UNIVERSITI
MALAYSIA
KELANTAN

EFFECTS OF LOW CALORIES, HIGH FIBRE DIET ON WEIGHT AND BODY CONDITION SCORE IN OVERWEIGHT OR OBESE PRONE SMALL BREED DOGS IN MALAYSIA

by

TAN PEI QI
(D19A0027)

A RESEARCH PAPER SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF VETERINARY MEDICINE

FACULTY OF VETERINARY MEDICINE
UNIVERSITI MALAYSIA KELANTAN

2024

ORIGINAL LITERARY WORK DECLARATION

☐	**OPEN ACCESS**	I agree that my thesis is to be made immediately available as hardcopy or online open access (full text).
☐	**EMBARGOES**	I agree that my thesis is to be made available as hardcopy or online (full text) for a period approved by the Post Graduate Committee. Dated from_____until_____.
☐	**CONFIDENTAL**	(Contains confidential information under the Official Secret Act 1972)*
☐	**RESTRICTED**	(Contains restricted information as specified by the organisation where research was done)*

I acknowledge that Universiti Malaysia Kelantan reserves the right as follows.

1. The thesis is the property of Universiti Malaysia Kelantan
2. The library of Universiti Malaysia Kelantan has the right to make copies for the purpose of research only.
3. The library has the right to make copies of the thesis for academic exchange.

SIGNATURE OF CANDIDATE	SIGNATURE OF SUPERVISOR
NRIC/PASSPORT NO. 990903025264	DR. AMIRUL FAIZ BIN MOHD AZMI
DATE: 15/12/2024	DATE: 15/12/2024

Note: * If the thesis is CONFIDENTIAL OR RESTRICTED, please attach the letter from the organization stating the period and reasons for confidentiality and restriction

ABSTRACT

An abstract of the research paper presented to the Faculty of Veterinary Medicine, Universiti Malaysia Kelantan, in partial requirement of the course DVT 55204 - Research Project.

Canine obesity is a growing concern due to its association with metabolic and chronic diseases. This study evaluated the effects of a low-calorie, high-fibre diet on weight loss, body condition score (BCS), satiety, and overall health in overweight small-breed dogs. The intervention also examined owner compliance and the safety of the feeding regimen, targeting a weekly weight loss rate of 0.5–1.0% body weight. Six small-breed overweight or obese dogs, averaging seven years old, were divided into a trial group and a control group, each with three dogs. Initial mean body weights were 9.33 kg and 8.00 kg, while mean BCS averaged 8 and 6.67 for the trial and control groups, respectively.

The trial group was fed a low-calorie, high-fibre diet, while the control group received a standard commercial diet for four weeks. A slight mean weight reduction was observed in the trial group (-0.17 kg) ($p>0.05$), while the control group showed a minor weight gain (+0.63 kg) ($p>0.12$). Mean BCS in the trial group decreased from 8.00 to 7.33 ($p>0.05$), and the control group exhibited a significant reduction from 6.67 to 5.67 ($p<0.001$). Satiety and palatability were satisfactory in the trial group, with minimal food leftovers.

These results indicate the diet is metabolically safe but may require an extended period or additional interventions for significant weight loss. Further studies are needed to refine canine weight management protocols.

Keywords: Body condition score, Canine obesity, High-fibre diet, Low-calorie, Weight loss.

ABSTRAK

Abstrak kertas penyelidikan yang dikemukakan kepada Fakulti Perubatan Veterinar, Universiti Malaysia Kelantan, sebagai sebahagian daripada keperluan kursus DVT 55204 - Projek Penyelidikan.

Obesiti pada anjing adalah masalah yang semakin meningkat dan dikaitkan dengan penyakit metabolik serta kronik. Kajian ini menilai kesan diet rendah kalori dan tinggi serat terhadap penurunan berat badan, skor kondisi badan (BCS), rasa kenyang, dan kesihatan keseluruhan pada anjing baka kecil yang berlebihan berat badan. Kajian ini turut mengkaji pematuhan pemilik terhadap rejim pemakanan yang disasarkan untuk penurunan berat badan sebanyak 0.5–1.0% setiap minggu. Enam ekor anjing baka kecil yang berlebihan berat badan, berumur purata tujuh tahun, dibahagikan kepada dua kumpulan: kumpulan percubaan dan kumpulan kawalan, masing-masing tiga ekor. Berat badan awal kumpulan percubaan adalah 9.33 kg, manakala kumpulan kawalan 8.00 kg, dengan BCS purata 8 dan 6.67.

Kumpulan percubaan diberikan diet rendah kalori dan tinggi serat, manakala kumpulan kawalan diberi diet komersial biasa selama empat minggu. Penurunan purata berat badan yang kecil dilihat dalam kumpulan percubaan (-0.17kg) ($p>0.55$), manakala kumpulan kawalan menunjukkan peningkatan purata berat badan (+0.63kg) ($p>0.12$). Purata BCS kumpulan percubaan menurun daripada 8.00 kepada 7.33 ($p>0.05$), manakala kumpulan kawalan menurun daripada 6.67 kepada 5.67 ($p<0.001$). Hasilnya menunjukkan diet ini metabolik selamat tetapi mungkin memerlukan tempoh yang lebih lama untuk mencapai penurunan berat badan yang ketara. Kajian lanjut diperlukan untuk memperbaiki pengurusan berat badan anjing.

Kata Kunci: Diet rendah kalori, Diet tinggi serat, Penurunan berat badan, Skor kondisi badan, Obesiti anjing.

CERTIFICATION

This is to certify that we have read this research paper entitled **"Effects of Low Calories, High Fibre Diet on Weight and Body Condition Score in Overweight or Obese Prone Small Breed Dogs in Malaysia"** by Tan Pei Qi, and in our opinion it is satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirements for the course DVT 44603 - Research Project.

—----------

Dr. Murshidah Binti Mohd Asri
DVM (UMK), MVSc (UPM)
Lecturer
Faculty of Veterinary Medicine
Universiti Malaysia Kelantan
(Supervisor)

—----------

Dr Amirul Faiz Bin Mohd Azmi
Bsc (UITM), MSc (UPM), Ph.D (UPM)
Lecturer
Faculty of Veterinary Medicine
Universiti Malaysia Kelantan
(Co-supervisor)

—----------

AP Dr Choong Siew Shean
DVM (UPM), MVt (UPM), Ph.D (University of Nottingham)
Deputy Dean
Faculty of Veterinary Medicine
Universiti Malaysia Kelantan
(Co- supervisor)

ACKNOWLEDGEMENT

Special thanks for those who have given their support, guidance, advice and aid for the completion of this project paper:

Dr Murshidah Binti Mohd Asri

Dr. Amirul Faiz Bin Mohd Azmi

AP Dr. Choong Siew Shean

Dr Muhammad Ali Imran Bin Mohamed Kamil

Nor Nazirah Binti Zuraki

My family

Tan Wei Jun

DVM 5

DVM 1

Friends

My dogs and hedgehog

Thank You

DEDICATIONS

This thesis is dedicated to extraordinary individuals whose unwavering support, guidance, and encouragement have been instrumental in this journey. To Dr. Murshidah Binti Mohd Asri, my supervisor, for your insightful guidance and steadfast support, which have shaped this project and inspired me to strive for excellence. To Dr. Amirul Faiz Bin Mohd Azmi, my co-supervisor and mentor, for your invaluable advice, patience, and belief in my abilities. To my second co-supervisor AP Dr. Choong Siew Shean for your expertise and constructive feedback, which enriched the quality of my work. To my project partner, Nor Nazirah Binti Zuraki, for your dedication, collaboration, and resilience throughout this shared endeavor. To Dr. Muhammad Ali Imran bin Mohamed Kamil, for your support in arranging volunteers to help me in the process of the project. To my family, whose unconditional love, sacrifices, and encouragement have been my constant source of strength and motivation. To my dear friend, Tan Wei Jun, for your enduring friendship and support that have carried me through challenging times. To my peers in DVM 5, DVM 1, and my friends Ang Hui Qian and Audrey Koh Rui Ping, for fostering a sense of community and encouragement that made this journey more meaningful. Finally, to my beloved dogs and hedgehogs whose companionship brought comfort and joy during the most demanding moments. To each of you, I owe my deepest gratitude, and I dedicate this work as a testament to your unwavering belief in me.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ABBREVIATION

BCS	**Body Condition Score**
Kg	**Kilogram**
G	**Gram**
SEM	**Standard Error of Mean**
p-value	**Sig.**
H0	**Null Hypothesis**
H1	**Alternative Hypothesis**
ME	**Metabolizable Energy**
DER	**Daily Energy Requirement**
RER	**Resting Energy Requirement**
BID	**Twice Daily**

CHAPTER 1

1.0 INTRODUCTION

Obesity in dogs is a prevalent and concerning health issue worldwide, resulting from an imbalance between energy intake and expenditure, exacerbated by factors such as overfeeding, high-calorie diets, and lack of exercise (Laflamme, 2012). Implementing a tailored diet plan, along with regular exercise and veterinary oversight, is crucial in managing weight effectively and improving overall health (Brooks *et al.,* 2014). Weight care diet feeds, formulated to support weight management while meeting nutritional needs, play a vital role in this regard. These feeds offer controlled calorie intake, promote satiety, preserve lean muscle mass, and are convenient for pet owners (German, 2006; Linder *et al*., 2010). Supported by scientific research and veterinary expertise, they have been shown to effectively achieve and maintain weight loss in obese dogs (German *et al*., 2009). Hence, weight care diet feeds represent an essential tool in combating dog obesity in Malaysia, contributing to improved health and well-being through their specialized formulation, convenience, and proven efficacy as part of comprehensive weight management strategies.

1.1 RESEARCH PROBLEM

In light of the increasing prevalence of obesity among dogs in Malaysia and the potential health risks associated with untreated obesity, there is a pressing need to investigate the efficacy of weight care feeds corresponding to the owner's compliance in the feeding regime. This study seeks to assess the effectiveness of weight care feeds in managing obesity among dogs at home through a controlled trial. By measuring weight loss, nutritional adequacy, and overall health outcomes, the study aims to provide empirical evidence on the practical effectiveness of these feeds for overweight or obese prone dogs in owner feeding practice. The findings will not only contribute to the theoretical understanding of obesity management in dogs but also offer practical insights for veterinarians and pet owners seeking evidence-based strategies to address this health

concern. Furthermore, by establishing a replicable methodology, this research can serve as a foundation for future studies exploring similar interventions in other regions or with different populations of owned dogs.

