




Valorisation of Food Waste into Sustainable Halal-Certified Pet Food

Nor Surilawana Sulaiman^{1*} 
Universiti Islam Sultan Sharif Ali, Brunei Darussalam

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Abstract

Compared to Southeast Asian neighbours, Brunei lags in sustainable waste management procedures. Landfills receive 36% of the wasted food. Converting food waste into pet food would be a good substitute for treating it as waste, and instead as a valuable resource. This study explores the valorisation of halal-compliant food waste, particularly *Category 3 animal by-products (ABPs)*, into nutritionally viable and Shariah-compliant pet food. This approach could mitigate environmental problems and create a nutritionally balanced pet food option. This initiative aims to address food waste management and pet nutrition sustainability, aligning with global sustainability goals and potentially revolutionising the pet food industry. The study consists of an experimental approach, which in the first stage involved collecting the waste from an identified local supermarket, raw material selection following halal compliance decision trees, and then processing it into pet food. The second stage of the experiment used an exploratory experimental design; the study processed supermarket-derived halal food waste into pet food and subsequently analysed its nutritional composition (protein, fat, sugars) and palatability. Findings confirm that the valorised halal pet food meets essential nutritional requirements and is acceptable to pets. This research contributes practical insights into sustainable halal waste management and advances theoretical discussions on Halal valorisation and circular economy practices. It highlights the potential for halal-certified pet food innovation in Brunei while emphasising the need for further risk assessment and consumer studies. From a policy perspective, the study highlights the need for dedicated regulatory frameworks and halal certification guidelines for food waste valorisation and sustainable pet food production in Brunei.

Keywords: *Brunei, Pet Food, Food Waste, Sustainable, Waste Management*

INTRODUCTION

It has been estimated that about 30% of the earth's food is either wasted or lost, which amounts to a staggering Global CO₂ emittance of roughly 12 billion metric tons, a considerable 6.8% of the net GHG (Ilakovac et al., 2020; Shahrajabian et al., 2019; Jeevahan et al., 2021; FAO, 2011). This statistic alone showcases the astronomical potential that needs to be catered towards waste management. Moreover, millions of tons of halal food go uneaten each year, ready to hit the dumpster (Sulaiman et al., 2014). Such food waste indeed is one of the largest causes of the environmental crisis we are facing, as food waste has the capability to attract pests, emit toxic gases and could also pollute the groundwater (Okareh et al., 2014). There is an utmost need for strict measures to be implemented to eliminate food waste from places like boarding schools, prisons, sports complexes, factories, and much more (Okareh et al., 2014) to conserve a clean and healthy ecosystem.

In turn, the European Union (EU) proposed the Circular Economy Package, intending to reach a 65% recycling rate for municipal waste by the year 2030 (European Commission, 2015). With this in mind, the waste streams can be treated as resources of utmost importance when implementing a circular economy (CE) (Slorach et al., 2019). Adopting the CE model can enable a paradigm shift in which food waste is viewed as a resource rather than discarded. This strategy promotes the

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Corresponding author's email: surilawana.sulaiman@gmail.com

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recycling and reuse of food waste, which lowers the halal food industry's overall environmental impact and helps create a more sustainable food system (Talib & Zulfakar, 2023).

Accordingly, there is an urgent need for the country to formulate effective waste management plans, which is especially crucial given the considerable importance of organic fractions. There is a need for the Brunei Darussalam (herein called Brunei) government to take quick measures to manage this issue, explicitly addressing waste created by the disposal of halal food. The halal sector should develop a detailed waste management plan to minimise food waste. Waste reduction considerations cover design, production, human resources (Long et al., 2013; Kannan et al., 2013), operations, distribution, and inventory components (Manzouri et al., 2014). This study seeks to explain that food waste management has the possibility of being transformed into value-added items such as pet food. This document also aims to explore whether pet food from the valorisation of food waste can be consumed and is beneficial for pets.

Despite the importance of waste management, there is a notable gap in the halal, sustainability, and waste management literature (Sulaiman et al., 2014), especially concerning Brunei. In addition, even with the abundance of Halal food waste in Brunei, the country lacks a structured, halal-compliant food waste valorisation framework, leaving most waste to be landfilled. This study addresses this practice gap by examining the feasibility of converting halal-compliant food waste into pet food, thereby offering a practical sustainability solution aligned with *Halalan Thayyiban*, CE principles, and national environmental targets.

To ensure clarity and direction consistent with applied research, this study aims:

1. To assess the nutritional composition (protein, fat, sugar) of pet food produced from Halal food waste.
2. To evaluate the safety and halal assurance embedded in the valorisation process.
3. To determine the palatability and acceptability of the valorised pet food among pets.
4. To explore the potential of halal-certified pet food innovation derived from food waste.

These objectives will be achieved by answering the research questions:

1. What is the nutritional content of pet food produced from halal food waste?
2. How can halal integrity be assured during the valorisation process?
3. Do pets accept and consume the valorised halal pet food?
4. What opportunities exist for halal-certified pet food production in Brunei?

This study makes distinct theoretical and practical contributions to the emerging field of halal sustainability, food waste valorisation, and pet food production by integrating Shariah principles with contemporary environmental and production frameworks.

Practically, the study provides a sustainable strategy for reducing halal food waste in Brunei, demonstrates a low-cost valorisation pathway with economic potential and supports national sustainability goals, SDGs 11 & 12, and *Wawasan Brunei 2035*. While theoretically, the study advances literature on Halal food waste valorisation, integrates Halal Assurance Systems (HAS) within CE and waste hierarchy frameworks, and contributes empirical evidence to the emerging halal pet food research domain

LITERATURE REVIEW

An Overview of Brunei's Food Waste

Waste management has become a pressing global problem in the 21st century, including in Brunei. The waste management concept spans the entire life cycle, from inception to final abatement. Its significant aspects comprise waste² generation, storage, collection, treatment methods and disposal strategies. Effective waste management aims to protect the environment by minimising ecological harm, protecting people's health, and contributing to sustainable development by reducing waste, reusing, and recycling activities.

Food waste is a serious issue in Brunei (Sulaiman, 2024), China (Chen, 2015) and many other nations. Although Brunei has a comparatively tiny population of only 400,000, it is among the top countries in the region for garbage output per capita. According to Shams et al. (2014), Brunei is the second-largest ASEAN country in solid waste production, with 1.4 kilograms per capita per day. 70% of Brunei's waste is dumped in its landfills, 2% is composted, and 40% is disposed of in other traditional ways (Shams et al., 2014). Thus, Brunei is the country that generates the most waste per person (Jain, 2017). Kon (2022) found that in 2019, food accounted for almost 32% of waste, a significant portion of the nation's already high waste creation rate of 1.15 kg per capita. However, it is estimated that just 11.3% of food waste has been recycled, with the remaining portion going to landfills (Sulaiman, 2023). Food waste will flood landfills if it is not properly handled, and as it decomposes, more greenhouse gases will be released (Sulaiman & Talib, 2024).

Management of Food Waste

Food waste management, particularly industrial food waste, involves a systematic approach to reducing, reusing, and recycling food that would otherwise be discarded. This process is crucial for minimising environmental impact and enhancing sustainability within the food industry. Food waste management refers to the strategies and practices employed to handle food waste generated by businesses, including manufacturers, retailers, and food service providers. It encompasses all stages, from production to disposal.

Food waste management is vital because it can mitigate environmental problems, such as methane emissions from landfills, which substantially contribute to climate change. In addition, it has the potential to result in economic benefits by lowering disposal costs and generating opportunities for resource regeneration.

On the other hand, landfilling is the most common method of waste disposal in the halal sector. Although the nation favours the 3R concepts, it is necessary to have a complete action plan to implement the 3R hierarchy fully. This strategy should prioritise the reduction of waste, reuse of waste, and recycling of trash in that order. Converting food waste into animal feed is one potential option that Brunei might implement to solve the issue of food waste. Eriksson et al. (2015) show that most of the food waste hierarchy, for instance, the European Waste Framework Directive, Food Waste Pyramid, Food Recovery Hierarchy and Moerman Ladder, show "reuse for animal feed" as one of the options for food waste management.

In response to the growing amount of garbage produced worldwide, the hierarchy of waste management places a higher priority on prevention and reuse than it does on disposal. This reflects a shift toward more environmentally friendly techniques. Preventing and reducing waste creation is an essential step before employing disposal solutions (Singh et al., 2024). Even HLPE (2014) stated that hierarchies for managing food waste prioritise these two alternatives (prevention and redistribution) concerning the utilisation of food waste as animal feed, the production of compost or energy, or its disposal in a landfill, which should be the final resort. Additionally, transforming food waste into animal feed is a sustainable practice compared to the environmental and health implications of other methods for processing food waste, such as anaerobic digestion and composting (Salamdeeb et al., 2016). It was discovered that the manufacturing of feed from food waste had the least impact, and as a result, it can provide environmental benefits on a societal level (Castrica, et al., 2018). Therefore, "*No Food Left Behind*" was chosen as the motto to encourage people to use food that would otherwise be thrown away (Sulaiman, 2025).

Furthermore, converting rejected food or food waste into resources for animal feed is not a novel concept. For a few decades, the process of transforming food waste into animal feed and reclaiming its value has been implemented. For instance, rejected bananas are exemplary of utilisation in swine feed (Clavijo & Maner, 1975), the use of coffee processing waste as animal feed

(Bressani et al., 1975), cows eat coffee pulp (Choussy, 1944), utilisation of pyrethrum waste product as a livestock feed (Were, 1975), maize stalks and rice hulls were included in pelleted rations for cattle and sheep (Abou-Raya et al., 1975), and cassava as a substitute for cereals in livestock and poultry rations (Muller et al., 1975).

