainor (2014) reported that hamster is a vegetarian or grain eaters thus this also shows that hamsters can survive with fresh feed diet.

A pair of hamsters in CF group shows a high fertility which they had produced 11 litters in this 3 months experiment. As the breeding life of a pair of hamsters is about 1 year, and up to 13 litters can be produced (Lerchl, 1995). Another pair of hamster in CFgroup does not produce any litters which means the fertility rate in processed feed is 50% when it is compared with 0% fertility rate of fresh feeding hamster. However there is also some assumption of why one pair of CF group and all of FF group hamster shows breeding disorders during this experiment. Both male and female hamsters are infertile as a result of old age, incompatibility of male and female hamsters that are trying to mate, malnutrition, the sperm quality and quantity are low in males, abnormal estrous cycle and problems in ovarian or uterine cysts in females.

The age of all the hamsters are unknown when they are bought from the pet shop, thus they might be old in age and their body condition is not favourable for them to produced litters. According to Horton and Yellon (2001) fertility was maintained in aged and adult males to a comparable extent with respect to latency to first litter and number of pups per litter; reproductive success was dramatically reduced in aged compared to adult females. Thus this may be why another 3 female hamsters does not produced litters in this 3 months. During the observation towards the behaviour of hamsters, there are a few time one of the male in FF mount the female with wrong posture which he did not mount behind of female but is towards the head. This show the incompatibility of male and female hamsters that are trying to mate.

Besides that, the malnutrition may occur in both processed feed and fresh feed group of hamsters. It shows that the protein content of processed feed which is only 12.5%, it does not meet the reproduction requirement of protein needed in hamster. Because Washington (1995) stated that in a diet containing 18 percent crude protein is thought to meet the amino acid needs for reproduction in hamsters. While for the fresh feed group of hamster, they might need more protein because their body weight also shown that they are in the intilal level of normal weight in dwarf hamster. Thus the malnutrition may also effect in low quality and quantity of sperm in male hamster and abnormal estrous cycle and problems in ovarian or uterine cysts in females.

The behaviour that wanted to study in this experiment is in connection with its level of activeness. Based on Snodgrass-Belt et al. (2005) active behaviours including wheel running, grooming and eating but in this experiment only jumping and grooming are considering as active behaviour. Based on the observation, there are not only jumping but hamsters also having somersaulting behaviour. The number of jumping of fresh feeding hamster is greater than processed feed while the somersault behaviour is also only shown by one of the fresh feeding male hamster in FF group. Thus it can be sum up that hamster which are feed with fresh feed having more active behaviour if compare with hamster that eat processed feed.

From the Table 4.2, it clearly stated that fresh feeding hamsters show more grooming behaviour than processed feeding hamsters. As it is a natural behaviour that hamster will groom them self but at the same time grooming also means that hamster is feeling secure and happy (Saliba, 2010). Thus this may assume that hamster that feed by fresh feed feel more content and happy and they are not refuse to eat fresh feed during this experiment. Thus by feeding fresh feed to hamster can reduce their sadness and makes them feel more happy if compared with processed feed.

There might have be some argument for the result demonstrate in the active behaviour of one of the female in CF group. The CF female may have shown non-active behaviour during gestation period and after giving birth because she needs to lactate enough milk to feed the pups and take care of them. In a journal of testing how does the running wheel affect the behaviour and reproduction of golden hamsters kept as pets by Gebhardt-Henrich, Vonlanthen, and Steiger (2005) also stated that during pregnancy, hamsters ran less in the wheel and stopped using the wheel from parturition until 10 days after parturition. Thus it may effect the performance of active behaviour of processed feed group. However over all result stated fresh feeding hamster still indicates that they have more active behaviour than processed feeding hamster. Thus it is still assume that the pregnancy issue of one female in CF group does not effect the result.

These result indicated that behaviour of hamster can be influnce by feed given to them. As reported by Tissier et al. (2017) showing a diet of corn turned wild hamsters in north-eastern France in to deranged cannibals that devour their offspring. This study show an agreement in animal behaviour can be affected by types of feed provided to them.

