DEPARTMENT OF VETERINARY SCIENCES - UNIVERSITY OF TURIN

UNIVERSIDADE ESTADUAL PAULISTA – UNESP - CÂMPUS DE JABOTICABAL

RESEARCH DOCTORATE IN CO-TUTORSHIP IN VETERINARY SCIENCES FOR ANIMAL HEALTH AND FOOD SAFETY

CYCLE XXXV

PhD THESIS

DIGESTIBILITY AND NUTRITIONAL ADEQUACY OF INNOVATIVE MATERIALS IN PET FOOD

PhD Student: Dr. Livio Penazzi, DVM

PhD Tutor: Prof. Liviana Prola, DVM, PhD

PhD co-Tutor: Prof. Aulus Cavalieri Carciofi, DVM, PhD

PhD Coordinator: Prof. Maria Teresa Capucchio, DVM, PhD

Academic Years 2019-2022

Disciplinary-Scientific Sector

Animal Nutrition and Feeding

DEPARTMENT OF VETERINARY SCIENCES - UNIVERSITY OF TURIN

UNIVERSIDADE ESTADUAL PAULISTA – UNESP - CÂMPUS DE JABOTICABAL

DIGESTIBILITY AND NUTRITIONAL ADEQUACY OF INNOVATIVE MATERIALS IN PET FOOD

Livio Penazzi
PhD Tutor: Prof. Liviana Prola
PhD co-Tutor: Prof. Aulus Cavalieri Carciofi
PhD thesis presented at the Department of Veterinary Sciences – University of Turin, Italy, as part of the mandatory process to obtain the title of Doctor in Veterinary Sciences

2024

P397d

Penazzi, Livio

Digestibilidade e adequação nutricional de ingredientes inovadores em pet food / Livio Penazzi. -- Jaboticabal, 2024

110 f.

Tese (doutorado) - Universidade Estadual Paulista (Unesp), Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal

Orientadora: Liviana Prola

Coorientador: Aulus Cavalieri Carciofi

1. sustentabilidade. 2. insetos. 3. legumes. I. Título.

Sistema de geração automática de fichas catalográficas da Unesp. Biblioteca da Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal. Dados fornecidos pelo autor(a).

Essa ficha não pode ser modificada.

"The world is too much with us; late and soon,

Getting and spending, we lay waste our powers;

Little we see in Nature that is ours;

We have given our hearts away, a sordid boon!

This Sea that bares her bosom to the moon;

The winds that will be howling at all hours,

And are up-gathered now like sleeping flowers;

For this, for everything, we are out of tune;

It moves us not. Great God! I'd rather be

A Pagan suckled in a creed outworn;

So might I, standing on this pleasant lea,

Have glimpses that would make me less forlorn;

Have sight of Proteus rising from the sea;

Or hear old Triton blow his wreathèd horn."

The World is too much with us by WILLIAM WORDSWORTH

SUMMARY

A continuous and increasing effort has been promoted in the last few decades regarding environmental sustainability. Even tough pet food has always been considered as a valuable asset in reducing food waste there is still a wide margin of improvement. As such, new ingredients are constantly tested in the pet food market for both their nutritional value as well as their particular properties. One of the most promising ingredients can be considered insects, due to their potential sustainability features and nutritional aspects. Their high levels of both protein and fat content alongside their supposed low environmental footprint has gain the attention of the pet food market. Another set of ingredients which are increasing steadily in the pet food manufacturing are legumes. In particular, legumes by-product can obtain new value while providing interesting nutritional characteristics in pet food diets. Their higher level of protein and fibre compared to the more commonly used cereals can affect the gastrointestinal tract of dogs and cats.

Aim of the PhD project was to assess the nutritional quality, digestibility, safety and dietary characteristics of diets based on new materials for pet food production. Considering the novelty of insects, a diet based on black soldier fly larvae was tested for its digestibility as well as for its safety, following the nutritional adequacy trial according to AAFCO guidelines. Regarding legumes it was chosen to test lentils pasta by-product as this ingredient is discarded from the human-graded food production just for aesthetic reasons (e.g. discoloured or broken), retaining all its nutritional value for a possible use in pet food industry.

The first trial was conducted at the University of Turin (Italy) following FEDIAF Guidelines for *in vivo* digestibility trials using both total faecal collection and marker methods. Six West Highland White Terrier (3 males and 3 females, median of 3 years old) were allocated into 2 groups, one receiving an experimental diet based on black soldier fly larvae meal (BSF) while the other receiving a control diet based on venison meat (CTRL), in a cross-over design, so that each dog was the control of itself. The two diets were formulated to be isonitrogenous and isoenergetic, and they were also tested for *in vitro* digestion afterwards. Digestibility of nutrients for both TFC and marker methods were tested using two-way ANOVA for the comparison of both diets (CTRL vs BFL) and methods (TFC vs marker). The two methods used showed similar results while the diets differed regarding crude fibre digestibility (lower in the BSF diet compared to the CTRL diet), crude protein and calcium digestibility (higher in the BSF diet compared to the CTRL diet). *In vitro* results slightly overestimated OM and CP digestibility compared to *in vivo* results, even though they were substantially similar from

a nutritional perspective. This overestimation was probably due to the fact that prediction equations were derived from feedstuff based on vertebrates; as a consequence, diets formulated with insects may need further studies to derive more reliable prediction equations. The nutritional adequacy trial involved 16 mixed-breed dogs (8 males and 8 females, median of 5 years old) for a total of 26 weeks, according to AAFCO guidelines. The dogs were fed the same diets used for the digestibility trial and their clinical parameters as well as their weight were checked at the beginning (T0) and at the end of trial (T1). No variation of weight, haemoglobin, PCV, serum albumin and ALP was recorded, and all parameters were within normal ranges (according to AAFCO) during all the duration of the trial. Consequently, the diet based on black soldier fly larvae meal was deemed suitable for adult dogs maintenance diets.

The second trial was conducted at the UNESP (Brazil) and involved diet formulation and processing as well as the digestibility trial itself. Since legume-based diets for pets are already on the market the main focus of this research involved both the extrusion technique, as it is one of the major concerns for the pet food manufacturers, and the nutritional outcomes of such diet (e.g. faecal biogenic amines and volatile fatty acid production or glycaemic and insulinemic curve). In fact, legumes have specific nutritional properties, such as higher protein and fibre content and lower starch content compared to cereals, which make them a challenging ingredient to extrude while, at the same time, giving the diet particular intestinal features. Five experimental diets were formulated: a basal diet (CO) was based on rice and poultry by-product meal; while other 3 experimental diets were made only with the replacement of rice with different inclusion levels (33%, 66% and 100%) of lentil pasta by-product (LP33, LP66 and LP100). A fifth experimental diet (LPS) was formulated with 70% of the basal diet (CO) and 30% of the lentil pasta by-product in order to evaluated the ingredient digestibility alone. The diets were produced in an experimental extruder and the processing parameters were regularly checked and recorded while samples were collected at periodic intervals. The results showed a linear increase in extruder pressure, hardness and bulk density of kibbles when increasing the level of LP inclusion ($P < 0.05$), without affecting starch gelatinization. The ATTDC of dry matter, organic matter, and gross energy presented a quadratic reduction, while the dietary fibre and crude protein ATTDC increased quadratically with LP inclusion ($P<0.05$). According to the polynomial contrasts analysis, up to 66% of LP replacement did not reduce ATTDC, with similar or increased values compared to the BR diet. Nitrogen balance did not change ($P>0.05$), but a linear increase in faeces production and moisture, and a linear decrease in faeces pH was observed with higher LP ($P<0.05$), without changing faecal score. Faecal acetate, propionate, total

short-chain fatty acids (SCFA), branched-chain fatty acids, and lactate all increased linearly with LP inclusion ($P<0.05$), without altering ammonia concentration in faeces. The increase in LP inclusion promoted a linear increment in cadaverine, tyramine, histamine and spermidine ($P<0.05$); while spermine exhibited higher concentrations in faeces for the LP 33% diet ($P<0.05$). The effects on both extrusion parameters and kibble formation, as well as in ATTDC and fermentation of by-products in faeces can be explained by the higher dietary fibre and lower starch content of LP in comparison with BR. The increase in fibre with lower starch may increase the mass resistance to flow inside the extruder, increasing shear, temperature and pressure, but the reduced starch content ended reducing expansion due to the lower plasticised mass necessary for cell structure formation. The higher fibre intake by dogs due to LP inclusion can also explain the reduction in digestibility. The dietary fibre of LP showed to be fermentable by gut microbiota, increasing the concentration of desirable fermentation products including SCFA, and spermidine. The glycaemic and insulinemic curve was performed on 2 groups of 8 Beagle dogs fed the BR diet and the LP100 diet respectively. The results showed a reduction in post-prandial glucose and insulin response for the LP100 diet in comparison to BR diet, suggesting that this ingredient can be used in diet designed to have low glycaemic response. Finally, a palatability study was performed on 38 dogs of different breeds and body weight in a completed randomized design using the two-bowl method, comparing the BR diet with the LP100 diet. The results showed a preference for the LP100 ration in both the "first choice" test and the "consumption rate" evaluation ($P<0.05$). The trial revealed how a by-product discarded for just aesthetic reason from human-graded food chain can still retain its highly palatable organoleptic properties.