In addition, there is a growing awareness of the importance of implementing environmentally friendly practices in managing halal food waste. There is an ongoing investigation into various strategies to transform food waste into goods with additional value, including waste reduction and zero-waste efforts. Not only do these practises improve the long-term viability of the halal food industry, but they also align with the global sustainability goals, such as the Sustainable Development Goals (SDGs) of the United Nations, which are related to responsible consumption and production (Talib & Zulfakar, 2023; Sulaiman, 2023; Sulaiman & Talib, 2024).

As a result, using technology that reduces environmental impacts for food waste prevention and remediation is becoming increasingly popular to create more sustainable global food and waste systems (Thyberg & Tonjes, 2017). Policies that are environmentally responsible for the management of food waste are being proposed and put into action, particularly in the United States and Europe (Thyberg & Tonjes, 2017), China (Sun et al., 2021), and Saudi Arabia (Waqas et al., 2018), and the United Kingdom (Slorach et al., 2020). The problem has received much attention because of concerns about the social, environmental, and economic ramifications of improper food disposal. Therefore, repurposing or reprocessing food waste into pet food is one approach that can be utilised to reduce the amount of food waste that is disposed of in landfills.

With this in mind, efficient management of industrial food waste solves environmental concerns and creates economic potential by transforming waste into valuable resources. By implementing comprehensive policies that prioritise prevention and recovery while contributing to a more sustainable food system, businesses can dramatically reduce the ecological footprint they leave behind through their operations.

Value-Added Products

The halal food business encounters significant challenges in managing food waste. Food waste must be reduced to reduce environmental consequences and promote a CE, and sustainable ways of reusing and recycling food scraps must be found. These initiatives depend on the long-term viability of the halal food industry and attaining more significant environmental and economic objectives.

Various food waste by-products from food processing companies, such as fats, bones, liver, intestines, wings, trimmed organs, and skin, can be utilised. Therefore, one way to efficiently manage food waste is to create value-added products from animal, poultry, marine, and vegetable waste. Strategies for efficient waste management must be put into place immediately. Waste management is most efficient when it focuses on reducing trash production at the source.

Matumoto-Pintro and Saraiva (2023) and Gunjal (2019) asserted that achieving sustainability objectives is intimately related to turning food scraps into goods with added value. Less waste, more resource conservation, and the development of new opportunities for economic growth (Tamboli et al., 2023) help support the United Nations' Sustainable Development Goals SDGs, specifically by encouraging responsible and environmentally conscious consumption and production patterns.

Matumoto-Pintro and Saraiva (2023) also emphasised that food waste is a rich source of bioactive elements, such as vitamins, vital amino acids, and antioxidants. Therefore, extracting and purifying these chemicals can create functional food ingredients that improve the food's nutritional content and health benefits.

Kaur et al.'s (2023) research findings indicate that specific food waste types can be converted into biodegradable bioplastics, which can be sustainable substitutes for traditional plastics. Because waste materials are reused, this procedure complies with the principles of the CE.

Liu et al.'s (2023) research indicates that food waste can be transformed into biofuels by producing biogas through anaerobic digestion. This sustainable energy source can reduce reliance on non-renewable fuels and greenhouse gas emissions associated with landfill decomposition.

According to Gunjal (2019), food waste items, like fruit and vegetable scraps, may be turned into animal feed, which lowers waste and gives cattle an affordable supply of nutrients. Another study uses bakery waste, such as stale bread, pastries, and other baked goods, to be repurposed as pet food ingredients due to their high carbohydrate content (Nath et al., 2023). Whereas Hasan and Lateef's (2024) study found that fruit and vegetable waste, such as overripe or damaged produce, can be dried and incorporated into pet food formulations, providing valuable nutrients and fibre. Additionally, scraps, bones, and other leftovers from processing meat and poultry can be rendered and used as protein sources in pet food (Simon et al., 2018).

Going forward, increasing the usefulness of food waste and advancing a more sustainable food system depend on ongoing study and innovation in this area. Technological developments and a focus on sustainability could transform food waste management practises, leading to financial benefits and less environmental impact. As a result, turning food waste into valuable products ensures that materials are reused and repurposed rather than disposed of, which supports the CE. This strategy not only lessens the environmental effects but also improves food security by generating more food sources and lowering the carbon footprint related to trash disposal.

Halal Pet Food

Halal pet food has become increasingly popular worldwide, indicating the rising demand for goods that respect Islamic dietary regulations and moral principles. This category is approved for quality, avoids banned materials like alcohol and pork, and guarantees the ethical treatment of animals. It is a popular choice in the pet food industry since it is consistent with Muslim pet owners' cultural and spiritual values (Ahmed H., 2024). This is in line with the findings of a study conducted by Sulaiman (2025), which reveals that most respondents believe that pet food made from food waste ought to be honest about the contents, halal, quality guaranteed, nutritional, hygienic, and safe. As a result of the rapid rise of "pet humanisation," individualised pet food propositions are becoming increasingly prevalent and will continue to be so.

The distinct vision of Tiana Halal, which was initiated in 2021, was to launch the first-ever halal-suitable cat food of superior quality grade, wherein recipes approved by eminent Muslim scholars are professionally crafted to cater to a cat's needs (Hills, 2023). Tiana Halal Pet Food identified a gap in the market, and the company decided to design goods that would appeal to the approximately 500,000 Muslim cat owners in the United Kingdom (Houghton, 2024). Like human food, pet food and treats are examined more rigorously than ever regarding nutritional value and their functional advantages. Pankaj Hurria, the proprietor of Tiana, emphasised that it is logical for a 'pet humanisation' movement, which already includes every conceivable 'food minority' interest, such as grain-free, vegan, bio-organic, paleo, enhanced gut health, and various dietary-specific options like joint relief, hypoallergenic, dental health, and vitamin supplements, to seek a pioneer in halal-friendly meals ultimately (Middle East Monitor, 2021).

Tiana may be the first branded halal cat food in Britain and possibly the globe (Aitchison, 2021), but it is not the first halal-certified cat food in the world. Within Indonesia, the Philippines, and Vietnam, neighbouring countries, the Malaysian brand Powercat, introduced in 2014 as the only halal-certified cat food, has gained much popularity. The establishment has reportedly

attracted the interest of non-Muslim cat owners who are looking for assurance that the food they provide for their cats is entirely free of any contaminants (Middle East Monitor, 2021).

It intends to address the dearth of natural, high-protein, genetically modified organism (GMO)-free, and preservative-free solutions in the United Kingdom market. Aihsham Rashid is creating a brand-new pet food company that is certified as 100 percent Halal (Storey, 2024; Pet Product Marketing, 2024). Aihsham initiated Hurayra Halal Pet Food, recognising that numerous Muslim pet owners prefer Halal pet food as an extension of their dietary customs and religious convictions, mainly when their cats consume food within their households. He also contended that pet food containing meat could be rendered halal if the animal was treated with compassion prior to a painless slaughter, ensuring complete blood drainage from the carcass and avoiding contamination by haram substances, such as pork, according to Quranic teachings (Slater, 2024).

Apart from cat feed, it has been alleged that Rawvolution Cape Town, the premier provider of halal food, has been producing dog food that is certified and fit for consumption. Rawvolution specialises in providing dogs with human-grade meat devoid of preservatives and additives, fulfilling the HACCP regulations (Rawvolution, 2024). Moreover, consumers are typically interested in sustainability, which affects their views on incorporating food waste into pet food. Many pet owners, especially millennials, emphasise sustainable sourcing and are receptive to pet food solutions that incorporate food waste as a resource. Surveys reveal numerous consumers anticipate companies implementing sustainable practices and are prepared to alter their purchase behaviours accordingly (Phillips-Donaldson, 2020; Ahmed et al., 2021). Nevertheless, apprehensions over safety, quality, and the stigma linked to food waste may impede acceptance, underscoring the necessity for good communication regarding the advantages and safety of these products (Allison et al., 2022; dos Santos, da Silveira, da Costa, & Duarte, 2022).

Furthermore, pet owners are progressively predisposed to acquire pet food derived from food waste when designated as organic or natural. Research suggests that almost 70% of Millennials and a considerable segment of Gen Z are prepared to invest more funds in sustainable and natural pet goods (Kakuk, 2022). Viewing food waste as a sustainable resource might increase attractiveness, mainly when promoted with organic or natural labels that resonate with consumers' aspirations for high-quality and ethically sourced components (Schleicher et al., 2019; Vanderhoydonck, 2023). Thus, consumer education regarding food waste's safety and nutritional worth is essential for its acceptance.

Sustainability Practices

Leveraging food waste for sustainability offers several advantages due to its environmental, economic, and social ramifications (Capanoglu et al., 2022). Food waste is a valuable resource that can be employed in various aspects of food production, providing potential remedies for economic, sociological, and environmental challenges. It provides nutrition, functionality, and nutraceutical attributes for many applications in food composition. As a result, animal feed was developed to reduce the adverse effects of food waste on the environment, the economy, and society. When it comes to the manufacture of animal feed, the major purpose is to use the edible component of food that has been abandoned to produce food for pets. Additionally, animal feed is created from components that are not suitable for sale, such as food items that are considered inferior, impaired, or defective.