I RESEARCH QUESTIONS

Can a low calorie, high fibre diet potentially reduces body weight by 0.5% to 1.0% per week in animals with a BCS of 6/9 and above, while improving quality of life, maintaining palatability, and minimizing the impact of free feeding by pet owners?

II RESEARCH HYPOTHESIS

H0: Low calorie, high fibre diet will not affect the weight, body condition score and overall health of overweight or obese prone small breed dogs, as practical for the owners to comply with the feeding regime for a weight loss program.

H1: Low calorie, high fibre diet will affect the weight, body condition score and overall health of overweight or obese prone small breed dogs, as practical for the owners to comply with the feeding regime for a weight loss program.

III RESEARCH OBJECTIVES

This study aims to evaluate the effects of a low-calorie, high-fibre diet on the weight, body condition score, and overall health of overweight or obesity-prone small breed dogs while also assessing the practicality of owner compliance in adhering to a structured feeding regimen for a weight-loss program.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 OVERVIEW OF OBESITY IN DOGS IN MALAYSIA

Obesity among dogs is a growing concern worldwide, including in Malaysia, where urbanization, lifestyle changes, and improper dietary management contribute to its rising prevalence. Multiple studies have highlighted an upward trend in canine obesity. For example, a study in urban areas of Malaysia reported an increase in obesity rates among dogs, primarily due to overfeeding, limited physical activity, and a preference for high-calorie commercial diets (Hall *et al*., 2016).

Genetic predisposition also plays a role in obesity risk, with certain breeds, such as Labrador Retrievers, Beagles, and Cocker Spaniels, being more prone to excessive weight gain (German, 2006). Research suggests that these breeds have variations in genes related to metabolism and appetite regulation, making weight management more challenging (Raffan *et al*., 2016). Additionally, metabolic and hormonal imbalances, such as leptin resistance, contribute to obesity in some dogs, regardless of dietary interventions (Pan *et al*., 2023).

Besides genetics and lifestyle, owner feeding habits significantly impact weight gain. Studies indicate that owner non-compliance with portion control and excessive treat-giving are major barriers to effective weight management in pet dogs (Flanagan *et al.,* 2017). Furthermore, palatability and food preferences influence weight loss success, as dogs are less likely to adhere to diets, they find unappealing (Tobie *et al*., 2015).

Environmental and dietary factors in Malaysia may further complicate obesity management. The hot and humid climate may discourage outdoor exercise, reducing opportunities for calorie expenditure (Teixeira *et al.,* 2024). Weight loss strategies must be tailored to a dog's environment, suggesting that indoor activity enrichment and controlled feeding plans are essential in regions where outdoor exercise is limited (Teixeira *et al*., 2024).

This growing issue necessitates a multi-faceted approach, including breed-specific dietary management, structured exercise routines, and increased owner awareness of portion control and nutritional needs (Flanagan *et al*., 2017; Raffan *et al*., 2016). Further research is needed to assess the long-term effectiveness of current weight management strategies in Malaysia and determine the best intervention practices for various dog populations (Pan *et al.,* 2023).

2.2 GENETIC FACTORS CONTRIBUTING TO OBESITY PREDISPOSITIONS

2.2.1. Metabolic Variations

Studies have revealed breed-specific differences in metabolic rates and energy expenditure, impacting the propensity for weight gain. For example, breeds such as Labrador Retrievers display lower metabolic rates, potentially contributing to their susceptibility to obesity (Raffan *et al*., 2016).

2.2.2. Appetite Regulation

Genetic variations in appetite-regulating hormones and neurotransmitter pathways can influence feeding behaviour and satiety signals in different breeds. Polymorphisms in genes encoding appetite-regulating peptides like ghrelin and leptin have been associated with obesity susceptibility in certain breeds (German *et al*., 2009).

2.2.3. Body Composition

Breed-specific differences in body composition, including adipose tissue distribution and muscle mass, can affect weight regulation. Breeds with a higher proportion of adipose tissue relative to lean muscle mass may be more prone to obesity (Mason *et al*., 2018).

2.2.4. Energy Expenditure

Breeds bred for specific purposes, such as herding or hunting, may exhibit higher energy levels and require increased physical activity. Reduced exercise levels in these breeds, coupled with genetic predispositions, can contribute to obesity development (Courcier *et al*., 2010).

2.2.5. Genetic Disorders

Certain breeds are predisposed to genetic disorders that disrupt metabolic processes and hormone regulation, increasing obesity risk. Hypothyroidism, for example, is more prevalent in breeds like the Golden Retriever and can lead to weight gain (Davies *et al*., 2004).

2.3 ROLE OF WEIGHT CARE FEED FORMULA

Obesity in dogs is managed through various strategies, including specialized weight care diets designed to promote weight loss while ensuring nutritional adequacy. Research has demonstrated the effectiveness of these diets, which provide controlled calorie intake and essential nutrients that support metabolism and satiety, facilitating gradual and sustainable weight reduction (German, 2006).

Beyond specialized feeds, a well-structured nutrition plan is crucial for managing obesity in Malaysian dogs. Studies emphasize the need for a balanced diet that includes controlled calorie intake, adequate protein to preserve lean muscle mass, and essential vitamins and minerals (Linder *et al*., 2010). Additionally, incorporating high-quality protein and fibre enhances satiety and metabolic function (Brooks *et al*., 2014).

While weight care diets offer a promising solution, their efficacy may be influenced by genetic predisposition. Therefore, an individualized nutrition plan, tailored to each dog's specific needs, is essential for effective and sustainable weight management.

2.4 INGREDIENT AND NUTRIENT FOR WEIGHT LOSS IN PET FOOD

2.4.1 Protein

Protein's role in pet weight management has been extensively studied. Increasing dietary protein while reducing carbohydrate intake can significantly enhance weight loss in pets. Research suggest that higher protein diets increase satiety, helping pets feel fuller for longer periods and thus reducing overall food intake (Parr & Remillard, 2014). Additionally, protein has a higher

thermic effect compared to fats and carbohydrates, meaning more calories are burned during digestion and absorption (Flanagan *et al.,* 2017). This thermogenic property of protein contributes to its efficacy in weight management.

2.4.2 Fibre

Fibre is another critical ingredient in weight loss diets for pets. Complex carbohydrates, such as those found in whole grains and vegetables, provide a good source of fibre. Increasing dietary fibre can promote a feeling of fullness, thereby reducing food intake. Soluble fibre increases satiety and lowers calorie density (Jackson *et al*.,2018). However, high fibre diets may lead to larger stools and gastrointestinal upset in some pets, and may be less palatable for cats, potentially leading to behavioural issues such as hunting or food stealing (Laflamme *et al*., 2019).

2.4.3 Water

High water content in pet food can aid in weight management by increasing satiety. Wet foods, although more expensive and requiring larger feeding volumes, have a lower calorie density compared to dry foods. Studies have shown that pets on high water content diets experience improved satiety and reduced overall calorie intake (Weber *et al*., 2020). Adding water to dry food is a potential alternative, though its acceptance varies among individual pets.

2.4.4 Fats

Dietary fats are the most calorie-dense macronutrient, and thus low-fat diets are often recommended for weight management. However, essential fatty acids, particularly omega-3 fatty acids from fish oil, are important for overall health and may aid in weight loss. Omega-3 fatty acids possess anti-inflammatory properties and may have a thermic effect that supports fat burning (Ishioka *et al*., 2017). Research indicates positive results from adding omega-3 fatty acids to calorie-restricted diets, though further research is needed to confirm their benefits for weight loss (German *et al*., 2015)

2.4.5 L-Carnitine

L-Carnitine, the bioavailable form of carnitine, facilitates the transport of fats to mitochondria for energy production. Research have shown that supplementing pet diets with L-Carnitine can enhance the rate and amount of weight loss compared to similar low-fat diets without supplementation (Ghaffari *et al*., 2018)

2.4.6 Other Nutraceuticals

Emerging research is exploring various nutraceuticals such as alpha-lipoic acid, betaine, amylase inhibitors, chromium, vitamin A, and dietary phytoestrogens for their potential in weight management. Current findings are inconclusive, but these ingredients represent promising areas for future study (Hand *et al*., 2020).

2.5 EFFECTS OF THERAPEUTIC WEIGHT LOSS DIET ON BODY WEIGHT LOSS DIET ON BODY WEIGHT AND METABOLIC HEALTH IN OVERWEIGHT AND OBESE DOGS.

Obesity has emerged as a significant health concern among canine populations, with prevalence rates ranging from 38.8% to 65% in developed countries (Courcier *et al*., 2010; German *et al*., 2018). It is associated with chronic low-grade inflammation, oxidative stress, and metabolic dysfunctions, increasing the risk of comorbidities such as osteoarthritis, gastrointestinal disorders, insulin resistance, and reduced overall quality of life (German, 2006; Laflamme, 2012; Wakshlag *et al*., 2011). Chronic inflammation, driven by excessive adipose tissue, results in elevated levels of pro-inflammatory cytokines and chemokines such as interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and monocyte chemoattractant protein-1 (MCP-1), which contribute to systemic insulin resistance and other metabolic disturbances (Blanchard *et al*., 2004; German *et al*., 2009).

Weight loss strategies for dogs typically involve a combination of caloric restriction and increased physical activity. While effective in reducing body weight, these methods often lead to a loss of lean body mass (LBM) in addition to body fat. The preservation of LBM is critical during weight loss as it helps maintain basal metabolic rate and overall metabolic health (Diez *et al*., 2002). High-protein diets have been shown to mitigate LBM loss while enhancing fat reduction during caloric restriction. For instance, Bierer and Bui (2004) demonstrated that dogs

fed a high-protein, low-carbohydrate diet achieved greater fat loss and improved lipid profiles compared to those fed a high-carbohydrate diet. Similar findings have been observed in studies on cats, where increased dietary protein reduced the loss of LBM during weight loss (Laflamme and Hannah, 2005).