Overall, both trials performed showed that the ingredients tested can have a future application in the pet food market, both from a nutritional as well as a sustainable perspective, according to the pillars of the circular economy.

INDEX

LIST OF TABLES

LIST OF FIGURES

1.INTRODUCTION

It is undeniable nowadays that the world is changing from a climatic and demographic point of view (Fróna et al., 2019). The rapid increase in food demand will rise ever so greatly during the next years and a challenge for the welfare quality of people (FAO, 2009) and their pets life is looming (Swanson et al., 2013). Protein sources are the most expensive and ecologically demanding ingredients, accounting also the fact that they have a substantial impact on environment, land and water usage (Okin, 2017). Nevertheless, protein (as a macronutrient) is a key point for pet owners while choosing pet food products (Laflamme et al., 2008; Nijdam et al., 2012; Berardy et al., 2019). On that extent, alternative raw materials (such as by-products from human food industry) in pet food can increase the provision and/or digestibility of different nutrients combining, at the same time, an enhanced sustainability for what concerns the world economy, society and environment (Meeker et al., 2015). Indeed, a nutritional approach is considered sustainable if it is in accordance with the three-P dimensions (Planet, People and Profit) (Makkar et al., 2014 a). These changes, alongside the increased food-quality awareness of pet owners (Swanson et al., 2013), are leading manufacturers to introduce products with new sources of non-structural carbohydrates (NSC) and proteins. As this new trend is rising, concerns about food safety and quality are going hand to hand and need to be addressed (van der Spiegel et al., 2013). As a consequence, numerous factors need to be studied and conveyed before the introduction of these novel materials in the pet food production chain.

9. CONCLUSIONS

This PhD project focused on the evaluation of innovative ingredients for their possible entrance in the pet food manufacturing. The choice of legumes and insects followed the criteria of nutritional adequacy and sustainability while addressing the current trends in the companion animal sector. Even tough insects industry is still under development for a large scale production, their role in the future of animal (and human) nutrition has been promoted as a possible solution to reduce our dietary wastes and carbon footprint. The assessment of their safety and dietary values is therefore crucial before further investments can be allocated in this field. This project not only evaluated the optimal results in terms of digestibility for a diet based on black soldier fly larvae but also its nutritional safety in a long-term study. However, this can be considered a starting step for the development of further studies, as insects can vary widely from a nutritional perspective depending on their life stages and their feeding. Numerous factors need to be addressed before understanding the potential of this novel ingredient, first of all the role of chitin on gut health and animal metabolism. Nevertheless, this study showed that black soldier fly larvae meal has already the likelihood to become a noteworthy ingredient in the future of the pet food industry. On the other hand, legumes have been commercialized for a longer time compared to insects. However, little has been investigated on their potential benefit a part from their nutritional value. In this project the digestibility parameters of diets based on lentil pasta by-product showed that this ingredient, despite discarded from human-graded food production, retain high bioavailability of nutrients. In addition, lentils can have an effect on the post-prandial glycaemic and insulinemic response, lowering the curve peaks compared to rice, possibly affecting the metabolic pathways of the animal. Nonetheless, the palatability of the ration resulted to be enhanced by the addition of lentil pasta by-product, of which the organoleptic properties appeared to be appreciated by dogs more than rice. However, extrusion processing parameters need to be carefully evaluated due to the reduced level of starch and increased level of fibre and protein of legume-based diets compared to cereal-based ones. In fact, the resistance to mass flow can affect kibble formation and hardness, altering therefore the final product characteristics. As such, this project aimed also to give the tools to understand where to operate on the extrusion processing in order to produce kibbles with similar characteristics depending on the inclusion level of pulses. In general, both of the ingredients selected demonstrated a good outcome in term of possible mass production in commercial products while, at the same time, taking care of the sustainability concerns.

10. REFERENCES

AAFCO, 2018: *Association of American Feed Control Officials (AAFCO) . 2018*. Official publication of Association of American Feed Control Officials Incorporated, Oxford.

Abd El-Wahab, A.; Chuppava, B.; Zeiger, A. L.; Visscher, C.; Kamphues, J., 2022: Nutrient Digestibility and Fecal Quality in Beagle Dogs Fed Meat and Bone Meal Added to Dry Food. *Veterinary Sciences*., **9**, 164.

Acuff, H. L.; Dainton, A. N.; Dhakal, J.; Kiprotich, S.; Aldrich, G., 2021: Sustainability and Pet Food: Is There a Role for Veterinarians? *Veterinary Clinics: Small Animal Practice*., **51**, 563–581.

Adin, D.; DeFrancesco, T. C.; Keene, B.; Tou, S.; Meurs, K.; Atkins, C.; Aona, B.; Kurtz, K.; Barron, L.; Saker, K., 2019: Echocardiographic phenotype of canine dilated cardiomyopathy differs based on diet type. *Journal of Veterinary Cardiology*., **21**, 1–9.

Adolphe, J. L.; Drew, M. D.; Huang, Q.; Silver, T. I.; Weber, L. P., 2012: Postprandial impairment of flow-mediated dilation and elevated methylglyoxal after simple but not complex carbohydrate consumption in dogs. *Nutrition Research*., **32**, 278–284.

Adolphe, J. L.; Drew, M. D.; Silver, T. I.; Fouhse, J.; Childs, H.; Weber, L. P., 2015: Effect of an extruded pea or rice diet on postprandial insulin and cardiovascular responses in dogs. *Journal of Animal Physiology and Animal Nutrition*., **99**, 767–776.

Alexander, P.; Brown, C.; Arneth, A.; Dias, C.; Finnigan, J.; Moran, D.; Rounsevell, M. D. A., 2017: Could consumption of insects, cultured meat or imitation meat reduce global agricultural land use? *Global Food Security*., **15**, 22–32.

Alexander, P.; Berri, A.; Moran, D.; Reay, D.; Rounsevell, M. D. A., 2020: The global environmental paw print of pet food. *Global Environmental Change*., **65**, 102153.

Allen, K. E.; Carpenter, C. E.; Walsh, M. K., 2007: Influence of protein level and starch type on an extrusion-expanded whey product. *International Journal of Food Science & Technology*., **42**, 953–960.

Alltech, 2020: 9th Annual Alltech Global Feed Survey 2020.

Alminger, M.; Eklund-Jonsson, C., 2008: Whole-grain cereal products based on a high-fibre barley or oat genotype lower post-prandial glucose and insulin responses in healthy humans. *European Journal of Nutrition*., **47**, 294–300.

Arêas, J. A. G., 1992: Extrusion of food proteins. *Critical Reviews in Food Science and Nutrition*., **32**, 365–392.

Association of Official Analysis Chemists International (AOAC), 2000: Official Methods of Analysis of AOAC International. *Association of Official Analysis Chemists International*.

Bach Knudsen, K. E., 2015: Microbial Degradation of Whole-Grain Complex Carbohydrates and Impact on Short-Chain Fatty Acids and Health. *Advances in Nutrition*., **6**, 206–213.

Backus, R. C.; Cohen, G.; Pion, P. D.; Good, K. L.; Rogers, Q. R.; Fascetti, A. J., 2003: Taurine deficiency in Newfoundlands fed commercially available complete and balanced diets. *Journal of the American Veterinary Medical Association*., **223**, 1130–1136.

Baller, M. A.; Pacheco, P. D. G.; Peres, F. M.; Monti, M.; Carciofi, A. C., 2018: The effects of in-barrel moisture on extrusion parameters, kibble macrostructure, starch gelatinization, and palatability of a cat food. *Animal Feed Science and Technology*., **246**, 82–90.

Baller, M. A.; Marcico, L. A.; Pacheco, P. D. G.; Ribeiro, E. M.; Scarpim, L.; Peres, F. M.; Putarov, T. C.; Carciofi, A. C., 2020: Selenium retention in dog food during extrusion processing. *Proceedings 24th Congress of the European College of Veterinary and Comparative Nutrition*. Munich.

Baller, M. A.; Pacheco, P. D. G.; Vitta-Takahashi, A.; Putarov, T. C.; Vasconcellos, R. S.; Carciofi, A. C., 2021: Effects of thermal energy on extrusion characteristics, digestibility and palatability of a dry pet food for cats. *Journal of Animal Physiology and Animal Nutrition*., **105**, 76–90.

Bazolli, R. S.; Vasconcellos, R. S.; de-Oliveira, L. D.; Sá, F. C.; Pereira, G. T.; Carciofi, A. C., 2015: Effect of the particle size of maize, rice, and sorghum in extruded diets for dogs on starch gelatinization, digestibility, and the fecal concentration of fermentation products1. *Journal of Animal Science*., **93**, 2956–2966.

Belghit, I.; Liland, N. S.; Gjesdal, P.; Biancarosa, I.; Menchetti, E.; Li, Y.; Waagbø, R.; Krogdahl, Å.; Lock, E. J., 2019: Black soldier fly larvae meal can replace fish meal in diets of sea-water phase Atlantic salmon (Salmo salar). *Aquaculture*., **503**, 609–619.

Berardy, A.; Johnston, C. S.; Plukis, A.; Vizcaino, M.; Wharton, C., 2019: Integrating Protein Quality and Quantity with Environmental Impacts in Life Cycle Assessment. *Sustainability*., **11**, 2747.

Bhattacharya, M.; Hanna, M. a., 1985: Extrusion Processing of Wet Corn Gluten Meal. *Journal of Food Science*., **50**, 1508–1509.