Around eight to ten percent of the world's GHG emissions are caused by food waste (Goodwin, 2023). The practice may lead to several environmental concerns, including air pollution, groundwater contamination, carbon footprint creation, and the emission of greenhouse gases, such as methane and hydrogen sulphide. Repurposing food waste to divert it from landfills might substantially diminish methane emissions, thereby addressing climate change. The practice may

lead to several environmental concerns, including air pollution, groundwater contamination, carbon footprint creation, and the emission of greenhouse gases, such as methane and hydrogen sulphide. Hence, repurposing food waste to divert it from landfills might substantially diminish methane emissions, so addressing climate change (Food Waste, n.d.). Consequently, repurposing food waste as animal feed or pet food may alleviate the environmental impacts of food waste.

The diversion of food waste from landfills to pet food production promotes sustainable and environmentally responsible waste management, aligning with SDG 11 - Sustainable Cities and Communities, mainly target 11.6, which aims to mitigate the environmental effects of urban areas. This method aligns with SDG 12 - Responsible Consumption and Production, specifically addressing target 12.3, which aims to minimise global per capita food waste, and target 12.5, which focuses on significantly decreasing waste generation.

In addition, the country's economy might gain from recycling food waste into food for pets. The spoiled goods supermarkets in Brunei produce amounts of up to BND1000 monthly, including imports from other countries (Dariah et al., 2022). If all the food waste in Brunei, not only the food waste in supermarkets, is considered, the loss cost will be greater than BND1000. While, according to Chen (2015), the economic value of wasted food in China was estimated to exceed RMB 200 billion. Reducing the amount of food waste produced by consumers by even 20% to 25% by the year 2030 may save the globe an estimated \$120 to 300 billion dollars annually (Goodwin, 2023). These money savings are realised at both the individual and the systemic level. Increasing the quantity of food that households consume after purchasing it from the supermarket is one way for households to lower their overall expenditures on food. The average household in the United Kingdom could save more than £700 per year by lowering the amount of food that is wasted that could have been avoided, whilst families in the United States could save approximately USD1,800 per year (Goodwin, 2023).

In addition, prices for garbage disposal can be reduced by diverting food waste away from landfills and towards more environmentally friendly solutions. The potential for economic savings is the most immediate advantage that can be gained by decreasing food waste. Businesses can realise significant cost savings by reducing the amount of wasted food through improved inventory management and more effective utilisation of resources. When food is used effectively, there is less waste to handle, which results in decreased expenses associated with getting rid of it (Donnelly, 2024).

The CE seeks to establish a closed-loop system in which products and resources are perpetually reused, remanufactured, and recycled. Scientific research supports this approach by creating breakthrough technologies and procedures that enable the conversion of trash into new products. The CE fosters sustainable resource management by diminishing dependence on virgin materials, ensuring economic expansion does not compromise environmental integrity. Consequently, a CE is bolstered by pet food manufacturing or converting food waste into pet food. Establishing a novel revenue stream for enterprises and nations is achievable by transforming food waste into pet food, facilitating income generation from refuse.

Ultimately, efficient food waste management strategies can mitigate social repercussions. Effective waste management can result in cleaner communities and diminished environmental repercussions from food waste (EPA, 2024). Equitable access to food and the conversion of discarded food into soil amendments can enhance soil health, produce renewable energy, and retain the economic and employment advantages of organic recycling within those areas (EPA, 2024). This strategy corresponds with the attainment of Goal 2 of Brunei Vision 2035 (*Wawasan Brunei 2035*), promoting a good quality of life through an emphasis on an environment that realises the national objectives of sustainability, cleanliness, and greenness.

In summary, utilising food waste for sustainability is a complex strategy that diminishes landfill usage, conserves vital resources, yields economic advantages, and fosters an environmentally sustainable society. This comprehension highlights the pressing need for effective waste management techniques to alleviate these environmental hazards (Somya et al., 2024). Therefore, transforming food waste into value-added products like pet food is essential for promoting a more sustainable future.

Case Studies Valorisation of Food Waste in Pet Food

The global halal food market is approximately USD 1.17 trillion, while the whole halal sector is estimated to be USD 2.02 trillion. The swift expansion of this sector highlights the rising need for halal products, particularly pet food, which can efficiently utilise food waste (Talib & Zulfakar, 2023). This signifies a substantial possibility for enhancement in waste management techniques, especially within the halal industry, where food waste can be converted into halal pet food items (Sulaiman & Talib, 2024).

The pet food market is expanding, driven by the rising number of people who own pets and the increased understanding of pet nutrition among consumers. There is a growing awareness of the importance of sustainability in today's society, and as a result, the sustainability of products is influencing purchase decisions. This includes pet food manufactured from food waste. Sustainability claims are becoming more prevalent in pet food, particularly regarding ingredients, packaging and origin.

Transforming food waste into pet food has been successfully applied in several nations. With the purpose of ensuring that the manufacturing of pet waste has been carried out in other locations, the utilisation of food waste in pet food is carried out. The investigation has uncovered several regional and worldwide practices, which are enumerated in Table 2.

Table 2. Production of Animal Feed / Pet Food from Food Waste

No	Country	Company Name	Details
1	Brunei	Golden Corporation Sdn Bhd	Brunei's first company to generate fish meal and prawn feed from surplus and unmarketable fish, hence reducing the amount of waste and pollution in the marine environment. This company is also the first of its kind in Brunei (Golden Corporation Sdn Bhd, n.d.)
2	United Kingdom	Waitrose & Partners	A trial in which leftover food containing animal by-products is redirected to the pet food industry for six months. The pilot will initially encompass twenty stores, and the goal of the initiative is to reduce food waste by fifty percent by the year 2030 (Jones, 2023).
3	Hong Kong	Furry Green	Creating sustainable pet food from food waste is a viable option. This strategy addresses environmental concerns and consumers' desire for environmentally friendly products, ultimately reducing the pet sector's carbon footprint (Shiba, 2023).
4	Europe	VAFO Planet Pet Society	Ingredients that are considered to be "with a second chance" are utilised by Planet Pet

No	Country	Company Name	Details
			Society. In this context, "food resources" refers to those that have been abandoned from the eating of humans (VAFO, 2023).
5	British	Waitrose	The British supermarket chain is converting surplus food into pet food as part of a trial to reduce waste. They segregate damaged or leftover food, including animal by-products unfit for human consumption, to create dry and wet pet meals. This initiative is part of a broader strategy to halve their food waste by 2030 (Rubio & Menon, 2023).
6	Australia	Food International	Recycle This company has developed a patented process to convert commercial food waste into high-performance animal feed. Their method ensures that discarded food retains its nutritional value while preventing it from ending up in landfills (Food Recycle International, 2024).
7	Philadelphia	Piggyback Company	Treats This company creates sustainable dog treats from rescued food waste, including salmon skins and spent grains from local breweries. Founded by a professional chef, Piggyback Treats aims to reduce food waste while providing unique, healthy treats for pets (Groth, 2019).
8	Connecticut	Bright Feeds	The start-up company has developed a high-tech facility that converts commercial food waste into animal feed. Using sensors and algorithms, Bright Feeds creates a consistent meal product that is cheaper than conventional feed ingredients (Penrod, 2023).
9	United States	Kemin Industries	Partnering with California Safe Soil (CSS), Kemin repurposes unsold food from supermarkets into nutritious pet food products. Their collaboration aims to tackle the significant food waste problem in the U.S. by utilising innovative recovery technology (Tyler, 2021).
10	United States	Shameless Pets	This company incorporates upcycled, dehydrated food ingredients into its sustainable dog treats, focusing on reducing food waste while providing high-quality pet products. It has partnered with Treasure8 to enhance its offerings with upcycled ingredients (Tyler, 2020; Tyler, 2021).

Another study concluded that pet owners worldwide are interested in upcycled ingredients. In Poland, 58% of pet owners believe that leftover pet food has a beneficial impact on the environment, while in France, 68% of pet owners believe the same (Cleaver, 2024a). Meanwhile, Brunei does not yet have a local food manufacturer for pets. While simultaneously addressing environmental concerns, this gives a chance for new enterprises to enter the market by concentrating on ingredients that are produced locally and sustainably. This might potentially fill a need in the market while also addressing environmental concerns.

The halal business emphasises sustainability and resource efficiency, as demonstrated by these case studies, which showcase the possibility of transforming food waste into halal pet food. Countries that implement comparable solutions might solve the difficulties of food waste while simultaneously achieving economic and environmental benefits.

Theoretical Foundations

This study is grounded in four complementary frameworks, namely, CE, Waste Hierarchy, ~~Halal Assurance System (HAS)~~ and *Halalan Thayyiban* Framework. CE emphasises closed-loop systems where resources are continually reused. To achieve the objective of a CE, the intrinsic value of food waste, encompassing nutrients and energy, should be recuperated via the transformation of food waste biomass into products with added value. This process is known as waste valorisation. Presently, food waste is predominantly processed through methods such as composting, landfilling, digestion, or incineration, irrespective of the biomass's composition. Valorising halal food waste into pet food aligns with CE by transforming waste into value-added products. Thus, the move from landfill to alternative approaches reflects the transition from a linear economy to a CE, whereby waste generation is avoided, and where waste is produced, it serves as a resource (Moonsamy, 2024). Mittal (2022), Sulaiman (2024) and Parte (2025) agree that repurposing food waste into pet food will reduce landfill pressure and greenhouse-gas emissions, while aligning with SDG 12 and CE models.

The waste hierarchy prioritises prevention, reuse, and recycling before disposal. Reusing food waste as pet food fits high in the hierarchy as a recovery intervention. Eriksso et al (2015) show that most of the food waste hierarchy, for instance, the European Waste Framework Directive, Food Waste Pyramid, Food Recovery Hierarchy and Moerman Ladder, show “reuse for animal feed” as one of the options for food waste management. In addition, according to Giordano et al (2020) and Mittal (2022), the food waste hierarchy has been established with the top priorities being food waste prevention and redistribution for human consumption, followed by methods of reuse, recovery and recycling.