Despite the availability of commercial weight loss diets, many fail to address key factors of canine obesity, such as chronic inflammation and oxidative stress. To address this, Pan *et al.* (2023) studied a therapeutic weight loss (TWL) diet enriched with high protein, omega-3 fatty acids, and soy germ isoflavones. This diet aimed to support healthy weight loss by preserving lean body mass (LBM), reducing fat, and lowering inflammation in overweight dogs.

In a six-month trial, 30 obese Labrador Retrievers (BCS ≥7) were divided into two groups: one received a standard commercial diet, while the other was fed the TWL diet. Both diets were restricted to 75% of baseline maintenance energy requirements (MER) for four months, with further reductions to 60% for dogs not reaching a BCS of 5. Weight loss progress was assessed using dual-energy X-ray absorptiometry (DEXA), while blood tests measured metabolic and inflammatory markers.

Results showed that while both diets led to weight loss, the TWL diet achieved greater fat reduction and completely preserved LBM. Dogs on the TWL diet lost 13.27% body fat, compared to 9.90% in the control group, highlighting its effectiveness for fat-specific weight loss. These findings align with previous research showing that high-protein diets help maintain LBM during caloric restriction (Diez *et al*., 2002; Bierer & Bui, 2004).

Metabolic health outcomes further distinguished the TWL diet from the control diet. Dogs on the TWL diet showed significant reductions in fasting serum cholesterol, triglycerides, insulin, and leptin compared to their baseline levels. This suggests that the TWL diet not only facilitates weight loss but also improves systemic metabolic regulation. Additionally, the TWL diet demonstrated potent anti-inflammatory effects, with significant reductions in pro-inflammatory cytokines such as IL-6, IL-18, and TNF-α, as well as chemokines like MCP-1 and IP-10. By comparison, the control diet exhibited limited anti-inflammatory effects, reducing only a single pro-inflammatory chemokine (IP-10).

The inclusion of omega-3 PUFAs and soy isoflavones in the TWL diet likely contributed to these outcomes. Omega-3 PUFAs, such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are known for their anti-inflammatory properties and their ability to reduce serum triglycerides and improve joint mobility in dogs (Moreau *et al*., 2013). Soy isoflavones, on the other hand, have been shown to mitigate oxidative stress and support LBM retention during weight loss (Pan *et al*., 2008).

The study's findings highlight the potential of targeted dietary interventions to address the multifaceted challenges of canine obesity. By combining high protein content with anti-inflammatory and muscle-preserving nutrients, the TWL diet represents a holistic approach to weight management. However, the study acknowledges that the synergistic effects of the diet's components complicate efforts to isolate the specific contributions of individual nutrients. Further research is needed to explore the roles of these components in achieving optimal weight loss outcomes and their applicability to broader canine populations.

In conclusion, the TWL diet offers a promising strategy for managing canine obesity by promoting healthy weight loss, preserving LBM, and improving metabolic and inflammatory markers. These findings provide valuable insights into the development of advanced therapeutic diets for overweight and obese dogs, paving the way for more effective and comprehensive approaches to obesity management in veterinary practice.

2.6 PET FOOD PALATABILITY ASSESSMENT

Pet food palatability is commonly assessed using single-bowl and two-bowl tests. The single-bowl test evaluates food acceptance by measuring the amount consumed when only one food type is offered, making it a practical and cost-effective method. However, it provides limited insight into comparative preferences and hedonic responses (Aldrich & Koppel, 2015; Tobie *et al*., 2015). In contrast, the two-bowl test presents two food options simultaneously, assessing preference based on relative consumption. While effective in controlled settings, this method does not account for long-term preferences or post-ingestive effects and may introduce biases due to its forced-choice nature (Aldrich & Koppel, 2015).

Recognizing the limitations of traditional methods, recent research has introduced more sophisticated approaches to evaluating palatability. Liking tests improve upon the single-bowl method by incorporating additional measures such as bowl completion rates, consumption speed, and deviations from reference intake, offering a more detailed assessment of feeding enjoyment (Tobie *et al*., 2015). Kinetic analysis further refines palatability evaluation by tracking feeding behaviors over time, including frequency and duration of visits to food bowls. This approach is particularly useful for assessing the effectiveness of satiety-inducing diets and distinguishing between immediate attractiveness and sustained interest (Tobie *et al*., 2015).

Innovative methodologies, such as the Cognitive Palatability Assessment Protocol (CPAP) and exploratory behaviour analysis, have also emerged. CPAP utilizes associative learning tasks, allowing animals to indicate food preferences without direct consumption, thereby reducing post-ingestive biases. However, its reliance on extensive training makes it less practical for routine use (Tobie *et al*., 2015). Exploratory behaviour analysis, which observes non-consumptive behaviours like sniffing, licking, or rejecting food bowls, provides additional insight into palatability but requires further validation for consistency and reliability (Tobie *et al*., 2015).

CHAPTER 3

3.0 MATERIALS AND METHODS

3.1 STUDY AREA

This study was conducted to small breed dog owners in Malaysia.

3.2 STUDY DESIGN

This study was executed by providing a low-calorie, high-fibre diet to clients who met the targeted weight criteria specified in Malaysia. Clients were given low-calorie, high-fibre kibble to be fed for a one-month duration, with an expected weight reduction of 0.5%–1.0% per week. The changes in body weight were evaluated and recorded throughout this period. This study was conducted as a prospective cohort study.

	Percentage (%)
Crude protein (min)	25%
Crude fat (min)	9%
Crude fibre (max)	12%
Moisture (max)	10%

Table 1: Nutrition Composition of Low-calorie High Fibre Dog Kibbles

	Percentage (%)
Crude protein (min)	> 23%
Crude fat (min)	> 12%
Crude fibre (max)	< 6.0%
Moisture (max)	< 8.5 %

Table 2: Nutrition Composition of control commercial diet dog kibbles

3.3 STUDY POPULATION

The study population included 6 small breed indoor dogs, and separated into 2 groups, 1 group of 3 was the subjects of the feed trial and another group of 3 was the control subjects.

3.4 SELECTION CRITERIA

3.4.1 Inclusion Criteria

The inclusion criteria were overweight or obese-prone small breed dogs with a body condition score of 6/9 based on the Snodgrass Veterinary Medical Center Body Condition Scores, at least 1 year old, and in healthy condition with no underlying disease upon physical examination. The dogs had to be indoor, neutered, and have minimal exercise, but were not restricted to a cage only.

3.5.2 Exclusion Criteria

The exclusion criteria for this study were overweight dogs whose owners did not give consent, dogs that were not in healthy condition, pregnant or lactating dogs, or those expected to be

during the trial period. Dogs with a history of adverse reactions to food, dogs requiring other therapeutic or special care diets, dogs scheduled for surgery during the trial period, and dogs involved in other clinical studies during the same period were also excluded.

3.6 SAMPLING TECHNIQUE

A recruitment poster was made to post on social media, to recruit 6 candidates that fit for this study research. 3 dogs for treatment and 3 dogs for control and the owners will be required to fill in a recruitment checklist.

	Pass	Failed
Physical examination (normal)		
Deworming status		
Vaccination status		
History of food allergy		
Lactating/ pregnant/ expected to be		
CBC (normal)		
Serum biochemistry (normal) Urinalysis (normal)		
Body weight		
BCS >6/9		
Age at least 1 years old		
Indoor		
Isolated feeding area		

Table 3: Recruitment Checklist

3.7 SAMPLING PROCEDURE

This study evaluated the effects of a low-calorie, high-fibre diet on weight loss and overall health in small-breed dogs by conducting comprehensive baseline assessments, including physical examinations, complete blood count (CBC), serum biochemistry for liver and kidney function tests, and urinalysis. Before day 0, feed intake for the control group was calculated, and daily fecal scores, weekly body weights, and body condition scores for the treatment group were collected, along with photographic documentation from multiple angles. The indoor environment and daily exercise levels of the dogs were assessed, and an isolated feeding area was prepared to ensure controlled conditions for dietary management.

Category	**Parameter**	**Time**
Body weight	Kg	Day 0, 7, 14, 21, 28
Body condition score	x/9 (based on Snodgrass Veterinary Medical Center Body Condition Scores chart)	Day 0, 7, 14, 21, 28
Complete blood count	Basic haematology parameters	Day 0 & 28
Serum biochemistry	- BUN - Creatinine - ALT - ALKP - Triglyceride	Day 0 & 28
Urinalysis	Urine strip	Day 0 and 28
Faecal score	Based on chart	Everyday
Daily exercise	2 hours walk / day	Everyday

Table 4: Health Screening and Check-up Chart For Both Control And Treatment Trial Group

<table>
<tr><td>CLIENT DATA</td><td>CASE NO :</td><td>PATIENT DATA</td><td>DATE:</td><td>VISIT NO:</td></tr>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">ID:</td></tr>
<tr><td colspan="2" rowspan="3">OWNER:

ADDRESS:

TEL : (H):
(HP):
(O):</td><td>SPECIES :</td><td>DOB/
AGE :</td><td>SEX:</td></tr>
<tr><td>BREED:</td><td colspan="2">COLOUR:</td></tr>
<tr><td colspan="3">VACC.
DATE : TYPE:
DUE:
WORM
DATE: TYPE:
DUE:

HEARTWORM PREVENT ( ) NA ( )
No ( ) Yes TYPE :</td></tr>
<tr><td colspan="5">REASON FOR VISIT:</td></tr>
<tr><td colspan="5">MANAGEMENT:</td></tr>
<tr><td colspan="5">HISTORY:</td></tr>
</table>

PHYSICAL EXAMINATION			**TEMPERAMENT**		
DEHYDRATION %	WEIGHT KG		TEMP °C	PULSE	RESP.
SYSTEM	**NAF**	**ABN**	**DESCRIPTION OF FINDINGS USING NO'S ADJACENT**		
1. General appearance					
0. Mucous membrane					
0. Integument					
0. Lymph nodes					
0. Cardiovascular					
0. Respiratory					
0. GIT 0. Urinary					
0. Musculoskeletal					
0. Nervous system					
0. Eyes					
0. Ears					

0. Reproductive			

Table 5: Physical Examination Form

3.7. 1 Feed plan for the treatment trial groups

Feeding for the treatment trial group was conducted in three steps. The transition to a new diet was completed over seven days, following the Royal Canin feed transition chart. Day 0 commenced after the feed transition was successfully completed. The feed trial lasted for 4 weeks, including the one-week feed transition period and acclimatization to the new environment.