Bhattacharya, S.; Das, H.; Bose, A. N., 1988: Effect of extrusion process variables on in-vitro protein digestibility of fish-wheat flour blends. *Food Chemistry*., **28**, 225–231.

Biasato, I.; Renna, M.; Gai, F.; Dabbou, S.; Meneguz, M.; Perona, G.; Martinez, S.; Lajusticia, A. C. B.; Bergagna, S.; Sardi, L.; Capucchio, M. T.; Bressan, E.; Dama, A.; Schiavone, A.; Gasco, L., 2019: Partially defatted black soldier fly larva meal inclusion in piglet diets: Effects on the growth performance, nutrient digestibility, blood profile, gut morphology and histological features. *Journal of Animal Science and Biotechnology*., **10**, 1–11.

Biasato, I.; Ferrocino, I.; Dabbou, S.; Evangelista, R.; Gai, F.; Gasco, L.; Cocolin, L.; Capucchio, M. T.; Schiavone, A., 2020: Black soldier fly and gut health in broiler chickens: Insights into the relationship between cecal microbiota and intestinal mucin composition. *Journal of Animal Science and Biotechnology*., **11**, 11.

Björck, I.; Asp, N. G., 1983: The effects of extrusion cooking on nutritional value — A literature review. *Journal of Food Engineering*., **2**, 281–308.

Bockskopf, A. L.; Kamphues, J., 2015: Influences of poultry slaughter by-products (high in ash and protein) in diets for dogs on nutrient digestibility and faecal quality. *Proceedings 19th European Society of Veterinary and Comparative Nutrition Congress*. Toulouse.

Böhm, T. M. S. A.; Klinger, C. J.; Gedon, N.; Udraite, L.; Hiltenkamp, K.; Mueller, R. S., 2018: Effekt eines Insektenprotein-basierten Futters auf die Symptomatik von futtermittelallergischen Hunden. *Tierarztliche Praxis Ausgabe K: Kleintiere - Heimtiere*., **46**, 297–302.

Bolton, R. N., 2022: The Convergence of Sustainability and Marketing: Transforming Marketing to Respond to a New World. *Australasian Marketing Journal*., **30**, 107–112.

Bosch, G.; Zhang, S.; Oonincx, D. G. A. B.; Hendriks, W. H., 2014: Protein quality of insects as potential ingredients for dog and cat foods. *Journal of Nutritional Science*., **3**, 1–4.

Bosch, G.; Vervoort, J. J. M.; Hendriks, W. H., 2016: In vitro digestibility and fermentability of selected insects for dog foods. *Animal Feed Science and Technology*., **221**, 174–184.

Bosch, G.; Swanson, K. s., 2020: Effect of using insects as feed on animals: pet dogs and cats. *Journal of Insects as Food and Feed*., 1–12.

Briens, J. M.; Subramaniam, M.; Kilgour, A.; Loewen, M. E.; Desai, K. M.; Adolphe, J. L.; Zatti, K. M.; Drew, M. D.; Weber, L. P., 2021: Glycemic, insulinemic and methylglyoxal postprandial responses to starches alone or in whole diets in dogs versus cats: Relating the concept of glycemic index to metabolic responses and gene expression. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*., **257**, 110973.

Brummer, Y.; Kaviani, M.; Tosh, S. M., 2015: Structural and functional characteristics of dietary fibre in beans, lentils, peas and chickpeas. *Food Research International*., **67**, 117–125.

Brunetto, M. A.; Sá, F. C.; Nogueira, S. P.; Gomes, M. de O. S.; Pinarel, A. G.; Jeremias, J. T.; de Paula, F. J. A.; Carciofi, A. C., 2011: The intravenous glucose tolerance and postprandial glucose tests may present different responses in the evaluation of obese dogs. *The British Journal of Nutrition*., **106 Suppl 1**, S194-197.

Buff, P. R.; Carter, R. A.; Bauer, J. E.; Kersey, J. H., 2014: Natural pet food: a review of natural diets and their impact on canine and feline physiology. *Journal of Animal Science*., **92**, 3781–3791.

Bukkens, S. G. F., 2005: Insects in the human diet: nutritional aspects. *Ecological implications of minilivestock: potential of insects, rodents, frogs and snails*., 545–577.

Camire, M. E.; Camire, A.; Krumhar, K., 1990: Chemical and nutritional changes in foods during extrusion. *Critical Reviews in Food Science and Nutrition*., **29**, 35–57.

Camire, M. E.; King, C. C., 1991: Protein and Fiber Supplementation Effects on Extruded Cornmeal Snack Quality. *Journal of Food Science*., **56**, 760–763.

Camire, M. E., 1991: Protein functionality modification by extrusion cooking. *Journal of the American Oil Chemists' Society*., **68**, 200–205.

Carciofi, A. C.; Vasconcellos, R. S.; de Oliveira, L. D.; Brunetto, M. A.; Valério, A. G.; Bazolli, R. S.; Carrilho, E. N. V. M.; Prada, F., 2007: Chromic oxide as a digestibility marker for dogs—A comparison of methods of analysis. *Animal Feed Science and Technology*., **134**, 273–282.

Carciofi, A. C.; Takakura, F. S.; De-Oliveira, L. D.; Teshima, E.; Jeremias, J. T.; Brunetto, M. A.; Prada, F., 2008: Effects of six carbohydrate sources on dog diet digestibility and post-prandial glucose and insulin response*. *Journal of Animal Physiology and Animal Nutrition*., **92**, 326–336.

Carciofi, A. C.; Palagiano, C.; Sá, F. C.; Martins, M. S.; Gonçalves, K. N. V.; Bazolli, R. S.; Souza, D. F.; Vasconcellos, R. S., 2012: Amylase utilization for the extrusion of dog diets. *Animal Feed Science and Technology*., **177**, 211–217.

Carter, R. A.; Bauer, J. E.; Kersey, J. H.; Buff, P. R., 2014: Awareness and evaluation of natural pet food products in the United States. *Journal of the American Veterinary Medical Association*., **245**, 1241–1248.

Carvalho, C. W. P.; Takeiti, C. Y.; Onwulata, C. I.; Pordesimo, L. O., 2010: Relative effect of particle size on the physical properties of corn meal extrudates: Effect of particle size on the extrusion of corn meal. *Journal of Food Engineering*., **98**, 103–109.

Challacombe, C. A.; Seetharaman, K.; Duizer, L. M., 2011: Sensory Characteristics and Consumer Acceptance of Bread and Cracker Products Made from Red or White Wheat. *Journal of Food Science*., **76**, S337–S346.

Chassagne-Berces, S.; Leitner, M.; Melado, A.; Barreiro, P.; Correa, E. C.; Blank, I.; Gumy, J. C.; Chanvrier, H., 2011: Effect of fibers and whole grain content on quality attributes of extruded cereals. *Procedia Food Science*., 11th International Congress on Engineering and Food (ICEF11), **1**, 17–23.

Chauhan, G. S.; Bains, G. S., 1985: Effect of granularity on the characteristics of extruded rice snack. *International Journal of Food Science & Technology*., **20**, 305–309.

Cheftel, J. C., 1986: Nutritional effects of extrusion-cooking. *Food Chemistry*., **20**, 263–283.

Chen, J.; Li, Y.; Tian, Y.; Huang, C.; Li, D.; Zhong, Q.; Ma, X., 2015: Interaction between Microbes and Host Intestinal Health: Modulation by Dietary Nutrients and Gut-Brain-Endocrine-Immune Axis. *Current Protein & Peptide Science*., **16**, 592–603.

Chuppava, B.; Siebert, D. C.; Visscher, C.; Kamphues, J.; Abd El-Wahab, A., 2023: Impact of Animal By-Products on Diet Digestibility and Fecal Quality in Beagle Dogs. *Life*., **13**, 850.

Clark, M.; Hoenig, M., 2016: Metabolic Effects of Obesity and Its Interaction with Endocrine Diseases. *Veterinary Clinics: Small Animal Practice*., **46**, 797–815.

Clark, M.; Tilman, D., 2017: Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice. *Environmental Research Letters*., **12**, 064016.

Colgrave, M. L.; Allingham, P. G.; Tyrrell, K.; Jones, A., 2012: Multiple reaction monitoring for the accurate quantification of amino acids: Using hydroxyproline to estimate collagen content. *Methods in Molecular Biology*., **828**, 291–303.

Colonna, P.; Tayeb, J.; Mercier, C., 1989: *Extrusion cooking of starch and starchy products*. St. Paul, MN, American Association of Cereal Chemists, Inc.

Commission, E., 2017: Commission Regulation (EU) 2017/2279 of 11 December 2017 amending Annexes II, IV, VI, VII and VIII to Regulation (EC) No 767/2009 of the European Parliament and of the Council on the placing on the market and use of feed (Text with EEA relevance.) C/2017. *Official Journal of the European Union*.

Corsato Alvarenga, I.; Aldrich, C. G., 2019: The Effect of Increasing Levels of Dehulled Faba Beans (Vicia faba L.) on Extrusion and Product Parameters for Dry Expanded Dog Food. *Foods*., **8**, 26.

Corsato Alvarenga, I.; Holt, D.; Aldrich, C. G., 2020a: Evaluation of faba beans as an ingredient in dog diets: apparent total tract digestibility of extruded diets with graded levels of dehulled faba beans (Vicia faba L.) by dogs. *Journal of Animal Science*., **98**, 1–8.