The halal pet food market comes under the halal regime due to concerns of pet owners (Sulaiman, 2025). Hence, halal requirements are needed to make sure the pet food is halal. There is HAS become critically needed. HAS ensures that all processes from sourcing to processing prevent contamination with non-halal or harmful substances. This study applies HAS, following the decision tree for halal pet production (Sulaiman, 2025) during material selection and processing. This perspective emphasises cleanliness, safety, and wholesomeness, guiding nutritional and safety considerations in valorised pet food. Even, Jais (2021) highlighted that diverse waste forms require careful handling and management since it is a component of *halalan thayyiban* in the HAS as prerequisite in Malaysia's MS1500:2019 and MMPHC (D).

Castrica et al., (2018) and Hasan and Lateef (2024) studies consistently confirm that food waste contains valuable nutrients and can be transformed into high-quality animal feed. Research also shows strong consumer interest in sustainable pet food, though acceptance depends on perceptions of safety and quality (Schleicher et al., 2019; dos Santos et al., 2022). However, despite

global examples of upcycled pet food, no known studies have systematically explored halal-certified valorisation pathways, particularly in Southeast Asia. This reinforces the gap this study addresses.

Based on prior findings and theoretical grounding, the following hypotheses are proposed:

H1: Halal food waste valorisation will produce pet food containing measurable levels of essential nutrients (protein, fats, sugars).

H2: Pet food produced from halal food waste will be acceptable and palatable to pets.

H3: Applying HAS principles ensures the valorisation process remains compliant with *Halalan Thayyiban* standards.

RESEARCH METHOD

The study consists of an exploratory qualitative experimental design consisting of two primary phases. In the first stage, waste was collected from an identified local supermarket and processed into pet food. The second stage involved conducting a food test on pet food.

Material

For the first stage, the main materials used in this study include Category 3 animal by-products (ABPs), which were collected from supermarkets and then kept in sealed containers to avoid contamination prior to processing (Parte, 2025). In the second stage of the experiment, laboratory equipment for food tests, including test tubes, reagents, and other standard lab tools, is also needed.

Method

The research methodology comprises preparing pet food and conducting food tests to analyse the presence of sugar, protein, and fat. Lastly, a short-term pet feeding trial was also conducted in November 2024 to evaluate palatability.

Preparation of Pet Food

The preparation process of pet food begins with collecting the raw materials of ABPs from local supermarkets that have agreed to give them away for free. The waste collected undergoes a selection criterion before being utilised in production, as tabulated in Table 3, to ensure the raw materials are of good quality.

Table 3. Raw Material Selection

Waste	By-products of fish and bycatch	By-products of chicken/meat
Inclusion	<ul style="list-style-type: none"> 1- 2 days fresh 	<ul style="list-style-type: none"> 1- 2 days fresh.
Criteria	<ul style="list-style-type: none"> appropriately stored in a cool condition 	<ul style="list-style-type: none"> Stored in a cool place.
Exclusion	<ul style="list-style-type: none"> Spoiled 	<ul style="list-style-type: none"> Spoiled
Criteria	<ul style="list-style-type: none"> Contaminated Pests 	<ul style="list-style-type: none"> Contaminated Pests

The raw material selection also followed the decision tree suggested by Sulaiman (2025) to ensure that pet food production would be halal. The raw materials must be from halal ingredients, from slaughtered animals, and not contaminated with haram and harmful substances. Then, the meat was sorted, cleaned, and processed into pet food formulations. Strict segregation procedures were implemented to prevent contamination. Besides, halal assurance measures were integrated throughout the process, particularly during raw material selection and contamination prevention.

The meat is ground with a meat grinding machine before mixing with cornstarch. Cornstarch, on the other hand, aids in creating a crispy coating and extending shelf life by reducing moisture content. Moreover, [García et al \(2020\)](#) indicate that cornstarch can also act as a carrier for antioxidant compounds, which suggests that it not only improves texture and shelf life but can also enhance the antioxidant properties of the product by delivering beneficial compounds.

After that, the mould was oven-baked at 240°C for 1 hour. Once baked, the pet food was cut into small cubes. Then, it was cooled down before being packed into the packaging.

Food Tests

Three primary food tests were conducted to evaluate the nutritional content of pet food: the fats test, sugar test, and protein test. Each test was designed to identify the presence and concentration of specific nutrients. The indicators for these tests are shown in Table 4. The pet food was analysed at the Ibnu Sina Laboratory, Universiti Islam Sultan Sharif Ali, Sinaut Campus, on November 5, 2024.

Table 4. Chemical Test for Nutrients and Results Indicator

Test	Indicator of Presence	Indicator of Absence
Ethanol Test (Fats)	Cloudy solution	Clear solution
Benedict's Test (Sugars)	Green (very low), Yellow (low), Orange (high), Red (very high)	Blue
Biuret Test (Proteins)	Violet or purple	Blue

To ensure the validity and reliability of the nutritional analysis, standardised laboratory procedures were employed in assessing protein, fat, and sugar content. All tests were conducted using calibrated equipment and followed established analytical protocols commonly applied in food science research ([Burke, 2021](#)). To enhance measurement validity, repeated testing was performed across the three production batches to ensure consistency of results. Additionally, where feasible, inter-laboratory comparison was considered by aligning testing procedures with recognised benchmarks and reference standards, ensuring that results are comparable to established nutritional datasets. These measures strengthen the reliability of the findings and reduce potential analytical bias, thereby supporting the robustness of the experimental outcomes ([Nielsen, 2017](#)).

Pet Food Trial on Pet

A pet food feeding trial is a crucial step in the product development process, especially for innovative pet food and treat formulations ([Feed Team, 2024](#)). Pet selection was conducted using a convenience sampling method, whereby the developed pet food was distributed to pets owned by friends and family members of the researcher to assess the acceptability and palatability of the pet food. The study did not specifically identify or classify the breeds of the cats involved, as the primary objective of the exploratory trial was to observe general palatability and acceptance behaviour rather than breed-specific responses. [Pongrácz and Dobos \(2024\)](#) stress that convenience breeds choice; studies often opt due to the availability and for a common breed in a particular country. This approach was adopted due to accessibility and the exploratory nature of the study ([Pongrácz & Dobos, 2024](#)) rather than generalisable behavioural outcomes.

While the feeding protocols implement single-bowl tests where pets are given one food option ([Aldrich & Koppel, 2015](#)) for one time. The one-bowl or single-bowl test is to measure the acceptance test, which presents a single sample and measures intake to assess consumption levels ([Kvamme, 2003](#); [Tobie et al., 2015](#)). This test is also used in home environments, as pets can be

either trained or untrained for the one-bowl test. The feeding trials in which small amounts of the feed to pets were conducted across three separate batch productions, with each administered on three different occasions to observe consistency in pet acceptance and consumer behaviour. Observations are noted on palatability and digestion as [Parte \(2025\)](#) did in its research.

As the study did not involve invasive procedures, clinical interventions, or harm to the animals, and was limited to observational feeding of nutritionally assessed food, formal ethical approval was not obtained. This approach is consistent with exploratory animal feeding studies where minimal risk and non-invasive observation are involved ([Mosco et al. 2025](#)).

FINDINGS AND DISCUSSION

Pet Food

These materials are of animal origin that people do not consume. ABPs include all parts of an animal slaughtered for human consumption that are not edible or not placed on the market as food, such as the skin, bones, horn and hooves, blood, fat, and offal. ABPs also include meat that, for some reason, is not suitable for human consumption due to commercial reasons, quality, and production failures ([European Commission, n.d.](#)).

These types of materials are essential raw materials for pets' diets since they could provide a source of energy and palatability. The utilisation of this material prevents the need for final disposition to the landfills. The pet food industry believes that food, such as Category 3 animal fats, which is not intended for human consumption, should be repurposed according to the food waste hierarchy, for instance, reused in food before any other use. The UK is keen to safeguard these Category 3 animal fats to help the industry sustainably feed its 38 million pets with safe and nutritious pet food ([UK Pet Food, 2023](#)). The prototype of the product from the valorisation of food waste into halal pet food is illustrated in Figure 1.



Figure 1. Final Product

While the study demonstrates the feasibility of converting halal food waste into pet food, several unexpected observations and limitations emerged. One key concern relates to the risk of contamination, which is inherent in food waste streams. Despite applying halal assurance and hygiene controls, food waste is naturally exposed to environmental, handling, and storage conditions that may introduce microbial or physical contaminants. Previous studies highlight that food waste valorisation may carry unintended risks, including the presence of undesirable or potentially harmful elements if not properly controlled. Therefore, the handling of the waste is hazardous, and processing is needed to provide safe products ([O'Connor et al., 2021](#)). This

underscores the importance of strict monitoring and standardisation, particularly when scaling up production.

Food Test of Pet Food

The fats test was conducted using ethanol to determine the presence of lipids in pet food. A small pet food sample was crushed and placed in a test tube. 2 ml of ethanol was then added to the test tube, and the mixture was shaken thoroughly to ensure the extraction of any lipids present. After allowing the mixture to settle for 5 minutes, the ethanol solution was observed for any changes. As shown in Figure 2, the solution became cloudy, indicating a positive result, meaning the pet food contains detectable fats.