During the feed transition, the diet plan was implemented as outlined in the table, ensuring a gradual shift to the low-calorie, high-fibre diet. After the transition, the low-calorie, high-fibre diet was fed in amounts calculated based on the dogs' individual resting energy requirements (RER), determined using the formula: RER = 70 x BWkg^0.75. Owners were instructed to divide the daily feed amount into two meals and to always provide fresh water.

Day	Percentage old food (%)	Percentage new food (%)
1	75%	25%
2	75%	25%
3	50%	50%
4	50%	50%
5	25%	75%
6	25%	75%
7	0%	100%

Table 6: Royal Canin Feed Transition Chart

The feeding requirements for each dog were calculated based on their stage of weight loss or maintenance. For weight loss, the daily energy requirement (DER) was calculated as 1.0 times the resting energy requirement (RER), while for maintenance in neutered dogs, the DER was calculated as 1.6 times the RER.

The actual metabolizable energy (ME) of the low-calorie, high-fibre diet kibbles was 290 kcal per 100g. The amount of low-calorie, high-fibre diet to be fed to the dogs was calculated by dividing the DER by the ME. During the weight loss phase, the daily energy requirement (DER) was calculated according to the table below. Weekly bodyweight and body condition scores are recorded to customize the feed volume based on the latest body weight and body condition score. Once the dogs achieved their ideal body condition score 4/9 or 5/9, owners were advised to adjust the feeding regimen to a maintenance stage, with the DER recalculated as shown by the table below.

Xiao Bai
10 kg neutered dog RER = 70 x $10^{0.75}$ = 394 kcal/day DER during weight loss = 1.0 x RER = 394 kcal/day Feed amount during weight loss = 394 kcal/day ÷ 290 kcal/100g = 136 g/day Number of 50g cups of feed given per day = 136 g/50g = 2.72 cups/ day ~ 3 cups/ day Number of 50g cups of feed to be given per meal = 3 cups/ 2 meal = 1.5 cups per meal, twice daily DER during maintenance= 1.6 x RER = 630.4 kcal/day Feed amount during maintenance = 630.4 kcal/day ÷ 290 kcal/100g = 217 g/day Number of 50g cups of feed given per day = 217g/ 50g = 4.34 cups /day ~ 4 cups / day

Number of 50g cups of feed to be given per meal = 4 cups/ 2 meal = 2 cups per meal, twice daily

Table 7: Daily Feed Requirements of Xiao Bai

Bing Bing
9 kg neutered dog RER = 70 x 9 $^{0.75}$ = 364 kcal/day DER during weight loss = 1.0 x RER = 364 kcal/day Feed amount during weight loss = 364 kcal/day ÷ 290 kcal/100g = 126 g/day Number of 50g cups of feed given per day = 126 g/50g = 2.5 cups/ day ~ 2+ ½ cup / day Number of 50g cups of feed to be given per meal = 2 + 1/2 cups/ 2 meal = 1+1/4 cups per meal, twice daily DER during maintenance= 1.6 x RER = 582.4 kcal/day Feed amount during maintenance = 582.4 kcal/day ÷ 290 kcal/100g =200 g/day Number of 50g cups of feed given per day = 200g/ 50g = 4 cups /day Number of 50g cups of feed to be given per meal = 4 cups/ 2 meal = 2 cups per meal, twice daily

Table 8: Daily Energy Requirement of Bing Bing

Ah Boy
9 kg neutered dog RER = 70 x 9 $^{0.75}$ = 364 kcal/day DER during weight loss = 1.0 x RER = 364 kcal/day Feed amount during weight loss = 364 kcal/day ÷ 290 kcal/100g = 126 g/day Number of 50g cups of feed given per day = 126 g/50g

= 2.5 cups/ day

~ 2+ ½ cup / day

Number of 50g cups of feed to be given per meal = 2 + 1/2 cups/ 2 meal

= 1+1/4 cups per meal, twice daily

DER during maintenance= 1.6 x RER = 582.4 kcal/day

Feed amount during maintenance = 582.4 kcal/day ÷ 290 kcal/100g =200 g/day

Number of 50g cups of feed given per day = 200g/ 50g

= 4 cups /day

Number of 50g cups of feed to be given per meal = 4 cups/ 2 meal

= 2 cups per meal, twice daily

Table 9: Daily Energy Requirement of Ah Boy

	Week 1	**Week 2**	**Week 3**	**Week 4**
Xiao Bai	1.5 cups, BID	1.25 cups, BID	1.25 cups, BID	1.5 cups, BID
Bing Bing	1.25 cups, BID	1.25 cups, BID	1 cup, BID	1.5 cups, BID
Ah Boy	1.25 cups, BID	1 cup, BID	1 cup, BID	1.25 cups, BID

Note: 1 cup = 50g, BID = Twice daily

Table 10: Feeding Regime for The Treatment Trial Group for The First 4 Weeks.

3.7.2 Feeding Plan for the Control Group

The actual metabolizable energy (ME) of the control group commercial diet was 380 kcal per 100g. The amount of the feed to be fed to the dogs was calculated by dividing the DER by the ME. During the weight loss phase, the daily energy requirement (DER) was calculated according to the table below. Once the dogs achieved their ideal body condition score 4/9 or 5/9, owners were advised to adjust the feeding regimen to a maintenance stage, with the DER recalculated as shown by the table below:

Nuan Nuan
7 kg neutered dog RER = 70 x 7 $^{0.75}$ = 301 kcal/day DER during weight loss = 1.0 x RER = 301 kcal/day Feed amount during weight loss = 301 kcal/day ÷ 380 kcal/100g = 79.2 g/day Number of 50g cups of feed given per day = 79.2 g/50g = 1.5 cups/ day ~ 1 + ½ cup / day Number of 50g cups of feed to be given per meal = 1 + 1/2 cups/ 2 meal = 3/4 cups per meal, twice daily DER during maintenance= 1.6 x RER = 481.6 kcal/day Feed amount during maintenance = 481.6 kcal/day ÷ 380 kcal/100g = 127 g/day Number of 50g cups of feed given per day = 127 g/ 50g = 2.54 cups /day ~ 2.5 cups/ day Number of 50g cups of feed to be given per meal = 2.5 cups/ 2 meal = 1 + ¼ cups per meal, twice daily

Table 11: Daily Energy Requirement of Nuan Nuan

Pui Pui
8 kg neutered dog RER = 70 x 8 $^{0.75}$ = 333 kcal/day DER during weight loss = 1.0 x RER = 333 kcal/day Feed amount during weight loss = 333 kcal/day ÷ 380 kcal/100g = 87.6 g/day Number of 50g cups of feed given per day = 87.6 g/50g = 1.75 cups/ day ~ 2 cup / day Number of 50g cups of feed to be given per meal = 2 cups/ 2 meal =1 cups per meal, twice daily DER during maintenance= 1.6 x RER = 532.8 kcal/day

Feed amount during maintenance = 532.8 kcal/day ÷ 380 kcal/100g = 140.2 g/day Number of 50g cups of feed given per day = 140.2 g/ 50g = 2.8 cups /day ~ 3 cups/ day Number of 50g cups of feed to be given per meal = 3 cups/ 2 meal = 1 + ½ cups per meal, twice daily

Table 12: Daily Energy Requirement of Pui Pui

Ah Girl
9 kg neutered dog RER = 70 x $9^{0.75}$ = 364 kcal/day DER during weight loss = 1.0 x RER = 364 kcal/day Feed amount during weight loss = 364 kcal/day ÷ 290 kcal/100g = 126 g/day Number of 50g cups of feed given per day = 126 g/50g = 2.5 cups/ day ~ 2+ ½ cup / day Number of 50g cups of feed to be given per meal = 2 + 1/2 cups/ 2 meal = 1+1/4 cups per meal, twice daily DER during maintenance= 1.6 x RER = 582.4 kcal/day Feed amount during maintenance = 582.4 kcal/day ÷ 290 kcal/100g =200 g/day Number of 50g cups of feed given per day = 200g/ 50g = 4 cups /day Number of 50g cups of feed to be given per meal = 4 cups/ 2 meal = 2 cups per meal, twice daily

Table 13: Daily Energy Requirement of Ah Girl

	Week 1	Week 2	Week 3	Week 4
Nuan Nuan	¾ cup, BID	1 cup, BID	¾ cup, BID	¾ cup, BID
Pui Pui	1 cup, BID	1.25 cups, BID	1 cup, BID	1.25 cups, BID
Ah Girl	1.25 cups, BID	1.5 cups, BID	1.25 cup, BID	1.5 cups, BID

Note: 1 cup = 50g, BID = Twice daily

Table 14: Feeding Regime for The Treatment Trial Group for The First 4 Weeks.

3.7.3 Feeding Methods

The owners were instructed to weigh the amount of feed before and after their pets ate. They were provided with a table to record the daily feed consumption, measured in cups, and a 50g measuring cup to assist in accurately determining the feed amount. At the beginning of the trial, the owners completed a questionnaire to assess their pets' quality of life, scoring aspects such as happiness, energy, appetite, behaviour, and stool consistency. Weekly follow-up assessments were conducted throughout the trial, during which body weight, body condition score, photos of the pets, feed consumption, and quality of life were recorded. The feeding practices were adjusted as necessary, ensuring that no pet experienced more than a 2% weight drop per week. If any pet was diagnosed with health issues during the trial, it was removed from the study and provided with appropriate treatment. On Day 28, both groups of dogs underwent complete blood count (CBC) and blood screening.