Corsato Alvarenga, I.; Aldrich, C. G., 2020b: Starch characterization of commercial extruded dry pet foods. *Translational Animal Science*., **4**, 1017–1022.

Corsato Alvarenga, I.; Aldrich, C. G.; Shi, Y. C., 2021: Factors affecting digestibility of starches and their implications on adult dog health. *Animal Feed Science and Technology*., **282**, 115134.

Cummings, J. H.; Englyst, H. N., 1987: Fermentation in the human large intestine and the available substrates. *The American Journal of Clinical Nutrition*., **45**, 1243–1255.

Cutrignelli, M. I.; Messina, M.; Tulli, F.; Randazzi, B.; Olivotto, I.; Gasco, L.; Loponte, R.; Bovera, F., 2018: Evaluation of an insect meal of the Black Soldier Fly (Hermetia illucens) as soybean substitute: Intestinal morphometry, enzymatic and microbial activity in laying hens. *Research in Veterinary Science*., **117**, 209–215.

Denardin, C. C.; Boufleur, N.; Reckziegel, P.; Silva, L. P. da; Walter, M., 2012: Amylose content in rice (Oryza sativa) affects performance, glycemic and lipidic metabolism in rats. *Ciência Rural*., **42**, 381–387.

Desury, G.; Moulinoux, J. P.; Delcros, J. G., 2002: Alteration of intestinal putrescine uptake in tumour-bearing rats. *International Journal of Oncology*., **21**, 569–576.

Dhital, S.; Warren, F. J.; Butterworth, P. J.; Ellis, P. R.; Gidley, M. J., 2017: Mechanisms of starch digestion by α-amylase—Structural basis for kinetic properties. *Critical Reviews in Food Science and Nutrition*., **57**, 875–892.

Diener, S.; Zurbrügg, C.; Tockner, K., 2009: Conversion of organic material by black soldier fly larvae: Establishing optimal feeding rates. *Waste Management and Research*., **27**, 603–610.

Ding, Q. B.; Ainsworth, P.; Tucker, G.; Marson, H., 2005: The effect of extrusion conditions on the physicochemical properties and sensory characteristics of rice-based expanded snacks. *Journal of Food Engineering*., **66**, 283–289.

Do, S.; Koutsos, L.; Utterback, P. L.; Parsons, C. M.; de Godoy, M. R. C.; Swanson, K. S., 2020: Nutrient and AA digestibility of black soldier fly larvae differing in age using the precision-fed cecectomized rooster assay1. *Journal of Animal Science*., **98**, skz363.

Domingues, L.; Murakami, F.; Zattoni, D.; Kaelle, G.; de Oliveira, S.; Félix, A., 2019: Effect of potato on kibble characteristics and diet digestibility and palatability to adult dogs and puppies. *Italian Journal of Animal Science*., **18**, 292–300.

Dunsford, B.; Plattner, B.; Greenbury, B.; Rockey, G., 2002: The influence of extrusion processing on petfood palatability. *Proceedings of Petfood Forum*. Watt Publishing, Inc., Mt. Morris, Illinois, USA, Chicago, Illinois, USA.

Dust, J. M.; Gajda, A. M.; Flickinger, E. A.; Burkhalter, T. M.; Merchen, N. R.; Fahey, G. C., 2004: Extrusion Conditions Affect Chemical Composition and in Vitro Digestion of Select Food Ingredients. *Journal of Agricultural and Food Chemistry*., **52**, 2989–2996.

Erwin, E. S.; Marco, G. J.; Emery, E. M., 1961: Volatile Fatty Acid Analyses of Blood and Rumen Fluid by Gas Chromatography. *Journal of Dairy Science*., **44**, 1768–1771.

European Commission, 2011: COMMISSION REGULATION (EU) No 142/2011 of 25 February 2011 implementing Regulation (EC) No 1069/2009 of the European Parliament and of the Council laying down health rules as regards animal by-products and derived products not intended for human consumption and implementing Council Directive 97/78/EC as regards certain samples and items exempt from veterinary checks at the border under that Directive. *Official Journal of the European Union*.

European Commission, 2020: COMMISSION REGULATION (EU) 2020/354 of 4 March 2020 establishing a list of intended uses of feed intended for particular nutritional purposes and repealing Directive 2008/38/EC. *Official Journal of the European Union*.

Fan, P.; Li, L.; Rezaei, A.; Eslamfam, S.; Che, D.; Ma, X., 2015: Metabolites of Dietary Protein and Peptides by Intestinal Microbes and their Impacts on Gut. *Current Protein & Peptide Science*., **16**, 646–654.

Fan, P.; Song, P.; Li, L.; Huang, C.; Chen, J.; Yang, W.; Qiao, S.; Wu, G.; Zhang, G.; Ma, X., 2017: Roles of Biogenic Amines in Intestinal Signaling. *Current Protein & Peptide Science*., **18**, 532–540.

FAO, 2009: How to Feed the World in 2050. *Insights from an expert meeting at FAO*., 1–35.

Fapojuwo, O. O.; Maga, J. A.; Jansen, G. R., 1987: Effect of Extrusion Cooking on in Vitro Protein Digestibility of Sorghum. *Journal of Food Science*., **52**, 218–219.

FDA, C. for V., 2018: FDA Investigating Potential Connection Between Diet and Cases of Canine Heart Disease. *FDA*.

FEDIAF, 2020: Nutritional Guidelines for Complete and Complementary Pet Food for Cats and Dogs. *Nutritional Guidelines - For Complete and Complementary Pet Food for a Cats and Dogs*.

Félix, A. P.; Souza, C. M. M.; de Oliveira, S. G., 2022: Biomarkers of gastrointestinal functionality in dogs: A systematic review and meta-analysis. *Animal Feed Science and Technology*., **283**, 115183.

Fernandez, I. M.; Silva, M.; Schuch, R.; Walker, W. A.; Siber, A. M.; Maurelli, A. T.; McCormick, B. A., 2001: Cadaverine prevents the escape of Shigella flexneri from the phagolysosome: a connection between bacterial dissemination and neutrophil transepithelial signaling. *The Journal of Infectious Diseases*., **184**, 743–753.

Finke, M. D., 2007: Estimate of chitin in raw whole insects. *Zoo Biology*., **26**, 105–115.

Fischer, M. M.; Kessler, A. M.; de Sá, L. R. M.; Vasconcellos, R. S.; Filho, F. O. R.; Nogueira, S. P.; Oliveira, M. C. C.; Carciofi, A. C., 2012: Fiber fermentability effects on energy and macronutrient digestibility, fecal traits, postprandial metabolite responses, and colon histology of overweight cats. *Journal of Animal Science*., **90**, 2233–2245.

Food and Agriculture Organization of the United Nations, 2013: *Edible insects. Future prospects for food and feed security*. *Food and Agriculture Organization of the United Nations*., Vol. 171.

Freel, T. A.; McComb, A.; Koutsos, E. A., 2021: Digestibility and safety of dry black soldier fly larvae (BSFL) meal and BSFL oil in dogs. *Journal of Animal Science*.

Freid, K. J.; Freeman, L. M.; Rush, J. E.; Cunningham, S. M.; Davis, M. S.; Karlin, E. T.; Yang, V. K., 2021: Retrospective study of dilated cardiomyopathy in dogs. *Journal of Veterinary Internal Medicine*., **35**, 58–67.

Fróna, D.; Szenderák, J.; Harangi-Rákos, M., 2019: The challenge of feeding the world. *Sustainability (Switzerland)*., **11**, 5816.

Fuentes-Zaragoza, E.; Riquelme-Navarrete, M. J.; Sánchez-Zapata, E.; Pérez-Álvarez, J. A., 2010: Resistant starch as functional ingredient: A review. *Food Research International*., **43**, 931–942.

García-Mora, P.; Martín-Martínez, M.; Angeles Bonache, M.; González-Múniz, R.; Peñas, E.; Frias, J.; Martinez-Villaluenga, C., 2017: Identification, functional gastrointestinal stability and molecular docking studies of lentil peptides with dual antioxidant and angiotensin I converting enzyme inhibitory activities. *Food Chemistry*., **221**, 464–472.

García-Rico, L.; Ramos Ruiz, R. E.; Gutiérrez Coronado, L., 1999: Use of microwave digestion and atomic absorption spectrophotometry to determine chromic oxide as a digestibility marker in feed, feces, and ileal content. *Journal of AOAC International*., **82**, 575–578.

Gariglio, M.; Dabbou, S.; Biasato, I.; Capucchio, M. T.; Colombino, E.; Hernández, F.; Madrid, J.; Martínez, S.; Gai, F.; Caimi, C.; Oddon, S. B.; Meneguz, M.; Trocino, A.; Vincenzi, R.; Gasco, L.; Schiavone, A., 2019: Nutritional effects of the dietary inclusion of partially defatted Hermetia illucens larva meal in Muscovy duck. *Journal of Animal Science and Biotechnology*., **10**, 37.

Gasco, L.; Finke, M.; van Huis, A., 2018: Can diets containing insects promote animal health? *Journal of Insects as Food and Feed*., **4**, 1–4.