On the other hand, there are some reasons that likely causes these hamster to act those behaviour. Based on developmental studies, both jumping in voles and jumping in mice, have been suggested to originate from attempts to escape the cage and it also stated that somersaulting in mouse will also have the same attemption (Wurbel, 2006). Besides that, exposure to external eliciting stimuli may complement internal causal factors for rodent to jump because they wanted to explore the environment or the smells and sounds of mice in neighbouring cages, or to search for shelter or additional food sources (Wurbel, 2006). So from these study it is also can say that hamster also have the same characteristic and thought as mice and voles to have the similar behavioural responses because they are consider as caged rodent.

To make it easy to understand, it may also say that hamsters jump and somersaulting during this experiment is because they wanted to see the world outside of their cage because they are curious of it or they want freedom so they tend to jump to escape from the cage.

Thusly based on the result of the body weight and the level of activeness of hamster, as it can see that the hamster having most haevy weight does not having much movement in the cage while the lightest hamster jumping the most during this experiment. Hence it is believe that the body weight of hamster could influence the activeness of hamster.

In summary, investment in study different kind of feed in hamster has helping in figured out what kind of feed will bring benefits to the hamster. The result obtained shows that fresh feed is better than processed feed.

CHAPTER 6

CONCLUSION AND RECOMMANDATION

6.1 Conclusion

As the conclusion of this research, all the objectives are accomplish successfully. The result of present study reported by only feeding hamster with processed feed can bring continuously increase body weight of hamster which will also cause obesity to the hamster. While feeding hamster with fresh feed will not stimulate obesity problem and mostly they reach the normal range of body weight requirement for hamster. The mortality rate of the hamsters are 0% which means both kind of feed does not bring death to the hamster during the experiment period. The fertility of hamster is 0% in fresh feed group of hamster and is 50% in processed feed group. Which show that both kind of feed does not hit the nutrient requirement needed for hamster to produced litters. The active behaviour is obviously shown in hamsters that eat fresh feed compared with processed meanwhile the reasons for the hamster has such behavioural responses which are jumping and somersaulting in the cage are because they tend to escape from the cage and they wanted to explore the environment. Besides, the hamster that feed with fresh feed are believe to be more content and happy when compared with processed feed hamster by showing more grooming behaviour.

6.2 Recommendation

For recommendation in aspect of further study in future prospects, researcher is encourage not to change the eating habits of hamster by too sudden because the body weight of hamsters decreases dramatically once their eating habit change from processed feed to fresh feed.

For the behavioural studies, it is better to use running wheel to calculate the activeness of hamster but with a condition which the running wheel is connected to a motion detectors so that it can be calculate accurately and easily. Other than that, the observation towards the behaviour of hamsters will be more accurate by using tool for example video camera which can also increase the observation time to 24hours. Thus the analyses towards behaviour of hamster will be easier and better.

Since the growth condition is consider in the study, it will be better to send the hamster to have body medical check up to get more accurate data for the body condition of hamster.

Besides, the most ideal and healthy diet for hamster that can be predict after this research is, it may be adding some commercial hamster food mix to the fresh feed diet. This is because fresh feed diet may have not enough of fat content while processed feed contain too high content of fat. Thus by mixing some processed feed into the feed might be the perfect and healthy diet for hamster. It is believe that this experiment could bring awareness to pet owner that is by giving processed feed only to hamster is not a briliant choice and it may harm their hamster at the end. Processed feed is only suitable as supplement to the hamster and feed hamster with fresh feed will bring a better result.