3.7.4 Owner Compliance for the Trial Group

Owners were required to ensure that the low-calorie, high-fibre diet was fed exclusively to the targeted pet, especially in multi-pet households. They were also instructed to provide only the recommended amount of the diet, without exceeding it, and to avoid feeding any other foods such as snacks, table scraps, or other pet food. Any health conditions or abnormalities observed in the targeted pet during the trial had to be reported to the veterinarian.

3.7.5 Owner Compliance for the Control Group

For the control group, owners were instructed to maintain the pet's original diet throughout the study. Any health conditions or abnormalities during the trial had to be reported to the veterinarian.

3.8 DATA COLLECTION TOOLS

A Google Form was sent to the dog owner to gather the data weekly. The Google Form was specifically designed to explore key aspects of latest body weight changes, body condition score, faecal score, behaviour changes, palatability score and satiety. The Google Form was distributed online via email to the owner, making it accessible and convenient for participants to complete anytime and anywhere. By gathering responses from the participating pet owners, this tool provided valuable data for feed trial performance evaluation at the end of the trial.

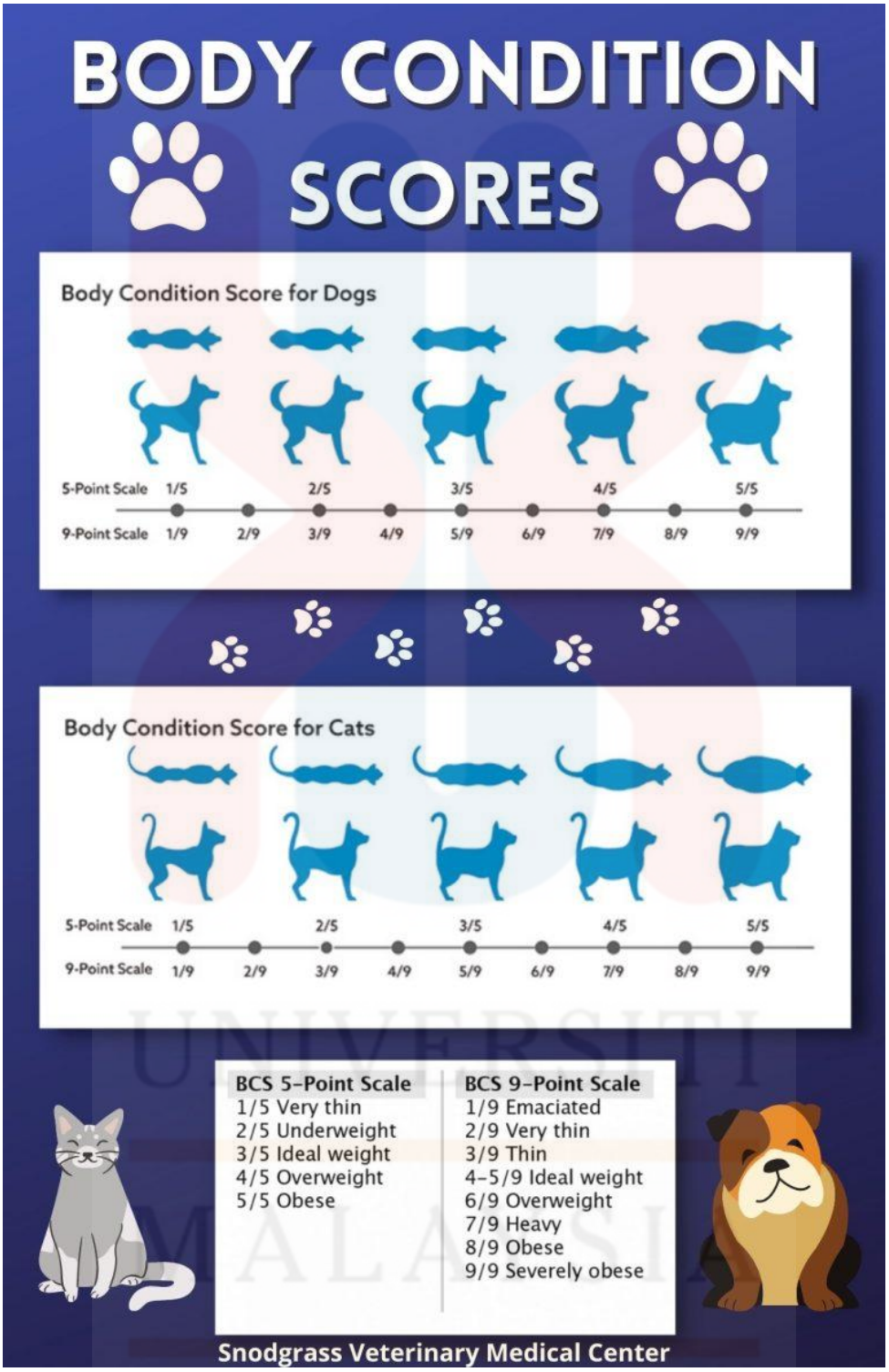

Figure 1: Snodgrass Veterinary Medical Center Body Condition Score Chart

PURINA FECAL SCORING CHART

Fecal consistency is primarily a function of moisture in stool and can be used to identify changes in colon health and other problems. In a healthy dog or cat, stools ideally should be firm but not hard, pliable, segmented and easy to pick up (Score 2).

Score	Specimen	Characteristics
1		■ Very hard and dry ■ Often expelled as individual pellets ■ Requires much effort to expel from the body ■ Leaves no surface residue when picked up
2		■ Firm, but not hard; pliable ■ Segmented appearance ■ Leaves little or no surface residue when picked up
3		■ Log shaped; moist surface ■ Little or no visible segmentation ■ Leaves surface residue, but holds form when picked up
4		■ Very moist and soggy ■ Log shaped ■ Leaves surface residue and loses form when picked up
5		■ Very moist, but has a distinct shape ■ Present in piles rather than logs ■ Leaves surface residue and loses form when picked up
6		■ Has texture, but no defined shape ■ Present as piles or spots ■ Leaves surface residue when picked up
7		■ Watery ■ No texture ■ Present in flat puddles

Figure 2: Purina Fecal Score Chart

	Week 1	Week 2	Week 3	Week 4
Body Weight (kg)				
Weight Loss (kg)				
Weight loss Percentage (%)				

Table 15: Weekly Body Weight Assessment

3.9 DATA ANALYSIS

	Criteria				Points
	1	2	3	4	
Body Weight	Body weight increased than before trial	Body weight remained the same	Body weight decrease less than 1kg	Body weight decrease more than 1 kg	
Body Condition Score	Body condition score remain BCS 6/9	Body condition score improve to BCS 5/9	Body condition score improve to BCS 4/9	Body condition score improve to BCS 3/9	
Satiety	The animal keeps asking for food, very fast in eating the food offered. (Hungry)	The animal keeps asking for food, fast in eating the food offered. (Unsatiated)	The animal seldom asks for food, at moderate speed to the food offered in the food bowl. (Moderately satiated)	The animals do not ask for food and even have leftovers, seldom eating once food is offered. (Highly satiated)	

Quality of life	The animal is not active, depressed and avoid socializing with humans and other companion animals (very poor)	The animal is not active, stressed, and has a reduced level of socializing with humans and other companion animals. (poor)	The animal is active, happy and good at socializing with humans and other companion animals. (good)	The animal is hyperactive, very excited and very playful with humans and other companion animals. (very good)	
Amount of feed consumed (cup)/ Palatability	The animal does not finish the trial feed given that day more than half cup (>50%) and asking for other food. (very poor)	The animal does not finish the trial feed given that day less than quarter cup (<25%) and asking for other food. (Poor)	The animal did not finish the trial feed given that day (<25%) the trial feed given that day and did not ask for other food. (Good)	The animal finished the trial feed given that day and did not ask for other food. (Very Good)	

Table 16: Assessment Rubric

The raw data collected through Google Forms were first transferred to Microsoft Excel. The awareness categorization was adapted from a previous study, and the respondents were categorized and scored based on the assessment rubrics. The data obtained from the dogs participating the feed trial for 1-month durations will be analysed and compared with the pre-trial body weight, body condition score, amount of feed consumed to determine the effectiveness of low-calorie high fibre diet in reducing the body weight in a safe rate of 0.5% to 1% of body

weight per week and improve the body condition score. The numerical data were analysed using SPSS software, where a paired t-test was performed to compare body weight before and after the trial. The p-value was calculated to assess the statistical significance of the results. Graphs were plotted to visually represent the findings.

CHAPTER 4

4.0 RESULTS

4.1 PHYSICAL EXAMINATION

Upon physical examination, all dogs in the trial and control groups appeared normal, showing no signs of systemic diseases. The dogs were neither pregnant nor lactating, and there were no indications that they would be during the trials. Additionally, none of the dogs had a history of adverse reactions to food. None of the participating dogs required other therapeutic diets or exceptional care, nor were any scheduled for surgery during the trial period. Furthermore, the dogs had not been involved in any other clinical studies during that time.

4.2 BODY WEIGHT

	Week 1	**Week 2**	**Week 3**	**Week 4**	**SEM**	**P-value**
Mean Body Weight (kg)	9.3	8.4	9.5	9.2	0.333	0.648
Mean Weight Loss (kg)	0.6	0.27	-1.1	0.33	0.316	0.077
Mean Weight Loss Percentage (%)	6.67	2.92	-13.09	3.39	3.335	0.210

Table 17: Weekly Body Weight Assessment for Treatment Trial Group

	Week 1	Week 2	Week 3	Week 4	SEM	P-value
Mean Body Weight (kg)	9	7.92	9.3	8.63	0.577	0.134
Mean Weight Loss (kg)	-1	1.08	1.42	0.7	0.316	0.077
Mean Weight Loss Percentage (%)	12.36	11.86	-17.88	7.39	3.335	0.210

Table 18: Weekly Body Weight Assessment for Control Group

	Control	Treatment	SEM	P value
Average initial body weight (kg)	**8.00**	**8.67**	**0.58(Control), 0.33 (Trial)**	**0.134**
Average final body weight (kg)	**8.63**	**9.17**	**0.35 (Control), 0.30 (Trial)**	**0.313**
Average body weight loss (kg)	**-0.63**	**-0.5**	**0.24 (Control), 0.23 (Trial)**	**0.075**
Average BCS initial	**6.67**	**8.00**	**0.33 (Control), 0.58 (Trial)**	**0.134**
Average BCS final	**5.67**	**7.33**	**0.33 (Control), 0.67 (Trial)**	**0.025**

Table 19: Overall Performance Result

The P-value of 0.075 suggested that the difference in body weight loss between the Control and Treatment groups was not statistically significant ($p > 0.05$). The SEM values indicated the variability of the mean body weight loss within each group.