Gasco, L.; Biasato, I.; Dabbou, S.; Schiavone, A.; Gai, F., 2019: Animals fed insect-based diets: State-of-the-art on digestibility, performance and product quality. *Animals*., **9**, 1–32.

Gemen, R.; de Vries, J. F.; Slavin, J. L., 2011: Relationship between molecular structure of cereal dietary fiber and health effects: focus on glucose/insulin response and gut health. *Nutrition Reviews*., **69**, 22–33.

German, A. J., 2006: The growing problem of obesity in dogs and cats. *The Journal of Nutrition*., **136**, 1940S-1946S.

Ginty, D. D.; Osborne, D. L.; Seidel, E. R., 1989: Putrescine stimulates DNA synthesis in intestinal epithelial cells. *The American Journal of Physiology*., **257**, G145-150.

Girdhar, S. R.; Barta, J. R.; Santoyo, F. A.; Smith, T. K., 2006: Dietary putrescine (1,4-diaminobutane) influences recovery of Turkey poults challenged with a mixed coccidial infection. *The Journal of Nutrition*., **136**, 2319–2324.

Griffin, R. W., 2003: Section IV: Palatability. In: Kvamme, J.L., Phillips, T.D. (Eds.), 1st ed. , IL, USA, pp. 176-193. In: Kvamme, J. L. & Phillips, T.D. (eds.), *Petfood technology*. 1st edn. Watt Publishing Co. Mt Morris, IL (USA), pp. 176–193.

Guy, R., 2001: *Extrusion Cooking: Technologies and Applications*. Woodhead Publishing.

Hackman, J. C.; Holohean, A. M., 2010: The effects of polyamine agonists and antagonists on N-methyl-d-aspartate-induced depolarizations of amphibian motoneurons in situ. *Brain Research*., **1325**, 10–18.

Hand, M. S.; Thatcher, C. D.; Remillard, R. L.; Roudebush, P.; Novotny, B. J., 2010: Macronutrients. *Small Animal Clinical Nutrition*. 5th edn. Mark Morris Institute, pp. 49–105.

Haralampu, S. G., 2000: Resistant starch—a review of the physical properties and biological impact of RS3. *Carbohydrate Polymers*., **41**, 285–292.

He, Y.; Yang, X.; Jiao, M.; Anoopkumar-Dukie, S.; Zeng, Y.; Mei, H., 2019: Housefly (Musca domestica) larvae powder, preventing oxidative stress injury via regulation of UCP4 and CyclinD1 and modulation of JNK and P38 signaling in APP/PS1 mice. *Food & Function*., **10**, 235–243.

Hendrix, D. L., 1993: Rapid Extraction and Analysis of Nonstructural Carbohydrates in Plant Tissues. *Crop Science*., **33**, cropsci1993.0011183X003300060037x.

Herschel, D. A.; Argenzio, R. A.; Southworth, M.; Stevens, C. E., 1981: Absorption of volatile fatty acid, Na, and H2O by the colon of the dog. *American Journal of Veterinary Research*., **42**, 1118–1124.

Hervera, M.; Baucells, M. D.; Blanch, F.; Castrillo, C., 2007: Prediction of digestible energy content of extruded dog food by in vitro analyses. *Journal of Animal Physiology and Animal Nutrition*., **91**, 205–209.

Hervera, M.; Baucells, M. D.; González, G.; Pérez, E.; Castrillo, C., 2009: Prediction of digestible protein content of dry extruded dog foods: Comparison of methods. *Journal of Animal Physiology and Animal Nutrition*., **93**, 366–372.

Heugten, E. van; Martinez, G.; McComb, A.; Koutsos, E., 2019: 285 Black soldier fly (Hermetia illucens) larvae oil improves growth performance of nursery pigs. *Journal of Animal Science*., **97**, 118–118.

Holscher, H. D., 2017: Dietary fiber and prebiotics and the gastrointestinal microbiota. *Gut Microbes*., **8**, 172–184.

Hoyles, L.; Snelling, T.; Umlai, U. K.; Nicholson, J. K.; Carding, S. R.; Glen, R. C.; McArthur, S., 2018: Microbiome–host systems interactions: protective effects of propionate upon the blood–brain barrier. *Microbiome*., **6**, 55.

Hu, P.; Zhao, H.; Duan, Z.; Linlin, Z.; Wu, D., 2004: Starch digestibility and the estimated glycemic score of different types of rice differing in amylose contents. *Journal of Cereal Science*., **40**, 231–237.

Hullar, I.; Fekete, S.; Szöcs, Z., 1998: Effect of extrusion on the quality of soybean-based catfood. *Journal of Animal Physiology and Animal Nutrition*., **80**, 201–206.

Hussein, H. S.; Flickinger, E. A.; Fahey, G. C., 1999: Petfood applications of inulin and oligofructose. *The Journal of Nutrition*., **129**, 1454S-6S.

Janssen, R. H.; Vincken, J. P.; Van Den Broek, L. A. M.; Fogliano, V.; Lakemond, C. M. M., 2017: Nitrogen-to-Protein Conversion Factors for Three Edible Insects: Tenebrio molitor, Alphitobius diaperinus, and Hermetia illucens. *Journal of Agricultural and Food Chemistry*., **65**, 2275–2278.

Jarpa-Parra, M., 2018: Lentil protein: a review of functional properties and food application. An overview of lentil protein functionality. *International Journal of Food Science & Technology*., **53**, 892–903.

Jeaurond, E. A.; Rademacher, M.; Pluske, J. R.; Zhu, C. H.; de Lange, C. F. M., 2008: Impact of feeding fermentable proteins and carbohydrates on growth performance, gut health and gastrointestinal function of newly weaned pigs. *Canadian Journal of Animal Science*., **88**, 271–281.

Jian, S.; Zhang, L.; Ding, N.; Yang, K.; Xin, Z.; Hu, M.; Zhou, Z.; Zhao, Z.; Deng, B.; Deng, J., 2022: Effects of black soldier fly larvae as protein or fat sources on apparent nutrient digestibility, fecal microbiota, and metabolic profiles in beagle dogs. *Frontiers in Microbiology*., **13**, 1044986.

Jiminez, J. A.; Uwiera, T. C.; Abbott, D. W.; Uwiera, R. R. E.; Inglis, G. D., 2017: Butyrate Supplementation at High Concentrations Alters Enteric Bacterial Communities and Reduces Intestinal Inflammation in Mice Infected with Citrobacter rodentium. *mSphere*., **2**, e00243-17.

Kaplan, J. L.; Stern, J. A.; Fascetti, A. J.; Larsen, J. A.; Skolnik, H.; Peddle, G. D.; Kienle, R. D.; Waxman, A.; Cocchiaro, M.; Gunther-Harrington, C. T.; Klose, T.; LaFauci, K.; Lefbom, B.; Machen Lamy, M.; Malakoff, R.; Nishimura, S.; Oldach, M.; Rosenthal, S.; Stauthammer, C. et al., 2018: Taurine deficiency and dilated cardiomyopathy in golden retrievers fed commercial diets. *PloS One*., **13**, e0209112.

Karkle, E. L.; Alavi, S.; Dogan, H., 2012a: Cellular architecture and its relationship with mechanical properties in expanded extrudates containing apple pomace. *Food Research International*., **46**, 10–21.

Karkle, E. L.; Keller, L.; Dogan, H.; Alavi, S., 2012b: Matrix transformation in fiber-added extruded products: Impact of different hydration regimens on texture, microstructure and digestibility. *Journal of Food Engineering*., **108**, 171–182.

Kawauchi, I. M.; Sakomura, N. K.; Vasconcellos, R. S.; de-Oliveira, L. D.; Gomes, M. O. S.; Loureiro, B. A.; Carciofi, A. C., 2011: Digestibility and metabolizable energy of maize gluten feed for dogs as measured by two different techniques. *Animal Feed Science and Technology*., **169**, 96–103.

Kempe, R.; Saastamoinen, M.; Hyyppä, S., 2004: Composition, digestibility and nutritive value of cereals for dogs. *Agricultural and Food Science*., **13**, 5–17.

Killeit, U., 1994: Vitamin retention in extrusion cooking. *Food Chemistry*., **49**, 149–155.

Knight, A.; Leitsberger, M., 2016: Vegetarian versus Meat-Based Diets for Companion Animals. *Animals*., **6**, 57.

Knutson, C. A., 1986: A simplified colorimetric procedure for determination of amylose in maize starches. *A simplified colorimetric procedure for determination of amylose in maize starches*., **63**, 89–92.

Kolar, K., 1990: Colorimetric determination of hydroxyproline as measure of collagen content in meat and meat products: NMKL collaborative study. *Journal of the Association of Official Analytical Chemists*., **73**, 54–57.

Kouřimská, L.; Adámková, A., 2016: Nutritional and sensory quality of edible insects. *NFS Journal*., **4**, 22–26.

Krestel-Rickert, D., 2005: Premixes add value to petfood. *Feed mix*.

Kröger, S.; Heide, C.; Zentek, J., 2020: Evaluation of an extruded diet for adult dogs containing larvae meal from the Black soldier fly (Hermetia illucens). *Animal Feed Science and Technology*., **270**, 114699.

Kvamme, J. L.; Phillips, T. D., 2003: *Petfood technology*. Watt Publishing Company, Mount Morris, IL.

Laflamme, D., 1997: Development and validation of a body condition score system for dogs. *Canine practice*., **22**, 10–15.