Fats are an important component of pet food since they provide specific health benefits that are fundamental for maintaining the pet's well-being. Fats have been classified as an energy-dense macronutrient since they offer more than double the caloric value per gram as compared to proteins and carbohydrates, which are vital in fulfilling the energy requirements of pets, particularly the active or working animals ([Global Alliance of Pet Food Associations, n.d.](#)). Furthermore, omega-3 and omega-6 fatty acids help maintain healthy skin, provide a healthy coat and facilitate normal cellular functions, amongst other functions ([Coates, 2022](#)). Fat-soluble vitamins, such as A, D, E, and K, are essential in a holistic physiologic process, and fats aid their absorption. This means pets will require a certain level of dietary fat to effectively absorb these nutrients ([Global Alliance of Pet Food Associations, n.d.](#)).

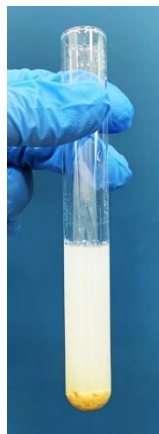


Figure 2. Presence of Fats in Pet Food

Next, the sugar test was conducted using Benedict's reagent to detect reducing sugars in pet food. Initially, a pet food sample was crushed and mixed with distilled water to create a solution. A portion of this solution was then placed in a test tube, and Benedict's reagent was added. The mixture was heated in a water bath for a few minutes. As shown in Figure 3, the solution turned green, indicating a deficiency of reducing sugars. This highlights that pet food contains only a minimal sugar content, which is advantageous for pets. Category 3 ABPs may contain hidden sugars that contribute to the overall carbohydrate content without providing substantial nutritional benefits.

Sugars are key macronutrients, along with protein and fat. Besides, small amounts of sugar in pet foods can provide a source of energy ([Amélie, n.d.](#)). Excessive sugar consumption can lead to obesity in pets, which is a significant health concern. Obesity is linked to various metabolic disorders, including diabetes mellitus, especially in dogs and cats that are already predisposed to these conditions ([Volhard Dog Nutrition, 2022](#)). Even though sugar is not toxic to pets, its presence in high amounts can be detrimental to their health ([Arnold, 2024](#)).



Figure 3. Presence of Sugar in Pet Food – Very Low Sugar

Finally, the protein test was conducted using the Biuret reagent to determine the presence of proteins in pet food. The Biuret reagent, a copper sulphate and sodium hydroxide mixture, reacts with protein peptide bonds to form a complex. If proteins are present, the solution changes colour from blue to purple (Dahal, 2024). The Biuret reagent was mixed with the apple skin extract during the food test analysis, and the resulting solution was observed. As shown in Figure 4, the solution turned purple, indicating the presence of proteins in pet food.



Figure 4. Presence of Proteins in Pet Food

The protein content is undoubtedly a crucial component of the final product for pets (Montegiove et al., 2022), along with carbohydrates and fats (Global Alliance of Pet Food Associations, n.d.). Protein consists of amino acids, and an adequate supply of protein-derived amino acids is essential for pets to sustain health by promoting robust muscles and an optimal immune system (Jewel & Jackson, 2023). Insufficient dietary protein intake prompts the body to reduce protein turnover and extract protein from lean body mass to facilitate protein synthesis. Integrating high-quality protein into pet food supports several health benefits, including muscle preservation and immune function. However, excessive protein consumption in pets results in their excrement contributing an undue nitrogen load to the environment (Jewel & Jackson, 2023). Consequently, pet owners must evaluate the protein amount and sources while choosing food to guarantee their pets have adequate nutrition according to their individual requirements.

However, there are limitations in the variability in the quality of by-products used. Food waste is not a uniform raw material; rather, it is highly heterogeneous depending on source, composition, and handling practices. This variability directly affects both nutritional outcomes and product consistency. Research confirms that food waste composition varies significantly by typology, origin, and supply chain factors, thereby influencing protein, fat, and carbohydrate content (Moonsamy, 2024).

The study observed variations in nutrient levels across the three production batches, particularly in fat and protein content. These variations can be attributed to the inherent heterogeneity of food waste inputs, as different batches may contain differing proportions of plant-based and animal-based materials (Garcia-Garcia, 2016). Animal-derived waste tends to be higher in protein and lipids, whereas plant-based waste contributes more carbohydrates and fibre, resulting in fluctuating nutritional profiles (Moonsamy, 2024). Yet, according to Mittal (2022), feed derived from food is often nutritionally balanced and of good quality, supporting the study of Chen et al. (2015).

Furthermore, processing conditions such as drying time, temperature, and mixing ratios may also contribute to variability in final nutrient composition (Oliveira et al., 2016; Jayawardena et al., 2022; Li et al., 2023). Even minor differences in preparation can influence moisture content and nutrient retention, thereby affecting analytical outcomes.

Another challenge lies in ensuring consistent product quality across batches, which is critical for potential commercialisation. Unlike conventional pet food production, which uses standardised ingredients, food waste valorisation relies on dynamic input streams. As noted in valorisation literature, variability in feedstock composition is one of the main barriers to achieving uniform product quality in waste-based production systems (Moonsamy, 2024; Pant, 2026). This highlights the need for pre-processing standardisation or formulation adjustments to stabilise output quality.

Pet Food Trial

The one-bowl feeding trial shows that the pet has accepted the pet food and is satisfied with its palatable taste. The one-bowl test notably provides insights into “acceptance” but does not furnish information regarding “preference” or “degree of liking” (Aldrich & Koppel, 2015). However, this method closely resembles real-life home environments, where pets are typically served a single type of food per meal (Calderón et al. 2024).

In addition, the pet foods meet the palatability of pets, which might be due to the fat and sugar they contain. Fat enhances the taste and aroma of pet food, making it more appealing to pets. Sugar can also enhance a pet food's palatability (Amélie, n.d.). Another study by Le Guillas et al. (2024), fats are predominantly coated on kibble to maximise the palatant power. This is particularly beneficial for products made from animal by-products, which may have less inherent flavour.

In addition, the palatability trials revealed varying degrees of acceptance among pets, particularly among more selective or “picky” animals. While most pets accepted the product, inconsistent consumption behaviour suggests that sensory attributes such as smell, texture, and flavour may differ across batches. This aligns with broader findings that pet food acceptance is influenced not only by nutritional content but also by sensory quality and familiarity (Petry et al., 2014; Raffan et al., 2015; Yan & Jin, 2025). Therefore, in terms of acceptability, prior studies indicate that pets can adapt to alternative protein sources and upcycled ingredients, although acceptance may vary depending on formulation and sensory characteristics. The variability observed in this study aligns with these findings, suggesting that while general acceptance is achievable, optimisation of formulation and sensory properties remains essential.

Linked to Hypotheses

The findings of this study provide empirical support for the proposed hypotheses, while also highlighting important nuances relevant to applied implementation.

H1 is supported. The laboratory analysis confirmed that the valorised pet food contained measurable levels of essential nutrients, including protein, fat, and sugars. Across the three production batches, all samples demonstrated nutritionally relevant compositions, indicating that halal food waste can be successfully transformed into a viable pet food product. However, variations in nutrient levels between batches suggest that while feasibility is confirmed, standardisation of input materials and processing conditions is necessary to ensure consistent nutritional quality. This finding aligns with previous research indicating that food waste can serve as a nutrient-rich resource, albeit with inherent variability.

H2 is partially supported. The feeding trials demonstrated that most pets accepted the valorised pet food, indicating general palatability. However, inconsistent consumption patterns were observed, particularly among more selective animals. This suggests that while the product is broadly acceptable, sensory attributes such as aroma, texture, and flavour require further optimisation. The variation in acceptance across batches may also reflect differences in ingredient composition, reinforcing the need for formulation consistency. Thus, although initial acceptability is promising, further refinement is needed before large-scale application.

H3 is supported. The study successfully integrated HAS principles throughout the valorisation process, including sourcing from halal-certified inputs, segregation of materials, and contamination control during processing. These measures ensured that the final product adhered to *Halalan Thayyiban* principles, encompassing both permissibility and safety. The absence of identified contamination issues and the controlled handling procedures indicate that halal integrity can be maintained even within a waste valorisation framework. This finding is particularly significant, as it demonstrates the feasibility of aligning CE practices with religious compliance requirements.

Collectively, the findings confirm that halal food waste valorisation into pet food is technically feasible, nutritionally viable, and conditionally acceptable, while maintaining halal compliance. However, the partial support for H2 and observed variability in H1 highlight the need for process optimisation, standardisation, and sensory enhancement. These insights reinforce the applied nature of the study, positioning it as a foundational step toward scalable and commercially viable halal pet food production.

CONCLUSION

The study demonstrates the feasibility of converting halal food waste into nutritionally viable pet food within a Halal-compliant framework. By integrating CE principles with HAS, the research provides a novel approach to sustainable waste management in Brunei. The findings highlight the potential for developing halal-certified pet food products while reducing environmental impact. This development is consistent with the tenets of responsible consumption and good production practice while aiding the protection of the environment and economic viability.

Producing halal pet food using food waste derived from category 3 ABPs provides a global solution to many current issues. It reduces the amount of organic waste that would add to landfill overflows and greenhouse gas emissions, which significantly helps curtail environmental issues related to waste disposal. This waste can be transformed into value-added products, thus enabling the halal food sector to encourage a CE geared towards resource preservation and sustainability.

In summary, the upcycling of food waste from category 3 animal derivatives into halal pet food has the advantage of addressing waste management issues and contributing to the growth of

the halal economy. This method allows us to help animals and the earth while being ethically and religiously compliant and, therefore, working towards a better future.

LIMITATION & FURTHER RESEARCH

The study only examined the conversion of food waste into pet food and conducted a simple food test, but risk assessment is just as crucial. Therefore, coordinated research is required to fully utilise such waste for animal feed. Future research must also implement the two-bowl tests, where pets can choose between two options to assess their palatability.