The final BCS showed a significant difference between the control and treatment groups, with a P-value of 0.025, which was below the 0.05 threshold for significance. This indicated that the treatment had a statistically significant effect on the body condition score, suggesting that the treatment improved the overall condition of the animals compared to the control group.

4.5 BODY CONDITION SCORE

Column 1	Day 0	Week 1	Week 2	Week 3	Week 4
Trial Group	8	8	8	8	7.67
Control Group	6.67	6.67	5.67	5.67	5.67

Table 20: Mean Body Condition Score For 4 Weeks

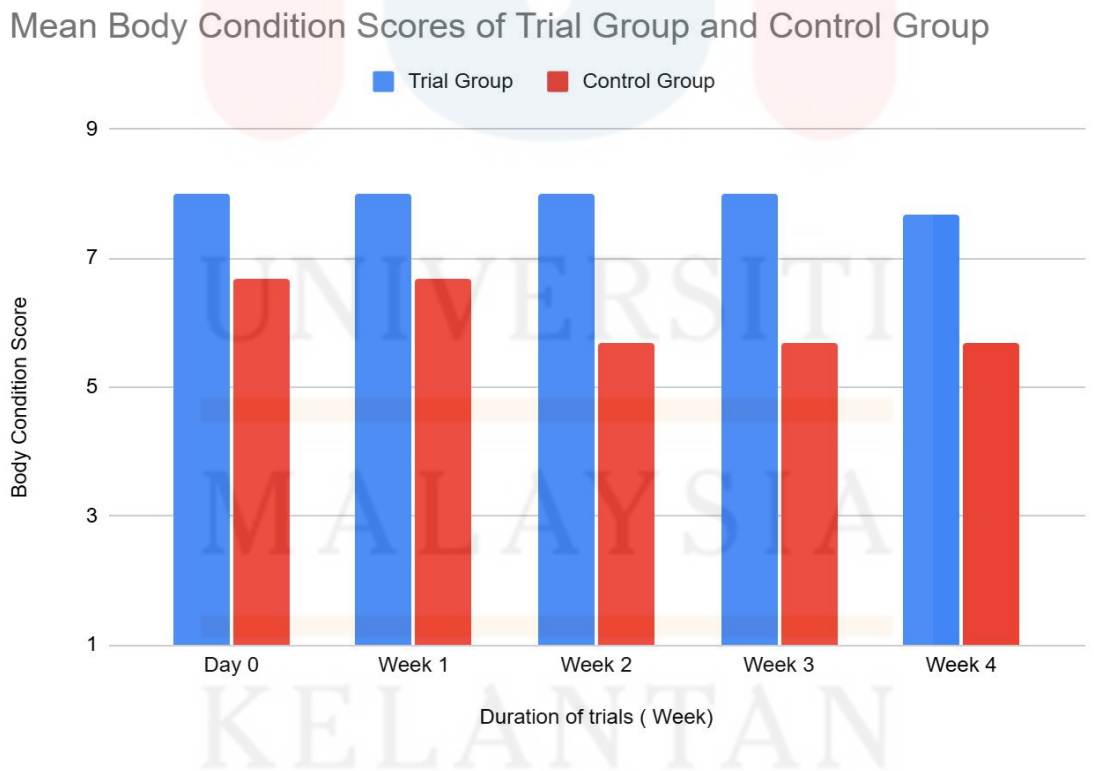

Figure 3: Bar Chart of Mean Body Condition Score (BCS) Comparison Between Trial Group and Control Group

4. 6 Satiety

Mean Satiety Score	Week 1	Week 2	Week 3	Week 4
Trial Group	3	3	2.33	2.9
Control Group	3.52	2.62	1.52	3.6

Table 21: Mean Satiety Score of Trial Group For 4 Weeks

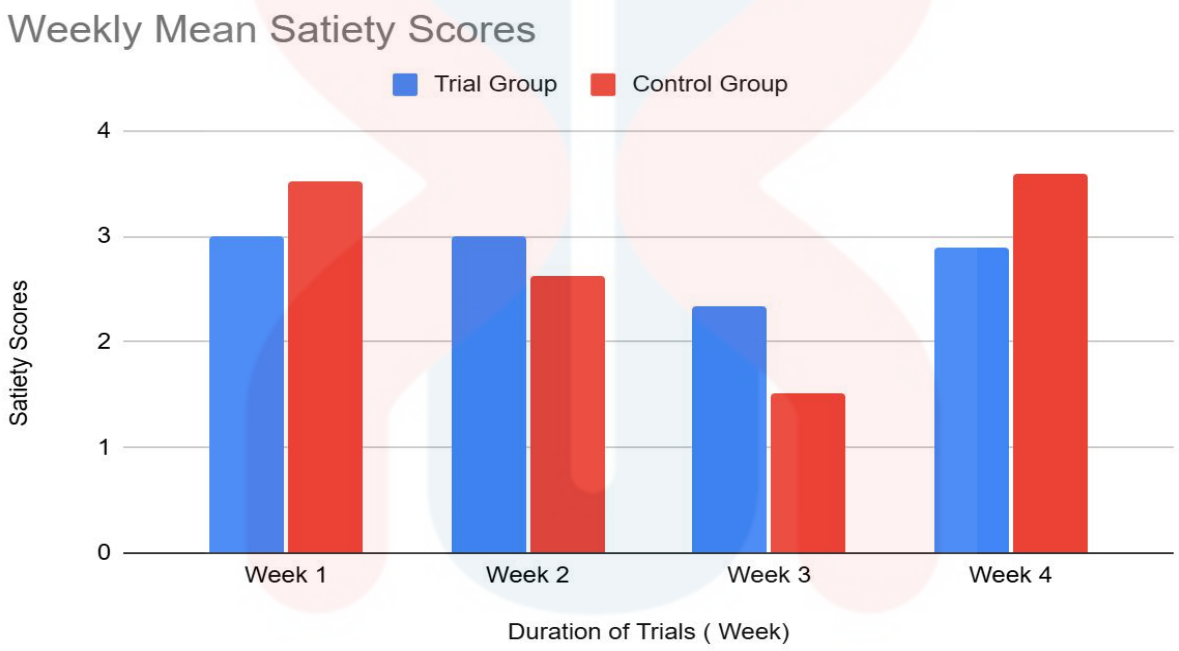

Figure 4: Bar Chart of Mean Satiety Score Comparison Between Trial Group and Control Group

Satiety scores suggested moderate effectiveness in managing hunger during the trial. The trial group satiety scores remained stable, with a slight decrease from 3.0 to 2.9 by the end of the trial. Control group showed greater variability in satiety scores was observed, with a decline noted in the initial weeks, followed by an increase in week 4. These results indicate that while hunger control was partially achieved, further optimization of the diet formulation may enhance its effectiveness in maintaining satiety.

4.7 Quality of life

Mean Quality of Life Scores of Trial Group and Control Group	Week 1	Week 2	Week 3	Week 4
Trial Group	2.95	3.29	3.95	3.95
Control Group	3.57	3.43	4	4

Table 22: Mean Quality of Life Scores of Trial Group and Control Group

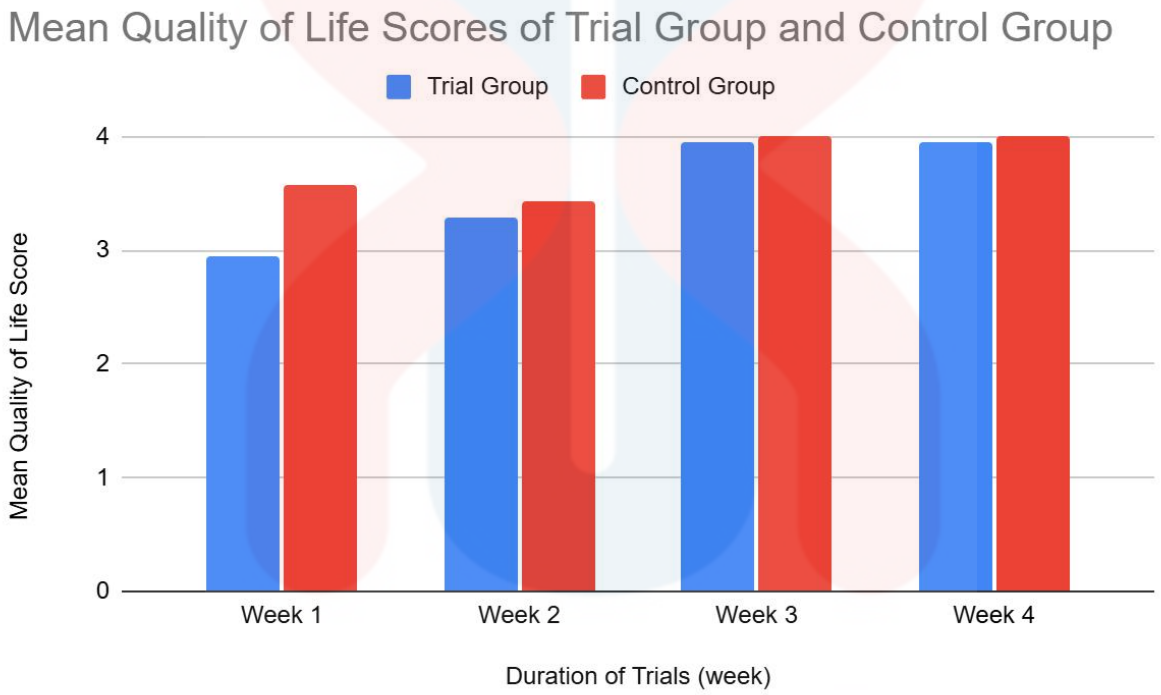

Figure 5: Bar Chart of Mean Quality of Life Scores of Trial Group and Control Group

Quality-of-life scores were shown to improve steadily in the trial group. A gradual increase from 2.95 in week 1 to 3.95 in week 4 was recorded, mirroring trends observed in the control group. These findings indicate that the diet may contribute positively to well-being, although differences between the groups were minimal.