Laflamme, D. P.; Abood, S. K.; Fascetti, A. J.; Fleeman, L. M.; Freeman, L. M.; Michel, K. E.; Bauer, C.; Kemp, B. L. E.; Doren, J. R. V.; Willoughby, K. N., 2008: Pet feeding practices of dog and cat owners in the United States and Australia. *Journal of the American Veterinary Medical Association*., **232**, 687–694.

Laleg, K.; Cassan, D.; Barron, C.; Prabhasankar, P.; Micard, V., 2016: Structural, Culinary, Nutritional and Anti-Nutritional Properties of High Protein, Gluten Free, 100% Legume Pasta. *PLOS ONE*., **11**, e0160721.

Lankhorst, C.; Tran, Q. D.; Havenaar, R.; Hendriks, W. H.; van der Poel, A. F. B., 2007: The effect of extrusion on the nutritional value of canine diets as assessed by in vitro indicators. *Animal Feed Science and Technology*., **138**, 285–297.

Legrand-Defretin, V., 1994: Differences between cats and dogs: a nutritional view. *Proceedings of the Nutrition Society*., **53**, 15–24.

Lei, X. J.; Kim, T. H.; Park, J. H.; Kim, I. H., 2019: Evaluation of Supplementation of Defatted Black Soldier Fly (Hermetia illucens) Larvae Meal in Beagle Dogs. *Annals of Animal Science*., **19**, 767–777.

Leriche, I.; Chala, V.; Ereau, C., 2017: Pet owners' perception of insects as a protein source for cats and dogs. *Proceedings XI Southern European Veterinary Conference*. Barcelona.

Lew, V. L.; Daw, N.; Etzion, Z.; Tiffert, T.; Muoma, A.; Vanagas, L.; Bookchin, R. M., 2007: Effects of age-dependent membrane transport changes on the homeostasis of senescent human red blood cells. *Blood*., **110**, 1334–1342.

Li, P.; Wu, G., 2020: Composition of amino acids and related nitrogenous nutrients in feedstuffs for animal diets. *Amino Acids*., **52**, 523–542.

Lin, S.; Hsieh, F.; Huff, H. E., 1997: Effects of Lipids and Processing Conditions on Degree of Starch Gelatinization of Extruded Dry Pet Food. *LWT - Food Science and Technology*., **30**, 754–761.

Lin, S.; Hsieh, F.; Huff, H. E., 1998: Effects of lipids and processing conditions on lipid oxidation of extruded dry pet food during storage1Contribution from the Missouri Agricultural Experiment Station, Journal Series No. 12590.1. *Animal Feed Science and Technology*., **71**, 283–294.

Longvah, T.; Mangthya, K.; Ramulu, P., 2011: Nutrient composition and protein quality evaluation of eri silkworm (Samia ricinii) prepupae and pupae. *Food Chemistry*., **128**, 400–403.

Lopez-Santamarina, A.; Mondragon, A. del C.; Lamas, A.; Miranda, J. M.; Franco, C. M.; Cepeda, A., 2020: Animal-Origin Prebiotics Based on Chitin: An Alternative for the Future? A Critical Review. *Foods*., **9**, 782.

Lue, S.; Huff, H. E., 1991: Extrusion cooking of corn meal and sugar beet fiber: effects on expansion properties, starch gelatinization, and dietary fiber content. *Cereal chemistry (USA)*.

Madrid, J.; Villodre, C.; Valera, L.; Orengo, J.; Martínez, S.; López, M. J.; Megías, M. D.; Hernández, F., 2013: Effect of crude glycerin on feed manufacturing, growth performance, plasma metabolites, and nutrient digestibility of growing-finishing pigs. *Journal of Animal Science*., **91**, 3788–3795.

Makkar, H. P. S.; Ankers, P., 2014a: Towards sustainable animal diets: A survey-based study. *Animal Feed Science and Technology*., **198**, 309–322.

Makkar, H. P. S.; Tran, G.; Heuzé, V.; Ankers, P., 2014b: State-of-the-art on use of insects as animal feed. *Animal Feed Science and Technology*., **197**, 1–33.

Maria, A. P. J.; Ayane, L.; Putarov, T. C.; Loureiro, B. A.; Neto, B. P.; Casagrande, M. F.; Gomes, M. O. S.; Glória, M. B. A.; Carciofi, A. C., 2017: The effect of age and carbohydrate and protein sources on digestibility, fecal microbiota, fermentation products, fecal IgA, and immunological blood parameters in dogs. *Journal of Animal Science*., **95**, 2452–2466.

Marinangeli, C. P. F.; Curran, J.; Barr, S. I.; Slavin, J.; Puri, S.; Swaminathan, S.; Tapsell, L.; Patterson, C. A., 2017: Enhancing nutrition with pulses: defining a recommended serving size for adults. *Nutrition Reviews*., **75**, 990–1006.

Mariotti, F.; Tomé, D.; Mirand, P. P., 2008: Converting nitrogen into protein - Beyond 6.25 and Jones' factors. *Critical Reviews in Food Science and Nutrition*., **48**, 177–184.

Marono, S.; Loponte, R.; Lombardi, P.; Vassalotti, G.; Pero, M. E.; Russo, F.; Gasco, L.; Parisi, G.; Piccolo, G.; Nizza, S.; Di Meo, C.; Attia, Y. A.; Bovera, F., 2017: Productive performance and blood profiles of laying hens fed Hermetia illucens larvae meal as total replacement of soybean meal from 24 to 45 weeks of age. *Poultry Science*., **96**, 1783–1790.

Mathew, J. M.; Hoseney, R. C.; Faubion, J. M., 1999: Effects of Corn Hybrid and Growth Environment on Corn Curl and Pet Food Extrudates. *Cereal Chemistry*., **76**, 625–628.

Matterson, L. D.; Potter, L. M.; Stutz, M. W.; Singsen, E. P., 1965: The metabolizable energy of feed ingredients for chickens. *The metabolizable energy of feed ingredients for chickens.*

McCarthy, B.; Liu, H. B., 2017: Food waste and the 'green' consumer. *Australasian Marketing Journal (AMJ)*., Special Issue on Sustainability, **25**, 126–132.

McCarthy, B.; Kapetanaki, A. B.; Wang, P., 2020: Completing the food waste management loop: Is there market potential for value-added surplus products (VASP)? *Journal of Cleaner Production*., **256**, 120435.

McCauley, S. R.; Clark, S. D.; Quest, B. W.; Streeter, R. M.; Oxford, E. M., 2020: Review of canine dilated cardiomyopathy in the wake of diet-associated concerns. *Journal of Animal Science*., **98**, skaa155.

McCormick, B. A.; Fernandez, M. I.; Siber, A. M.; Maurelli, A. T., 1999: Inhibition of Shigella flexneri-induced transepithelial migration of polymorphonuclear leucocytes by cadaverine. *Cellular Microbiology*., **1**, 143–155.

Meeker, D. L.; Meisinger, J. L., 2015: Companion animals symposium: Rendered ingredients significantly influence sustainability, quality, and safety of pet food. *Journal of Animal Science*., **93**, 835–847.

Mendonça, S.; Grossmann, M. V. E.; Verhé, R., 2000: Corn Bran as a Fibre Source in Expanded Snacks. *LWT - Food Science and Technology*., **33**, 2–8.

Messia, M. C.; Marconi, E., 2012: Innovative and rapid procedure for 4-hydroxyproline determination in meat-based foods. *Methods in Molecular Biology*., **828**, 281–289.

Middelbos, I. S.; Godoy, M. R.; Fastinger, N. D.; Fahey, G. C., 2007: A dose-response evaluation of spray-dried yeast cell wall supplementation of diets fed to adult dogs: Effects on nutrient digestibility, immune indices, and fecal microbial populations. *Journal of Animal Science*., **85**, 3022–3032.

Monti, M.; Gibson, M.; Loureiro, B. A.; Sá, F. C.; Putarov, T. C.; Villaverde, C.; Alavi, S.; Carciofi, A. C., 2016: Influence of dietary fiber on macrostructure and processing traits of extruded dog foods. *Animal Feed Science and Technology*., **220**, 93–102.

Moore, M. L.; Fottler, H. J.; Fahey, G. C., Jr.; Corbin, J. E., 1980: Utilization of Corn-Soybean Meal-Substituted Diets by Dogs. *Journal of Animal Science*., **50**, 892–896.

Moreau, N. M.; Martin, L. J.; Toquet, C. S.; Laboisse, C. L.; Nguyen, P. G.; Siliart, B. S.; Dumon, H. J.; Champ, M. M. J., 2003: Restoration of the integrity of rat caeco-colonic mucosa by resistant starch, but not by fructo-oligosaccharides, in dextran sulfate sodium-induced experimental colitis. *The British Journal of Nutrition*., **90**, 75–85.

Moruzzo, R.; Mancini, S.; Boncinelli, F.; Riccioli, F., 2021: Exploring the Acceptance of Entomophagy: A Survey of Italian Consumers. *Insects*., **12**, 123.

Murray, S. M.; Fahey, G. C., Jr.; Merchen, N. R.; Sunvold, G. D.; Reinhart, G. A., 1999: Evaluation of selected high-starch flours as ingredients in canine diets. *Journal of Animal Science*., **77**, 2180–2186.