Moreover, further research is needed to quantify the environmental benefits of utilising food waste in halal pet food production, including waste reduction, carbon footprint, and resource conservation metrics. Perhaps a study of understanding the motivations behind consumer preferences for halal pet food can provide insights into marketing strategies and product development that cater to diverse demographics.

CONFLICT OF INTEREST

The author declares no conflict of interest.

REFERENCES

- Abou-Raya, A., Abou-Hussein, E., Abou-El Hassan, A., & El-Shinnawy, M. (1975). The use of some by-products in feed mixtures for animals. In *Proceedings of the Conference on Animal Feeds of Tropical and Subtropical Origin* (pp. 159–160). Tropical Products Institute.
- Ahmed, H. (2024, March 4). *The rise of halal pet food in global markets*. The Halal Times. <https://www.halaltimes.com/the-rise-of-halal-pet-food-in-global-markets/>
- Ahmed, S., Stewart, A., Smith, E., Warne, T., & Shanks, C. (2021). Consumer perceptions, behaviors, and knowledge of food waste in a rural American state. *Frontiers in Sustainable Food Systems*, 5, Article 734785. <https://doi.org/10.3389/fsufs.2021.734785>
- Aitchison, M. (2021, August 8). *World's first halal cat food containing chicken, fish and goat will go on sale in Britain as Islamic scholars question why pets need to have packs of religious food*. Daily Mail. <https://www.dailymail.co.uk/news/article-9873073/Worlds-halal-cat-food-containing-chicken-fish-goat-sale-Britain.html>
- Aldrich, G. C., & Koppel, K. (2015). Pet food palatability evaluation: A review of standard assay techniques and interpretation of results with a primary focus on limitations. *Animals*, 5(1), 43–55. <https://doi.org/10.3390/ani5010043>
- Allison, A., Lorencatto, F., Michie, S., & Miodownik, M. (2022). Barriers and enablers to food waste recycling: A mixed methods study amongst UK citizens. *International Journal of Environmental Research and Public Health*, 19(5), Article 2729. <https://doi.org/10.3390/ijerph19052729>
- Amélie. (n.d.). *Why does pet food contain sugar?* Purina. <https://www.purina.co.uk/your-questions-matter/ingredients/sugar>
- Arnold, V. L. (2024, September 23). *Can dogs eat sugar?* PetMD. <https://www.petmd.com/dog/nutrition/can-dogs-eat-sugar>
- Berry, D. (2023, June 22). *Insect ingredients buzzing into the pet nutrition space*. Pet Food Processing.
- Bressani, R., Cabezas, M., Jarquin, R., & Murillo, B. (1975). The use of coffee processing waste as animal feed. In *Proceedings of the Conference on Animal Feeds of Tropical and Subtropical Origin* (pp. 107–117). Tropical Products Institute.
- Burke, N., Zacharski, K., Adley, C. C., & Southern, M. (2021). A comparison of analytical test methods in dairy processing. *Food Control*, 121, Article 107637. <https://doi.org/10.1016/j.foodcont.2020.107637>

- Calderón, N., White, B. L., & Seo, H.-S. (2024). Measuring palatability of pet food products: Sensory components, evaluations, challenges, and opportunities. *Journal of Food Science*, *89*(2), 8175–8196. <https://doi.org/10.1111/1750-3841.17511>
- Capanoglu, E., Nemli, E., & Tomas-Barberan, F. (2022). Novel approaches in the valorization of agricultural wastes and their applications. *Journal of Agricultural and Food Chemistry*, *70*, 6787–6804.
- Castrica, M., Tedesco, D., Panseri, S., Ferrazzi, G., Ventura, V., Frisio, D., & Balzaretto, C. (2018). Pet food as the most concrete strategy for using food waste as feedstuff within the European context: A feasibility study. *Sustainability*, *10*(6), Article 2035. <https://doi.org/10.3390/su10062035>
- Chen, T., Jin, Y., & Shen, D. (2015). A safety analysis of food waste-derived animal feeds from three typical conversion techniques in China. *Waste Management*, *45*, 42–50. <https://doi.org/10.1016/j.wasman.2015.06.041>
- Choussy, F. (1944). *La pulpa de café como alimento del ganado*. *Anales del Instituto Tecnológico de El Salvador*, *1*, 265–280.
- Clavijo, H., & Maner, J. (1975). The use of waste bananas for swine feed. In *Proceedings of the Conference on Animal Feeds of Tropical and Subtropical Origin* (pp. 99–106). Tropical Products Institute.
- Cleaver, L. (2024, January 31). *3 key global pet food trends emerge*. Pet Food Industry. <https://www.petfoodindustry.com/pet-food-market/news/15663179/3-key-global-pet-food-trends-emerge>
- Coates, J. (2022, November 17). *Fats for dogs*. PetMD. <https://www.petmd.com/dog/nutrition/fats-for-dogs>
- Dahal, P. (2024, May 22). *Biuret test for protein: Principle, procedure, results, uses*. Microbe Notes. <https://microbenotes.com/biuret-test-for-protein/>
- Dariah, A., Abdullah, R., Hidayat, A., & Matahir, F. (2022). Sustainable economic sectors in Indonesia and Brunei Darussalam. *Sustainability*, *14*(5), Article 3044. <https://doi.org/10.3390/su14053044>
- Donnelly, K. (2024, April 23). *Food waste reduction: Quantifying the benefits for businesses and the environment*. Gradeall International Ltd. <https://gradeall.com/food-waste-reduction-quantifying-the-benefits-for-businesses-and-the-environment/>
- dos Santos, J., da Silveira, D., da Costa, M., & Duarte, R. (2022). Consumer behaviour in relation to food waste: A systematic literature review. *British Food Journal*, *124*(12), 4420–4439. <https://doi.org/10.1108/BFJ-09-2021-1075>
- EPA. (2024, June 11). *Sustainable management of food basics*. <https://www.epa.gov/sustainable-management-food/sustainable-management-food-basics>
- Eriksson, M., Strid, I., & Hansson, P.-A. (2015). Carbon footprint of food waste management options in the waste hierarchy: A Swedish case study. *Journal of Cleaner Production*, *93*, 115–125. <https://doi.org/10.1016/j.jclepro.2015.01.026>
- European Commission. (n.d.). *Animal by-products*. https://food.ec.europa.eu/food-safety/animal-products_en
- European Commission. (2015). *Proposal for a directive of the European Parliament and of the Council amending Directive 2008/98/EC on waste*. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015PC0595>
- Feed Team. (2024, November 8). *Navigating the path to a pet food feeding trial: A step-by-step guide*. Hollywood Feed Education. <https://hfu.hollywoodfeed.com/navigating-the-path-to-a-pet-food-feeding-trial-a-step-by-step-guide/>
- FAO. (2011). *Global food losses and food waste: Extent, causes and prevention*. Food and Agriculture

Organization.

- Food and Agriculture Organization. (2015). *Food wastage footprint and climate change*. <https://openknowledge.fao.org/server/api/core/bitstreams/7ffcaf9-91b2-4b7b-bceb-3712c8cb34e6/content>
- Food Recycle International. (2024). *Food Recycle International*. <https://www.foodrecycle.com/>
- Harvard T.H. Chan School of Public Health. (n.d.). *Food waste*. <https://nutritionsource.hsph.harvard.edu/sustainability/food-waste/>
- García, A., Álvarez-Pérez, O., Rojas, R., Aguilar, C., & Garrigós, M. (2020). Impact of olive extract addition on corn starch-based active edible films properties for food packaging applications. *Foods*, 9(9), Article 1339. <https://doi.org/10.3390/foods9091339>
- Garcia-Garcia, G., Woolley, E., Rahimifard, S., Colwill, J., White, R., & Needham, L. (2017). A methodology for sustainable management of food waste. *Waste and Biomass Valorization*, 8(6), 2209–2227. <https://doi.org/10.1007/s12649-016-9720-0>
- Giordano, C., Falasconi, L., Cicatiello, C., & Pancino, B. (2020). The role of food waste hierarchy in addressing policy and research: A comparative analysis. *Journal of Cleaner Production*, 252, Article 119617. <https://doi.org/10.1016/j.jclepro.2019.119617>
- Global Alliance of Pet Food Associations. (n.d.). *The science of pet food: Role of fat* [Factsheet]. https://www.gapfa.org/files/download/GAPFA_Factsheet_The_science_of_pet_food_Role_of_fat.pdf
- Global Alliance of Pet Food Associations. (n.d.). *The science of pet food: Role of protein*. https://www.gapfa.org/files/download/GAPFA_Factsheet_The_Science_of_Pet_Food_Role_of_Protein.pdf
- Golden Corporation Sdn. Bhd. (n.d.). *About*. <http://www.golden-corp.com/about.php>
- Goodwin, L. (2023, April 20). *The global benefits of reducing food loss and waste, and how to do it*. World Resources Institute. <https://www.wri.org/insights/reducing-food-loss-and-food-waste>
- Groshek, N. (2024, February 28). *How HPP works for raw dog & cat food*. Stella & Chewy's. <https://www.stellaandchewys.com/food-feeding/high-pressure-processing/>
- Groth, L. (2019, August 7). *This local company turns food waste into sustainable pet treats*. Philadelphia Magazine. <https://www.phillymag.com/be-well-philly/2019/07/08/piggyback-treats-company/>
- Gunjal, B. (2019). Value-added products from food waste. In A. Gunjal, M. Waghmode, N. Patil, & P. Bhatt (Eds.), *Global initiatives for waste reduction and cutting food loss* (pp. 20–30). IGI Global. <https://doi.org/10.4018/978-1-5225-7706-5.ch002>
- Hasan, Z., & Lateef, M. (2024). Transforming food waste into animal feeds: An in-depth overview of conversion technologies and environmental benefits. *Environmental Science and Pollution Research*, 31, 17951–17963. <https://doi.org/10.1007/s11356-023-30152-0>
- Hills, I. (2023, August 21). *Tiana Halal carves out profitable niche within upmarket cat food*. London Daily News. <https://www.londondaily.news/tiana-halal-carves-out-profitable-niche-within-upmarket-cat-food/>
- HLPE. (2014). *Food losses and waste in the context of sustainable food systems: A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security*. HLPE.
- Houghton, A. (2024, March 21). *Halal pet food firm wins Start Up Loans backing as it aims to expand internationally and grow product range*. Business Live. <https://www.business-live.co.uk/enterprise/halal-pet-food-firm-wins-28854567>
- Ilakovac, B., Cerjak, M., & Voca, N. (2020). Why do we waste food? In-depth interviews with consumers. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 1–15.