4.8 PALATABILITY

Mean Palatability Score	Week 1	Week 2	Week 3	Week 4
Trial group	3	3	4	3
Control group	3	3	4	3

Table 23: Mean Palatability Score of Trial Group and Control Group

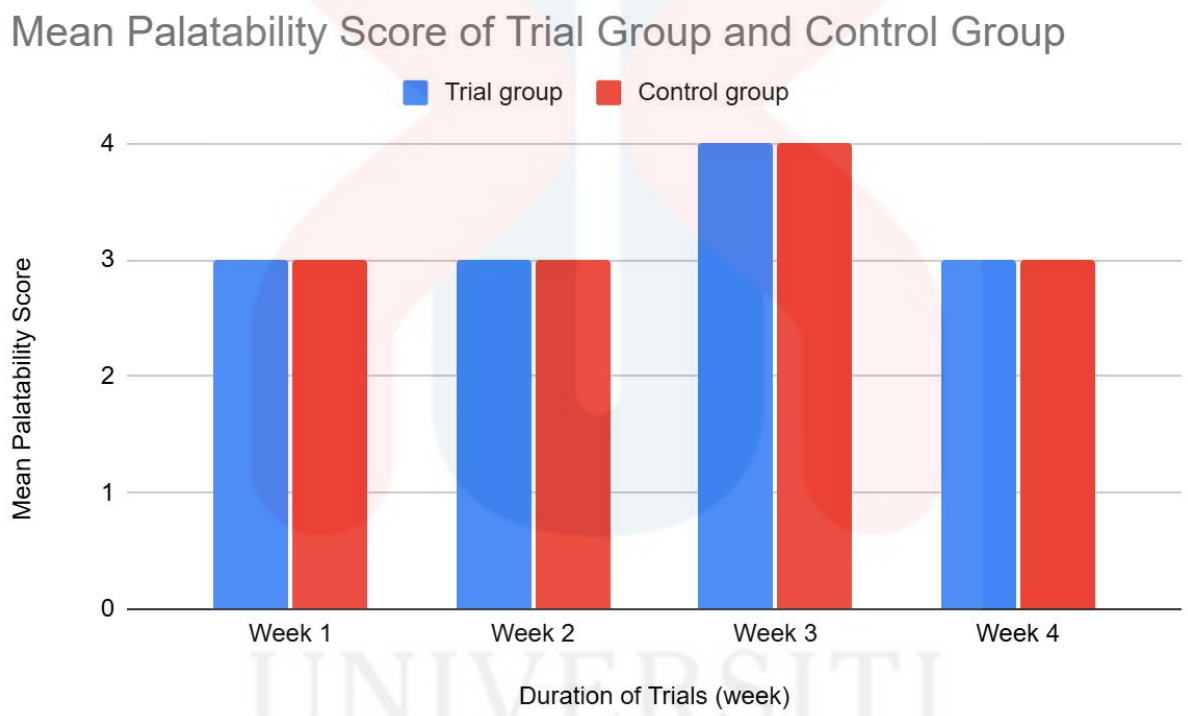

Figure 6: Bar Chart of Mean Palatability Score of Trial Group and Control Group

The diet was accepted by the dogs, as indicated by minimal feed leftover percentages and consistent palatability scores. Both groups rated the diet as "palatable" or "highly palatable," and minimal differences were observed between groups in feed acceptance. These findings suggest that the diet's formulation was well-suited to canine preferences, supporting its potential for long-term use.

CHAPTER 5

5.0 DISCUSSION

Obesity in dogs is a significant health issue globally, particularly in small breed dogs, which are more susceptible to developing obesity due to their size and metabolic rate. As obesity is associated with a range of metabolic and chronic diseases, including diabetes, osteoarthritis, and cardiovascular issues, weight management is essential to promoting long-term health. This study aimed to evaluate the effectiveness of a low-calorie, high-fibre diet in promoting weight loss, improving body condition score (BCS), and enhancing the overall health of small breed dogs.

5.1 EFFECTIVENESS OF THE LOW-CALORIE, HIGH FIBRE DIET

The study results indicate that the low-calorie, high-fibre diet tested in this study effectively facilitated weight loss in small breed dogs prone to obesity. The test group showed a rapid and consistent weight loss, with a weekly reduction of 1.2% body weight, exceeding the target weight loss rate of 0.5–1.0% body weight per week (Flanagan *et al*., 2017). This outcome aligns with the findings of previous research (Flanagan *et al*., 2017), which reported that a similar diet formulation helped reduce body fat while maintaining lean muscle mass. The test group, which received a tailored low-calorie, high-fibre diet that included high-quality protein sources, L-carnitine, psyllium husk, and antioxidants such as marigold extract and ginkgo biloba, demonstrated significant weight loss and enhanced satiety.

These ingredients are known to support metabolic health, promote fat metabolism, and reduce inflammation, thus aiding in weight reduction (Pan *et al*., 2023; Flanagan *et al*., 2017). The L-carnitine included in the test diet is particularly significant, as it facilitates the oxidation of fatty acids and helps preserve lean muscle mass during caloric restrictions (Williams & Williams, 2024). In the present study, the test group showed improved satiety, suggesting that L-carnitine contributed to enhanced fat metabolism and weight loss, which is consistent with research (Pan *et al*., 2023; Flanagan *et al*., 2017).

5.2 ROLE OF FIBRE IN WEIGHT LOSS AND SATIETY

A key component of the test diet was its high fibre content, which was designed to increase the dogs' feeling of fullness and reduce overall caloric intake. Psyllium husk and beet pulp were used to achieve this goal. The increased fibre content promoted slower gastric emptying and prolonged satiety, helping to control appetite and prevent overeating (Flanagan *et al*., 2017). This mechanism was evident in the test group, where food leftovers were significantly reduced by week 3, suggesting that the dogs had adapted to the new diet and were consuming the prescribed portions without resistance.

The fibre-rich diet resulted in a 1.2% weekly weight loss in the test group, which exceeded the typical target of 0.5–1.0%. This result is supported by the research (Flanagan *et al*. 2017) and (Teixeira *et al*. 2024), who observed similar effects in dogs on fibre-enriched diets. These findings suggest that fibre not only enhances satiety but also contributes to sustainable weight loss by reducing the dog's caloric intake without sacrificing nutritional quality.

5.3 COMPARATIVE RESULTS WITH CONTROL DIET

In contrast, the control group, which was fed a standard commercial maintenance diet, experienced weight fluctuations, including an unexpected weight gain in week 3. The higher fat content and the glycaemic index of the carbohydrates in the control diet (e.g., corn and rice) likely contributed to these fluctuations (Teixeira *et a*l., 2024). High-glycaemic carbohydrates can cause insulin spikes, which may impede fat metabolism and encourage fat storage (Pan *et al*., 2023). This observation underscores the benefits of a low-calorie, high-fibre diet, as seen in the trial group, where weight loss remained steady without fluctuations.

The comparison between the test and control diets further highlights the importance of a tailored approach for managing weight in overweight and obese dogs. The test diet not only supported weight reduction but also preserved lean muscle mass, which is vital for long-term weight management (Flanagan *et al*., 2017). This aligns with the findings of Teixeira *et al.* (2024), who noted that high-fibre diets help reduce fat while preserving lean mass. However, some studies have suggested that the long-term efficacy of such diets might depend on the animal's individual

metabolic response (Williams & Williams, 2024). The consistency of results in this study supports the effectiveness of a high-fibre, low-calorie diet in managing obesity in small-breed dogs, but further investigation into the long-term sustainability of these changes is necessary.

5.4 OWNER COMPLIANCE AND BEHAVIORAL ADAPTATION

Owner compliance is crucial for the success of dietary interventions in canine weight management. In this study, the test group exhibited a complete reduction in food leftovers by week 3, indicating successful adaptation to the feeding regimen. This finding aligns with previous research emphasizing that owner adherence to prescribed feeding protocols significantly influences the success of weight loss programs (Flanagan *et al*., 2017). The initial challenges with leftover food in week 2 were resolved as the dogs became accustomed to the new diet, highlighting the importance of gradual adaptation when introducing dietary changes (Tobie *et al*., 2015).

Additionally, understanding food preferences plays a significant role in achieving successful weight loss, as dogs are more likely to accept and continue eating a diet that meets their palatability preferences (Tobie *et al*., 2015). In this study, the high-quality ingredients and palatable formulation of the test diet contributed to higher compliance rates, leading to better outcomes for the test group.

However, it's important to note that while palatability can enhance compliance, it doesn't guarantee weight loss success. A study found that even highly palatable diets may not lead to weight loss if not properly portioned or if owners don't adhere to feeding guidelines. Therefore, combining palatability with clear feeding instructions and regular monitoring is essential for effective weight management (Williams & Williams, 2024).

5.5 SAFETY AND HEALTH MONITORING

Health monitoring throughout the study confirmed that the test diet did not cause any adverse health effects. There were no significant deviations in liver function, renal health, or blood glucose levels, indicating that the low-calorie, high-fibre diet was well-tolerated and safe for the

dogs. This supports the findings of previous studies that have demonstrated the safety of carefully formulated weight loss diets in dogs (Flanagan *et al*., 2017; Pan *et al*., 2023). No signs of hepatic lipidosis or muscle wasting were observed in the test group, suggesting that the rate of weight loss, although rapid, did not result in harmful side effects. These results highlight the importance of maintaining balanced nutrient levels and gradual weight loss to avoid potential health risks, such as liver dysfunction (Teixeira *et al*., 2024).

5.6 LONG TERM CONSIDERATIONS AND FUTURE RESEARCH

While the short-term results of the low-calorie, high-fibre diet were promising, the long-term sustainability of such a diet remains a critical consideration. The test group's rapid weight loss suggests that the diet may not be sustainable for extended periods without careful monitoring, particularly to ensure that dogs do not experience nutrient deficiencies or muscle loss over time. Future studies should explore the long-term effects of these diets, including their impact on lean muscle mass preservation and metabolic health over extended periods.