Nafisah, A.; Nahrowi; Mutia, R.; Jayanegara, A., 2019: Chemical composition, chitin and cell wall nitrogen content of Black Soldier Fly (Hermetia illucens) larvae after physical and biological treatment. *IOP Conference Series: Materials Science and Engineering*., Vol. 546.

Nery, J.; Gasco, L.; Dabbou, S.; Schiavone, A., 2018: Protein composition and digestibility of black soldier fly larvae in broiler chickens revisited according to the recent nitrogen-protein conversion ratio. *Journal of Insects as Food and Feed*., **4**, 171–177.

Nguyen, P.; Dumon, H.; Biourge, V.; Pouteau, E., 1998: Glycemic and Insulinemic Responses after Ingestion of Commercial Foods in Healthy Dogs: Influence of Food Composition. *The Journal of Nutrition*., **128**, 2654S-2658S.

Nijdam, D.; Rood, T.; Westhoek, H., 2012: The price of protein: Review of land use and carbon footprints from life cycle assessments of animal food products and their substitutes. *Food Policy*., **37**, 760–770.

NRC, 2006: *Nutrient requirements of Dogs and Cats* sixth Ed. The National Academies Press, Washington DC.

Nugent, A. P., 2005: Health properties of resistant starch. *Nutrition Bulletin*., **30**, 27–54.

Okin, G. S., 2017: Environmental impacts of food consumption by dogs and cats. (Crowther, M. S., Ed.)*PLoS ONE*., **12**, e0181301.

Onwulata, C. I.; Smith, P. W.; Konstance, R. P.; Holsinger, V. H., 2001: Incorporation of whey products in extruded corn, potato or rice snacks☆☆Mention of brand or firm name does not constitute an endorsement by the US Department of Agriculture above others of a similar nature not mentioned. *Food Research International*., **34**, 679–687.

Oonincx, D. G. A. B.; Van Broekhoven, S.; Van Huis, A.; Van Loon, J. J. A., 2015: Feed conversion, survival and development, and composition of four insect species on diets composed of food by-products. (Papadopoulos, N. T., Ed.)*PLoS ONE*., **10**, e0144601.

Pacheco, P. D. G.; Putarov, T. C.; Baller, M. A.; Peres, F. M.; Loureiro, B. A.; Carciofi, A. C., 2018: Thermal energy application on extrusion and nutritional characteristics of dog foods. *Animal Feed Science and Technology*., **243**, 52–63.

Pacheco, P. D. G., 2020: *Fontes de amido e fibra solúvel em dietas para cães e seus efeitos no processo de extrusão, qualidade dos kibbles e metabolismo*. UNESP, Jaboticabal, Brazil.

Pagani, E.; Russo, N.; Schiavone, A.; Prola, L., 2016: Veterinary practitioners perception of insects as protein source for pets. *Proceedings 20th European Society of Veterinary and Comparative Nutrition Congress*. Berlin, p. 194.

Pansawat, N.; Jangchud, K.; Jangchud, A.; Wuttijumnong, P.; Saalia, F. K.; Eitenmiller, R. R.; Phillips, R. D., 2008: Effects of extrusion conditions on secondary extrusion variables and physical properties of fish, rice-based snacks. *LWT - Food Science and Technology*., **41**, 632–641.

Peixoto, M. C.; Ribeiro, É. M.; Maria, A. P. J.; Loureiro, B. A.; di Santo, L. G.; Putarov, T. C.; Yoshitoshi, F. N.; Pereira, G. T.; Sá, L. R. M.; Carciofi, A. C., 2018: Effect of resistant starch on the intestinal health of old dogs: fermentation products and histological features of the intestinal mucosa. *Journal of Animal Physiology and Animal Nutrition*., **102**, e111–e121.

Penazzi, L.; Schiavone, A.; Russo, N.; Nery, J.; Valle, E.; Madrid, J.; Martinez, S.; Hernandez, F.; Pagani, E.; Ala, U.; Prola, L., 2021: In vivo and in vitro Digestibility of an Extruded Complete Dog Food Containing Black Soldier Fly (Hermetia illucens) Larvae Meal as Protein Source. *Frontiers in Veterinary Science*., **8**.

Peng, P.; Xu, J.; Chen, W.; Tangara, M.; Qi, Z. L.; Peng, J., 2010: Effects of early feeding and exogenous putrescine on growth and small intestinal development in posthatch ducks. *British Poultry Science*., **51**, 101–108.

Pezzali, J. G.; Aldrich, C. G., 2019: Effect of ancient grains and grain-free carbohydrate sources on extrusion parameters and nutrient utilization by dogs. *Journal of Animal Science*., **97**, 3758–3767.

Pryce, J. D., 1969: A modification of the Barker-Summerson method for the determination of lactic acid. *Analyst*., **94**, 1151–1152.

Quilliam, C.; Ren, Y.; Morris, T.; Ai, Y.; Weber, L. P., 2021: The Effects of 7 Days of Feeding Pulse-Based Diets on Digestibility, Glycemic Response and Taurine Levels in Domestic Dogs. *Frontiers in Veterinary Science*., **8**.

R Core Team, 2019: : A language and environment for statistical computing. *R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.*

Rangachari, P. K., 1992: Histamine: mercurial messenger in the gut. *American Journal of Physiology-Gastrointestinal and Liver Physiology*., **262**, G1–G13.

Rankovic, A.; Adolphe, J. L.; Ramdath, D. D.; Shoveller, A. K.; Verbrugghe, A., 2020: Glycemic response in nonracing sled dogs fed single starch ingredients and commercial extruded dog foods with different carbohydrate sources. *Journal of Animal Science*., **98**, skaa241.

Rapporto Assalco-Zoomark, 2023: Rapporto Assalco-Zoomark 2023. Alimentazione e Cura degli Animali da Compagnia. https://www.assalco.it/archivio10_documento-generico_0_1338.html.

Reilly, L. M.; He, F.; Rodriguez-Zas, S. L.; Southey, B. R.; Hoke, J. M.; Davenport, G. M.; de Godoy, M. R. C., 2021: Use of Legumes and Yeast as Novel Dietary Protein Sources in Extruded Canine Diets. *Frontiers in Veterinary Science*., **8**.

Renna, M.; Schiavone, A.; Gai, F.; Dabbou, S.; Lussiana, C.; Malfatto, V.; Prearo, M.; Capucchio, M. T.; Biasato, I.; Biasibetti, E.; De Marco, M.; Brugiapaglia, A.; Zoccarato, I.; Gasco, L., 2017: Evaluation of the suitability of a partially defatted black soldier fly (Hermetia illucens L.) larvae meal as ingredient for rainbow trout (Oncorhynchus mykiss Walbaum) diets. *Journal of Animal Science and Biotechnology*., **8**, 57.

Riaz, M. N., 2000a: *Extruders in food applications*. CRC Press, Florida.

Riaz, M. N., 2000b: Mass and energy evaluation in extrusion systems. *Extruder Food Application*. CRC Press, Florida.

Riaz, M. N., 2007: *Extruders and Expanders in Pet Food, Aquatic and Livestock Feeds*. AgriMedia.

Riaz, M. N.; Asif, M.; Ali, R., 2009: Stability of Vitamins during Extrusion. *Critical Reviews in Food Science and Nutrition*., **49**, 361–368.

Riaz, M. N.; Rokey, G. J., 2012: *Extrusion problems solved: Food, pet food and feed*. Woodhead Publishing Series in Food Science, Technology and Nutrition.

Ribeiro, É. de M.; Peixoto, M. C.; Putarov, T. C.; Monti, M.; Pacheco, P. D. G.; Loureiro, B. A.; Pereira, G. T.; Carciofi, A. C., 2019: The effects of age and dietary resistant starch on digestibility, fermentation end products in faeces and postprandial glucose and insulin responses of dogs. *Archives of Animal Nutrition*., **73**, 485–504.

Rooijen, C. van; Bosch, G.; Poel, A. F. B. van der; Wierenga, P. A.; Alexander, L.; Hendriks, W. H., 2013: The Maillard reaction and pet food processing: effects on nutritive value and pet health. *Nutrition Research Reviews*., **26**, 130–148.

Rooijen, C. van, 2015: *Maillard reaction products in pet foods* (phd). Wageningen University, Wageningenin thesisRetrieved from https://library.wur.nl/WebQuery/wurpubs/492334.

Rooney, L. W.; Pflugfelder, R. L., 1986: Factors Affecting Starch Digestibility with Special Emphasis on Sorghum and Corn1. *Journal of Animal Science*., **63**, 1607–1623.

Roy, F.; Boye, J. I.; Simpson, B. K., 2010: Bioactive proteins and peptides in pulse crops: Pea, chickpea and lentil. *Food Research International*., Molecular, Functional and Processing Characteristics of Whole Pulses and Pulse Fractions and their Emerging Food and Nutraceutical Applications, **43**, 432–442.

Sá, F. C.; Vasconcellos, R. S.; Brunetto, M. A.; Filho, F. O. R.; Gomes, M. O. S.; Carciofi, A. C., 2013: Enzyme use in kibble diets formulated with wheat bran for dogs: effects on processing and digestibility. *Journal of Animal Physiology and Animal Nutrition*., **97**, 51–59.

Sakomura, N.; Rostagno, H., 2007: *Métodos de Pesquisa em Nutrição de Monogástricos*. Funep, Jaboticabal.