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APPENDICES

Appendix A: Figure

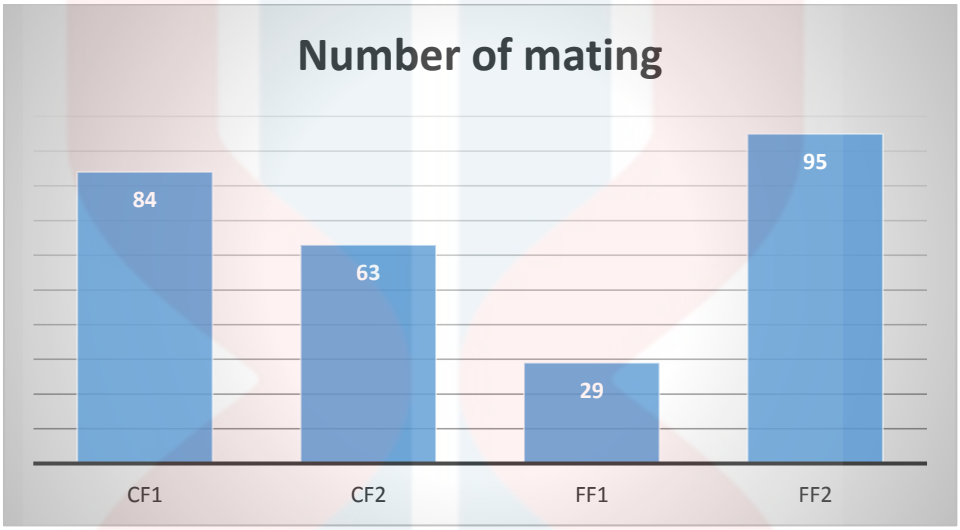

Figure A.1: the number of hamster mating.

Figure A.2: Fresh feed (carrot) given to hamster.

Figure A.3: Fresh feed (broccoli) given to hamster.

Figure A.4: Fresh feed (pumpkin) given to hamster.

Figure A.5: Fresh feed given to hamster.

Figure A.6: Processed feed given to hamster.

Appendix B: Raw Data

Date: 2/7/2017-29/7/2017

Data record of hamster

Behaviour / Cage:	CF1 M	CF1F	CF2M	CF2F	FF1M	FF1F	FF2M	FF2F
Grooming:	143	149	462	98	391	119	325	370
Mating:	5		24		0		2	
Jumping:	604	2490	1467	712	2277	5882	1479	635
Somersaulting:	-	-	-	-	-	-	-	-

Other behaviour: -

Others remark: 23th of July, CF2 female give birth 7 babies but at the end 5 survived.

Date: 30/7/2017-26/8/2017

Data record of hamster

Behaviour / Cage:	CF1 M	CF1F	CF2M	CF2F	FF1M	FF1F	FF2M	FF2F
Grooming:	158	141	435	113	412	156	353	361
Mating:	42		31		11		39	
Jumping:	561	2432	1428	703	2324	6121	1466	653
Somersaulting:	-	-	-	-	21	-	-	-

Other behaviour: -_____

_____

Others remark: 19th of Auggust CF2 female give birth again. 5 litters are produced and all survived.

Date: 27/8/2017-23/9/2017

Data record of hamster

Behaviour	Cage:	CF1 M	CF1F	CF2M	CF2F	FF1M	FF1F	FF2M	FF2F
Grooming:		147	174	423	107	398	122	359	377
Mating:		37		8		18		56	
Jumping:		507	2480	1455	1082	2343	6357	1476	648
Somersaulting:		-	-	-	-	69	-	-	-

Other behaviour: -_____

_____

Others remark: -_____

_____

Table A.1: Body weight of hamster.

Week	CF1		CF2		FF1		FF2	
	Male	Female	Male	Female	Male	Female	Male	Female
1	45.410g	27.502g	28.093g	22.580g	35.307g	28.065g	25.064g	24.109g
2	48.623g	30.580g	29.764g	26.585g	28.545g	21.687g	22.462g	19.990g
3	51.115g	32.402g	29.729g	32.585g	30.397g	24.128g	27.760g	22.800g
4	54.390g	34.761g	31.664g	-	30.869g	24.889g	30.527g	24.438g
5	55.681g	37.490g	34.257g	-	32.786g	25.185g	33.408g	26.779g
6	59.680g	40.033g	31.746g	31.189g	31.207g	26.649g	32.140g	27.128g
7	68.447g	40.807g	32.350g	40.241g	29.251g	26.409g	32.405g	27.559g
8	69.890g	41.658g	34.575g	47.241g	30.760g	27.582g	33.598g	28.940g
9	70.187g	42.870g	35.769g	-	31.918g	28.179g	35.016g	30.801g
10	70.506g	43.483g	37.982g	-	32.400g	29.052g	36.336g	30.927g
11	71.231g	44.157g	40.104g	32.671g	34.218g	28.998g	36.880g	31.953g
12	71.831g	45.157g	40.904g	36.982g	34.859g	29.398g	38.325g	31.851g

CF1: Commercial hamster food mix cage 1
CF2: Commercial hamster food mix cage 2
FF1: Fresh vegetables, fruits and legumes cage 1
FF2: Fresh vegetables, fruits and legumes cage 2