Furthermore, future research should focus on developing personalized weight management plans for different dog breeds and sizes. Given the variation in energy requirements and metabolism across breeds, tailoring weight loss diets to meet the specific needs of individual dogs could improve the effectiveness and safety of these interventions (Teixeira *et al*., 2024).

This study provides strong evidence that a low-calorie, high-fibre diet can be an effective and safe approach to weight loss and metabolic health improvement in overweight dogs. The inclusion of bioactive compounds such as L-carnitine, marigold extract, and ginkgo biloba enhances fat metabolism, reduces inflammation, and improves satiety. The test group's rapid weight loss, coupled with improvements in BCS and overall health, supports the diet's potential as a viable intervention for managing canine obesity. However, the fast rate of weight loss observed requires further investigation to determine its long-term sustainability and safety. Personalized dietary plans and continued owner education will be key to optimizing the management of obesity in dogs and ensuring successful long-term weight maintenance.

CHAPTER 6

6.0 CONCLUSION AND RECOMMENDATION

This study compared two different diets for weight management in overweight dogs. The trial group received a low-calorie, high-fibre diet with high-quality protein, functional additives, and low-glycaemic carbohydrates to aid in weight loss, increase fullness, and support metabolic health. Additional bioactive ingredients like L-carnitine, marigold extract, and ginkgo biloba were included to boost fat metabolism, reduce inflammation, and further improve satiety. The control group was fed a standard maintenance kibble with higher fat, moderate fibre, and higher glycaemic carbohydrates, intended for general health.

The results showed that the low-calorie, high-fibre diet led to consistent and rapid weight loss, with improvements in body condition and overall health. This supports the diet as a safe and effective option for managing canine obesity. Functional ingredients in the diet contributed to better metabolic health and fat reduction while preserving lean muscle mass. However, the fast weight loss observed raises concerns about the long-term sustainability and safety of such a regimen, requiring further study to ensure it doesn't have negative long-term effects.

Key differences between the diets reveal their distinct purposes. The trial diet focused on reduced caloric density while incorporating bioactive compounds like L-carnitine and psyllium husk to aid fat reduction and satiety without compromising lean muscle mass. In contrast, the control diet, with its moderate-quality protein sources and higher caloric density, was less effective for weight loss.

The findings underscore the importance of ingredient quality, nutrient composition, and functional additives in effective weight management strategies. Overall, the trial diet's design is more closely aligned with weight loss objectives, highlighting the critical roles of owner compliance, safety, and nutritional adequacy in achieving successful weight management outcomes in dogs and paving the way for future research and clinical practices.

Looking ahead, future research on weight-loss dog food studies can benefit from a few important steps. First, it would be helpful to include a larger and more diverse group of dogs, considering different breeds, ages, and health conditions to see how various dogs respond to weight-loss diets. Additionally, conducting long-term studies will help us understand how to maintain weight loss over time and if dietary changes are effective in the long run. Future studies should also look into how changes in a dog's behaviour can affect their weight loss when paired with diet changes. Investigating specific ingredients in weight-loss foods could help us find the best nutrition for each dog. Using clear data analysis methods and gathering feedback from dog owners about their pets' behaviour and health will also be valuable.

Keeping in mind the well-being of the dogs during the trials will ensure that all animals are treated ethically. By taking these steps, future research can not only add to our knowledge about dog nutrition but also provide useful advice for dog owners and breeders who want to effectively manage obesity in their pet**s.**

7.0 REFERENCES

1. Flanagan, J., Bissot, T., Hours, M. A., Moreno, B., Feugier, A., & German, A. J. (2017). Success of a weight loss plan for overweight dogs: The results of an international weight loss study. *PLOS ONE, 12*(9), e0184199. https://doi.org/10.1371/journal.pone.0184199
2. Pan, Y., Spears, J. K., Xu, H., & Bhatnagar, S. (2023). Effects of a therapeutic weight loss diet on weight loss and metabolic health in overweight and obese dogs. *Journal of Animal Science, 101*, skad183. https://doi.org/10.1093/jas/skad183
3. Tobie, C., Péron, F., & Larose, C. (2015). Assessing food preferences in dogs and cats: A review of the current methods. *Animals, 5*(1), 126-137. https://doi.org/10.3390/ani5010126
4. Williams, S., & Williams, S. (2024, April 22). L-Carnitine for dogs: Benefits, dosage, side effects, and more. *Puppadogs.com*. https://puppadogs.com/l-carnitine-for-dogs-benefits-dosage-side-effect/
5. Wag. (2024, May 15). Obesity in dogs. Symptoms, causes, diagnosis, treatment, recovery, management, cost. *Wag Walking*. https://wagwalking.com/condition/obesity
6. Cornell University College of Veterinary Medicine. (n.d.). Obesity and weight loss in dogs. *Cornell University College of Veterinary Medicine*. https://www.vet.cornell.edu/departments-centers-and-institutes/riney-canine-health-center/canine-health-information/obesity-and-weight-loss-dogs
7. Cvpm, S. W. R. (2022, February 9). Feeding strategies for overweight and obese patients. *Today's Veterinary Practice*. https://todaysveterinarypractice.com/nutrition/feeding-strategies-for-overweight-and-obese-patients/
8. Williams, J. (2024, December 2). Ginkgo biloba and weight loss: Exploring the connection. *LeafyBark*. https://leafybark.com/is-ginkgo-biloba-good-for-weight-loss/
9. Teixeira, F. A., Pedrinelli, V., Porsani, M. Y. H., Bonder, B. S. A., Fasolai, A. B., & Brunetto, M. A. (2024). Retrospective investigation of the energy requirements for weight loss and weight maintenance after weight loss programme in obese dogs. *Journal of Animal Physiology and Animal Nutrition, 108*(S1), 36–41. https://doi.org/10.1111/jpn.13965
10. N, M. (2023, September 11). The physiology of weight loss in dogs: How low-calorie diets work. *Boneitup*. https://www.en.boneitup.com/blogs/news/the-physiology-of-weight-loss-in-dogs-how-low-calorie-diets-work?shpxid=93882bc4-c365-42eb-8c6d-382c2fef9d32

8.0 APPENDICES

Trial Group Candidates

Candidate 1: Xiao Bai

Figure 7: Profile Picture of Xiao Bai

	Pass	Failed
Physical examination (normal)	Pass	
Deworming status	Up To Date	
Vaccination status	Up To Date	
History of food allergy	No	
Lactating/ pregnant/ expected	No	

to be		
CBC (normal)	Pass	
Serum biochemistry (normal) Urinalysis (normal)	Pass	
Body weight	10kgPass	
BCS >6/9	9/9 Pass	
Age at least 1 years old	10 years old Pass	
Indoor	Pass	
Isolated feeding area	Pass	

Table 24: Recruitment Checklist of Xiao Bai

Candidate 2: Bing Bing

Figure 8: Profile Picture of Bing Bing

	Pass	Failed
Physical examination (normal)	Pass	
Deworming status	Up To Date	
Vaccination status	Up To Date	
History of food allergy	No	
Lactating/ pregnant/ expected to be	No	
CBC (normal)	Pass	
Serum biochemistry (normal) Urinalysis (normal)	Pass	
Body weight	9 kgPass	

BCS >6/9	8/9 Pass	
Age at least 1 years old	6 years old Pass	
Indoor	Pass	
Isolated feeding area	Pass	

Table 25: Recruitment Checklist of Bing Bing

Candidate 3: Ah Boy

Figure 9: Profile Picture of Ah Boy

	Pass	Failed
Physical examination (normal)	Pass	
Deworming status	Up To Date	
Vaccination status	Up To Date	
History of food allergy	No	

Lactating/ pregnant/ expected to be	No	
CBC (normal)	Pass	
Serum biochemistry (normal) Urinalysis (normal)	Pass	
Body weight	9 kgPass	
BCS >6/9	8/9 Pass	
Age at least 1 years old	4 years old Pass	
Indoor	Pass	
Isolated feeding area	Pass	

Table 26: Recruitment Checklist oh Ah Boy

Control Group Candidate

Candidate 1: Nuan Nuan

Figure 10: Profile Picture of Nuan Nuan

	Pass	Failed
Physical examination (normal)	Pass	
Deworming status	Up To Date	
Vaccination status	Up To Date	
History of food allergy	No Pass	
Lactating/ pregnant/ expected to be	No Pass	
CBC (normal)	Pass	

Serum biochemistry (normal) Urinalysis (normal)	Pass	
Body weight	7 kgPass	
BCS >6/9	6/9 Pass	
Age at least 1 years old	4 years old Pass	
Indoor	Pass	
Isolated feeding area	Pass	

Table 27: Recruitment Checklist of Nuan Nuan

Candidate 2 : Pui Pui

Figure 11: Profile Picture of Pui Pui

	Pass	Failed
Physical examination (normal)	Pass	

Deworming status	Up To Date	
Vaccination status	Up To Date	
History of food allergy	No Pass	
Lactating/ pregnant/ expected to be	No Pass	
CBC (normal)	Pass	
Serum biochemistry (normal) Urinalysis (normal)	Pass	
Body weight	8 kgPass	
BCS >6/9	7/9 Pass	
Age at least 1 years old	4 years old Pass	
Indoor	Pass	
Isolated feeding area	Pass	

Table 28: Recruitment Checklist of Pui Pui

Candidate 3: Ah Girl

Figure 12: Profile Picture of Ah Girl

	Pass	Failed
Physical examination (normal)	Pass	
Deworming status	Up To Date	
Vaccination status	Up To Date	
History of food allergy	No Pass	
Lactating/ pregnant/ expected to be	No Pass	
CBC (normal)	Pass	
Serum biochemistry (normal) Urinalysis (normal)	Pass	
Body weight	9 kgPass	

BCS >6/9	7/9 Pass	
Age at least 1 years old	4 years old Pass	
Indoor	Pass	
Isolated feeding area	Pass	

Table 29: Recruitment Checklist of Ah Girl