- <https://doi.org/10.1080/15567036.2020.1787564>
- Jain, A. (2017). *Summary report: Waste management in ASEAN countries*. United Nations Environment Programme.
- Jais, A. (2021). *Internal halal control systems (IHCS) in foodservices and food-based manufacturing for the micro & small enterprise*. Politeknik Tun Syed Nasir Syed Ismail.
- Jayawardena, S. R., Morton, J. D., Bekhit, A. E. A., Bhat, Z. F., & Brennan, C. S. (2022). Effect of drying temperature on nutritional, functional and pasting properties and storage stability of beef lung powder, a prospective protein ingredient for food supplements. *LWT*, *161*, Article 113315. <https://doi.org/10.1016/j.lwt.2022.113315>
- Jeevahan, J., Anderson, A., Sriram, V., Durairaj, R., Joseph, G., & Mageshwaran, G. (2021). Waste into energy conversion technologies and conversion of food wastes into potential products: A review. *International Journal of Ambient Energy*, *42*(9), 1083–1101. <https://doi.org/10.1080/01430750.2018.1537939>
- Jewel, D., & Jackson, M. (2023). Ensuring healthier pets through improved nutrient precision in pet foods. *Open Access Government*, 518–519. <https://doi.org/10.56367/OAG-038-10660>
- Jones, S. (2023, March 2). *Waitrose to turn surplus food waste into animal feed as part of new trial*. The Grocer. <https://www.thegrocer.co.uk/waitrose/waitrose-to-turn-surplus-food-waste-into-animal-feed-as-part-of-new-trial/676872.article>
- Kakuk, C. (2022, March 17). *Humanization of pets driving innovation in natural ingredients*. Natural Products Insider. <http://www.naturalproductinsider.com/natural-product-development/humanization-of-pets-driving-innovation-in-natural-ingredients>
- Kannan, G., Selladurai, D., & Karthi, S. (2013). Swaging process for productivity improvement in the manufacture of spindles. *Journal of Scientific & Industrial Research*, *72*(11), 681–684.
- Kaur, M., Singh, A., & Singh, A. (2023). Bioconversion of food industry waste to value added products: Current technological trends and prospects. *Food Bioscience*, *55*, Article 102935. <https://doi.org/10.1016/j.fbio.2023.102935>
- Keçińska-Pacelik, J., & Biel, W. (2022). Insects in pet food industry—Hope or threat? *Animals*, *12*(12), Article 1515. <https://doi.org/10.3390/ani12121515>
- Kon, J. (2022, February 25). *Making use of food waste*. Borneo Bulletin. <https://borneobulletin.com.bn/making-use-of-food-waste/>
- Kvamme, J. L. (2003). Section IV, chapter 1: What is palatability? In J. L. Kvamme & T. D. Phillips (Eds.), *Petfood technology* (pp. 176–177). Watt Publishing Co.
- Le Guillas, G., Vanacker, P., Salles, C., & Labouré, H. (2024). Insights to study, understand and manage extruded dry pet food palatability. *Animals*, *14*(7), Article 1095. <https://doi.org/10.3390/ani14071095>
- Li, S., Liu, F., Wu, M., Li, Y., Song, X., & Yin, J. (2023). Effects of drying treatments on nutritional compositions, volatile flavor compounds, and bioactive substances of broad beans. *Foods*, *12*(11), Article 2160. <https://doi.org/10.3390/foods12112160>
- Liu, Z., de Souza, T., Holland, B., Dunshea, F., Barrow, C., & Suleria, H. A. R. (2023). Valorization of food waste to produce value-added products based on its bioactive compounds. *Processes*, *11*(3), Article 840. <https://doi.org/10.3390/pr11030840>
- Long, C., Ismail, W., Rasid, S., Hwee, K., & Jiun, L. (2013). Sustaining customers' loyalty: A survey of a coating resins manufacturer. *Journal of Scientific & Industrial Research*, *72*, 387–392.
- Manzouri, M., Ab-Rahman, M. S., Zain, C. R. C. M., & Jamsari, E. A. (2014). Increasing production and eliminating waste through lean tools and techniques for halal food companies. *Sustainability*, *6*(12), 9179–9204. <https://doi.org/10.3390/su6129179>
- Matumoto-Pintro, P. T., & Saraiva, B. R. (2023). High value-added products from food waste. *Foods*, *12*(21), Article 4038. <https://doi.org/10.3390/foods12214038>

- Middle East Monitor. (2021, September 9). *Entrepreneur launches UK's first halal cat food*. <https://www.middleeastmonitor.com/20210909-entrepreneur-launches-uks-first-halal-cat-food/>
- Mittal, A. (2022). Conversion of food waste to healthy pet food as a multi-pronged solution to environmental crises. *International Journal of All Research Education & Scientific Methods*, 10(9), 120–128.
- Montegiove, N., Calzoni, E., Cesaretti, A., Pellegrino, R., Emiliani, C., Pellegrino, A., & Leonardi, L. (2022). The hard choice about dry pet food: Comparison of protein and lipid nutritional qualities and digestibility of three different chicken-based formulations. *Animals*, 12(12), Article 1538. <https://doi.org/10.3390/ani12121538>
- Moonsamy, T., Rajauria, G., Priyadarshini, A., & Jansen, M. (2024). Food waste: Analysis of the complex and variable composition of a promising feedstock for valorisation. *Food and Bioprocess Processing*, 148, 31–42. <https://doi.org/10.1016/j.fbp.2024.08.012>
- Mosco, E., Kilroy, D., & Kumar, A. H. S. (2025). Assessment of pupillometry across different commercial systems of laying hens to validate its potential as an objective indicator of welfare. *Poultry*, 4(3), Article 31. <https://doi.org/10.3390/poultry4030031>
- Muller, Z., Chou, K., & Nah, K. (1975). Cassava as a total substitute for cereals in livestock and poultry rations. In *Proceedings of the Conference on Animal Feeds of Tropical and Subtropical Origin* (pp. 85–96). Tropical Products Institute.
- Nath, P. C., Ojha, A., Debnath, S., Sharma, M., Nayak, P., Sridhar, K., & Inbaraj, B. S. (2023). Valorization of food waste as animal feed: A step towards sustainable food waste management and circular bioeconomy. *Animals*, 13(8), Article 1366. <https://doi.org/10.3390/ani13081366>
- Nielsen, S. S. (2017). *Food analysis*. Springer. <https://doi.org/10.1007/978-3-319-45776-5>
- O'Connor, J., Hoang, S. A., Bradney, L., Dutta, S., Xiong, X., Tsang, D. C. W., Ramadass, K., Vinu, A., Kirkham, M., & Bolan, N. S. (2021). A review on the valorisation of food waste as a nutrient source and soil amendment. *Environmental Pollution*, 272, Article 115985. <https://doi.org/10.1016/j.envpol.2020.115985>
- Okareh, O., Oyewole, S., & Taiwo, L. (2014). Conversion of food wastes to organic fertilizer: A strategy for promoting food security and institutional waste management in Nigeria. *Journal of Research in Environmental Science and Toxicology*, 3(4), 66–72. <http://dx.doi.org/10.14303/jrest.2012.031>
- Oliveira, S. M., Brandão, T. R. S., & Silva, C. L. M. (2016). Influence of drying processes and pretreatments on nutritional and bioactive characteristics of dried vegetables: A review. *Food Engineering Reviews*, 8, 134–163. <https://doi.org/10.1007/s12393-015-9124-0>
- Pant, M., Bisen, D., Kewlani, P., Srivastav, A. L., Bhatt, I. D., & Chakma, S. (2026). Review of food waste valorization technologies: A sustainable approach to resource recovery and utilization. *Biomass Futures*, 1, Article 100001. <https://doi.org/10.1016/j.bmf.2025.100001>
- Parte, R. M. (2025). A study on exploring sustainable solution for pet nutrition from food waste. *International Journal of Progressive Research in Engineering Management and Science*, 5(5), 328–340.
- Penrod, E. (2023, March 28). *Startup using tech to turn food waste into animal feed*. Feed Strategy. <https://www.feedstrategy.com/animal-feed-manufacturing/article/15443431/startup-using-tech-to-turn-food-waste-into-animal-feed>
- Pet Product Marketing. (2024). *Leeds-based entrepreneur to launch ground-breaking halal pet food company*.
- Petry, G., Fourie, J., & Wolken, S. (2014). Comparison of the palatability of a new flavoured Drontal® Plus tablet (Drontal® Plus Treat 10 kg) and Milbemax® chewable tablets when presented to privately owned dogs. *Open Journal of Veterinary Medicine*, 4, 163–169.

- <https://doi.org/10.4236/ojym.2014.48018>
- Phillips-Donaldson, D. (2020, May 28). *Do pet food consumers still care about sustainability?* Pet Food Industry. <https://www.petfoodindustry.com/pet-food-market/blog/15466838/do-pet-food-consumers-still-care-about-sustainability>
- Pongrácz, P., & Dobos, P. (2025). Behavioural differences and similarities between dog breeds: Proposing an ecologically valid approach for canine behavioural research. *Biological Reviews*, *100*(1), 68–84. <https://doi.org/10.1111/brv.13128>
- Raffan, E., Smith, S. P., O’Rahilly, S., & Wardle, J. (2015). Development, factor structure and application of the Dog Obesity Risk and Appetite (DORA) questionnaire. *PeerJ*, *3*, Article e1278. <https://doi.org/10.7717/peerj.1278>
- Rawvolution Food. (2024). *About us Rawvolution Cape Town – Pet supplies*. <https://rawvolutionfood.com/pages/about-us>
- Reus, A. (2022, July 19). *Should you use high-pressure processing for your pet food?* Pet Food Industry. <https://www.petfoodindustry.com/production/pet-food-processing/article/15468843/should-you-use-highpressure-processing-for-your-pet-food>
- Rubio, D., & Menon, J. (2023, April 25). *Turning food waste into pet food? British supermarkets are up for it*. GlobalPETS. <https://globalpetindustry.com/news/turning-food-waste-pet-food-british-supermarkets-are-it/>
- Salamdeeb, R., zu Ermgassen, E. K. H. J., Kim, M. H., Balmford, A., & Al-Tabbaa, A. (2017). Environmental and health impacts of using food waste as animal feed: A comparative analysis of food waste management options. *Journal of Cleaner Production*, *140*, 871–880. <https://doi.org/10.1016/j.jclepro.2016.05.049>
- Schleicher, M., Cash, S. B., & Freeman, L. M. (2019). Determinants of pet food purchasing decisions. *The Canadian Veterinary Journal*, *60*(6), 644–650.
- Serra-Castelló, C., Possas, A., Jofré, A., Garriga, M., & Bover-Cid, S. (2023). High pressure processing to control *Salmonella* in raw pet food without compromising the freshness appearance: The impact of acidulation and frozen storage. *Food Microbiology*, *109*, Article 104139. <https://doi.org/10.1016/j.fm.2022.104139>
- Shahrajabian, M. H., Sun, W., & Cheng, Q. (2019). Measures to achieve a stable farming system in sustainable agriculture: A short review. *Annales Universitatis Paedagogicae Cracoviensis Studia Naturae*, *4*, 170–179. <https://doi.org/10.24917/25438832.4.11>
- Shams, S., Juani, R., & Guo, Z. (2014). Integrated and sustainable solid waste management for Brunei Darussalam. In *5th Brunei International Conference on Engineering and Technology (BICET 2014)* (pp. 1–6). <https://doi.org/10.1049/cp.2014.1066>
- Shiba, P. (2023, December 20). *Upcycled pet foods: The future of sustainable pet food*. FurryGreen. <https://furrygreen.hk/blogs/information/upcycled-pet-foods-the-future-of-sustainable-pet-food>
- Simon, C., Salina, M., Irvin, S., Blyth, D., Bourne, N., & Smullen, R. (2019). The effect of poultry protein concentrate and phosphorus supplementation on growth, digestibility and nutrient retention efficiency in barramundi (*Lates calcarifer*). *Aquaculture*, *498*, 305–314. <https://doi.org/10.1016/j.aquaculture.2018.08.069>
- Singh, G., Saha, P., Sharma, N., Thakur, V., Kaur, K., & Singh, J. (2024). Municipal solid waste management and recycling technologies. In R. Mehra, P. Kumar, & B. Hung (Eds.), *Municipal solid waste management and recycling technologies* (pp. 203–240). IGI Global. <https://doi.org/10.4018/979-8-3693-4054-7.ch008>
- Slater, R. (2024, April 26). *Muslim man launches UK’s first certified halal cat food*. *The Telegraph*.
- Slorach, P., Jeswani, H. K., Cuéllar-Franca, R., & Azapagic, A. (2019). Energy demand and carbon footprint of treating household food waste compared to its prevention. *Energy Procedia*, *161*,

- 17–23. <https://doi.org/10.1016/j.egypro.2019.02.053>
- Somya, A., Peter, A., Varshney, A., & Thakur, A. (2024). Recent technologies used in waste management. In R. Mehra, P. Kumar, & B. Hung (Eds.), *Municipal solid waste management and recycling technologies* (pp. 177–202). IGI Global. <https://doi.org/10.4018/979-8-3693-4054-7.ch007>
- Storey, I. (2024, April 11). *Entrepreneur to launch groundbreaking halal pet food company*. Dewsbury Reporter. <https://www.dewsburyreporter.co.uk/lifestyle/shopping/entrepreneur-to-launch-groundbreaking-halal-pet-food-company-4588206>
- Sulaiman, A., Othman, N., Baharuddin, A. S., Mokhtar, M. N., & Tabatabaei, M. (2014). Enhancing the halal food industry by utilizing food wastes to produce value-added bioproducts. *Procedia – Social and Behavioral Sciences*, 121, 35–43. <https://doi.org/10.1016/j.sbspro.2014.01.1106>
- Sulaiman, N. S. (2023). Halal industrial food waste management: Lesson learnt from Japan. *Dinar: Jurnal Ekonomi & Keuangan Islam*, 10(1), 17–33.
- Sulaiman, N. S. (2025). Utilization of industrial food waste as raw material of halal pet food. In S. Al-Humairi, A. Hajamydeen, & A. Mahfoudh (Eds.), *Sustainable smart cities and the future of urban development* (pp. 463–486). IGI Global. <https://doi.org/10.4018/979-8-3693-6740-7.ch019>
- Sulaiman, N., & Talib, M. (2024). Promoting sustainability in utilizing halal food waste in producing value-added products. In K. D. T. & A. Basid (Eds.), *Proceedings of the 4th International Conference on Halal Development (4th ICHaD 2023) (Advances in Social Sciences, Education and Humanities Research*, pp. 184–194). Atlantis Press. https://doi.org/10.2991/978-2-38476-261-3_17
- Sun, W., Shahrajabian, M. H., & Cheng, Q. (2021). Organic waste utilization and urban food waste composting strategies in China: A review. *Notulae Scientia Biologicae*, 13(2), 1–16. <https://doi.org/10.15835/nsb13210881>
- Talib, M. S. A., & Zulfakar, M. H. (2023). Sustainable halal food supply chain management in a small rentier halal market. *Arab Gulf Journal of Scientific Research*. <https://doi.org/10.1108/AGJSR-11-2022-0251>
- Tamboli, T., Vaiude, N., & Raison, H. (2023). A multidimensional analysis of economic, environmental, and social implications of transitioning from landfill-based waste disposal to a zero-landfill model. *International Journal of Progressive Research in Science and Engineering*, 4(9), 10–16.
- Thyberg, K. L., & Tonjes, D. J. (2017). The environmental impacts of alternative food waste treatment technologies in the U.S. *Journal of Cleaner Production*, 158, 101–108. <https://doi.org/10.1016/j.jclepro.2017.04.169>
- Tobie, C., Péron, F., & Larose, C. (2015). Assessing food preferences in dogs and cats: A review of the current methods. *Animals*, 5, 126–137. <https://doi.org/10.3390/ani5010126>
- Tyler, J. (2020, January 30). *Shameless Pets shakes on sustainable partnership*. Pet Food Processing. <https://www.petfoodprocessing.net/articles/13592-shameless-pets-shakes-on-sustainable-partnership>
- Tyler, J. (2021, January 13). *Kemin, CSS partner to repurpose food waste into pet food*. Pet Food Processing. <https://www.petfoodprocessing.net/articles/14387-kemin-css-partner-to-repurpose-food-waste-into-pet-food>
- UK Pet Food. (2023). *Category 3 animal fats*.
- VAFO. (2023, October 16). *VAFO gives unused ingredients a second chance with the new brand Planet Pet Society*. <https://www.vafo.com/vafo-gives-unused-ingredients-a-second-chance-with-the-new-brand-planet-pet-society/>

- Valdés, F., Villanueva, V., Durán, E., Campos, F., Avendaño, C., Sánchez, M., et al. (2022). Insects as feed for companion and exotic pets: A current trend. *Animals*, 12(11), Article 1450. <https://doi.org/10.3390/ani12111450>
- Vanderhoydonck, P. (2023, February 10). *Pet food ingredients: What do pet owners actually prefer?* GlobalPETS.
- Volhard Dog Nutrition. (2022, November 23). *How much sugar can hurt a dog?* <https://www.volharddognutrition.com/blog/how-much-sugar-can-hurt-a-dog/>
- Waqas, M., Nizami, A. S., Aburizaiza, A. S., Barakat, M. A., Rashid, M. I., & Ismail, I. M. I. (2018). Optimizing the process of food waste compost and valorizing its applications: A case study of Saudi Arabia. *Journal of Cleaner Production*, 176, 426–438. <https://doi.org/10.1016/j.jclepro.2017.12.165>
- Were, H. (1975). Utilisation of pyrethrum waste product as a livestock feed. In *Proceedings of the Conference on Animal Feeds of Tropical and Subtropical Origin* (pp. 147–154). Tropical Products Institute.
- Yan, Z., & Jin, Y. (2025). *Owners say yuck but pets say yum: Factors influencing pet owners' behavior toward sustainable pet food* (Master's thesis, Uppsala University). <https://uu.diva-portal.org/smash/get/diva2:1978863/FULLTEXT01.pdf>