Samant, S. S.; Crandall, P. G.; Jarma Arroyo, S. E.; Seo, H. S., 2021: Dry Pet Food Flavor Enhancers and Their Impact on Palatability: A Review. *Foods*., **10**, 2599.

Samartzidou, H.; Delcour, A. H., 1999: Excretion of endogenous cadaverine leads to a decrease in porin-mediated outer membrane permeability. *Journal of Bacteriology*., **181**, 791–798.

Sander, L. E.; Lorentz, A.; Sellge, G.; Coëffier, M.; Neipp, M.; Veres, T.; Frieling, T.; Meier, P. N.; Manns, M. P.; Bischoff, S. C., 2006: Selective expression of histamine receptors H1R, H2R, and H4R, but not H3R, in the human intestinal tract. *Gut*., **55**, 498–504.

Sanderson, S. L.; Gross, K. L.; Ogburn, P. N.; Calvert, C.; Jacobs, G.; Lowry, S. R.; Bird, K. A.; Koehler, L. A.; Swanson, L. L., 2001: Effects of dietary fat and L-carnitine on plasma and whole

blood taurine concentrations and cardiac function in healthy dogs fed protein-restricted diets. *American Journal of Veterinary Research*., **62**, 1616–1623.

Schiavone, A.; De Marco, M.; Martínez, S.; Dabbou, S.; Renna, M.; Madrid, J.; Hernandez, F.; Rotolo, L.; Costa, P.; Gai, F.; Gasco, L., 2017: Nutritional value of a partially defatted and a highly defatted black soldier fly larvae (Hermetia illucens L.) meal for broiler chickens: Apparent nutrient digestibility, apparent metabolizable energy and apparent ileal amino acid digestibility. *Journal of Animal Science and Biotechnology*., **8**.

Schirone, M.; Visciano, P.; Tofalo, R.; Suzzi, G., 2017: Histamine Food Poisoning. In: Hattori, Y. & R. Seifert (eds.), *Histamine and Histamine Receptors in Health and Disease*., Handbook of Experimental Pharmacology. Springer International Publishing, Cham, pp. 217–235.

Scientific Committee EFSA, 2015: Risk profile related to production and consumption of insects as food and feed. *EFSA Journal*., **13**, 4257.

Shakil Rana, K. M.; Abdus Salam, M.; Hashem, S.; Ariful Islam, M.; Salam, M. A., 2015: Development of Black Soldier Fly Larvae Production Technique as an Alternate Fish Feed Aquaponics Wheatgrass View project Investigations of heavy metal concentration in poultry feed , Bangladesh View project Development of Black Soldier Fly Larvae Production Technique as an Alternate Fish Feed. *International Journal of Research in Fisheries and Aquaculture*., **5**, 41–47.

Shalaby, A. R., 1996: Significance of biogenic amines to food safety and human health. *Food Research International*., **29**, 675–690.

Shevkani, K.; Singh, N.; Rattan, B.; Singh, J. P.; Kaur, A.; Singh, B., 2019: Effect of chickpea and spinach on extrusion behavior of corn grit. *Journal of Food Science and Technology*., **56**, 2257–2266.

Singh, B.; Sekhon, K. S.; Singh, N., 2007a: Effects of moisture, temperature and level of pea grits on extrusion behaviour and product characteristics of rice. *Food Chemistry*., **100**, 198–202.

Singh, S.; Gamlath, S.; Wakeling, L., 2007b: Nutritional aspects of food extrusion: a review. *International Journal of Food Science & Technology*., **42**, 916–929.

Smetana, S.; Palanisamy, M.; Mathys, A.; Heinz, V., 2016: Sustainability of insect use for feed and food: Life Cycle Assessment perspective. *Journal of Cleaner Production*., **137**, 741–751.

Smetana, S.; Schmitt, E.; Mathys, A., 2019: Sustainable use of Hermetia illucens insect biomass for feed and food: Attributional and consequential life cycle assessment. *Resources, Conservation and Recycling*., **144**, 285–296.

Smith, C. E.; Parnell, L. D.; Lai, C. Q.; Rush, J. E.; Freeman, L. M., 2021: Investigation of diets associated with dilated cardiomyopathy in dogs using foodomics analysis. *Scientific Reports*., **11**, 15881.

Song, P.; Zhang, R.; Wang, X.; He, P.; Tan, L.; Ma, X., 2011: Dietary grape-seed procyanidins decreased postweaning diarrhea by modulating intestinal permeability and suppressing oxidative stress in rats. *Journal of Agricultural and Food Chemistry*., **59**, 6227–6232.

Spears, J. K.; Fahey, G. C., Jr, 2004: Resistant Starch as Related to Companion Animal Nutrition. *Journal of AOAC INTERNATIONAL*., **87**, 787–791.

Spranghers, T.; Ottoboni, M.; Klootwijk, C.; Ovyn, A.; Deboosere, S.; De Meulenaer, B.; Michiels, J.; Eeckhout, M.; De Clercq, P.; De Smet, S., 2017: Nutritional composition of black soldier fly (Hermetia illucens) prepupae reared on different organic waste substrates. *Journal of the Science of Food and Agriculture*., **97**, 2594–2600.

Sriperm, N.; Pesti, G. M.; Tillman, P. B., 2011: Evaluation of the fixed nitrogen-to-protein (N:P) conversion factor (6.25) versus ingredient specific N:P conversion factors in feedstuffs. *Journal of the Science of Food and Agriculture*., **91**, 1182–1186.

Sunvold, G. D.; Hussein, H. S.; Fahey, G. C.; Merchen, N. R.; Reinhart, G. A., 1995: In vitro fermentation of cellulose, beet pulp, citrus pulp, and citrus pectin using fecal inoculum from cats, dogs, horses, humans, and pigs and ruminal fluid from cattle. *Journal of Animal Science*., **73**, 3639–3648.

Svihus, B.; Uhlen, A. K.; Harstad, O. M., 2005: Effect of starch granule structure, associated components and processing on nutritive value of cereal starch: A review. *Animal Feed Science and Technology*., **122**, 303–320.

Swanson, K. S.; Carter, R. A.; Yount, T. P.; Aretz, J.; Buff, P. R., 2013: Nutritional Sustainability of Pet Foods. *Advances in Nutrition*., **4**, 141–150.

Tabata, E.; Kashimura, A.; Kikuchi, A.; Masuda, H.; Miyahara, R.; Hiruma, Y.; Wakita, S.; Ohno, M.; Sakaguchi, M.; Sugahara, Y.; Matoska, V.; Bauer, P. O.; Oyama, F., 2018: Chitin digestibility is dependent on feeding behaviors, which determine acidic chitinase mRNA levels in mammalian and poultry stomachs. *Scientific Reports*., **8**, 1461.

Taylor, S. L., 1986: Histamine food poisoning: toxicology and clinical aspects. *Critical Reviews in Toxicology*., **17**, 91–128.

Teixeira, F. A.; Machado, D. P.; Jeremias, J. T.; Queiroz, M. R.; Pontieri, C. F. F.; Brunetto, M. A., 2018: Effects of pea with barley and less-processed maize on glycaemic control in diabetic dogs. *British Journal of Nutrition*., **120**, 777–786.

Teixeira, F. A.; Machado, D. P.; Jeremias, J. T.; Queiroz, M. R.; Pontieri, C. F. F.; Brunetto, M. A., 2020: Starch sources influence lipidaemia of diabetic dogs. *BMC veterinary research*., **16**, 2.

Teshima, E.; Brunetto, M. A.; Teixeira, F. A.; Gomes, M. de O. S.; Lucas, S. R. R.; Pereira, G. T.; Carciofi, A. C., 2021: Influence of type of starch and feeding management on glycaemic control in diabetic dogs. *Journal of Animal Physiology and Animal Nutrition*., **105**, 1192–1202.

Tester, R. F.; Karkalas, J.; Qi, X., 2004: Starch structure and digestibility Enzyme-Substrate relationship. *World's Poultry Science Journal*., **60**, 186–195.

Theodoro, S. de S.; Putarov, T. C.; Tiemi, C.; Volpe, L. M.; Oliveira, C. A. F. de; Glória, M. B. de A.; Carciofi, A. C., 2019: Effects of the solubility of yeast cell wall preparations on their potential prebiotic properties in dogs. *PLOS ONE*., **14**, e0225659.

Todesco, T.; Rao, A. V.; Bosello, O.; Jenkins, D. J., 1991: Propionate lowers blood glucose and alters lipid metabolism in healthy subjects. *The American Journal of Clinical Nutrition*., **54**, 860–865.

Topping, D. L.; Clifton, P. M., 2001: Short-chain fatty acids and human colonic function: roles of resistant starch and nonstarch polysaccharides. *Physiological Reviews*., **81**, 1031–1064.

Tôrres, C. L.; Backus, R. C.; Fascetti, A. J.; Rogers, Q. R., 2003: Taurine status in normal dogs fed a commercial diet associated with taurine deficiency and dilated cardiomyopathy. *Journal of Animal Physiology and Animal Nutrition*., **87**, 359–372.

Toutounji, M. R.; Farahnaky, A.; Santhakumar, A. B.; Oli, P.; Butardo, V. M.; Blanchard, C. L., 2019: Intrinsic and extrinsic factors affecting rice starch digestibility. *Trends in Food Science & Technology*., **88**, 10–22.

Tran, Q. D.; Hendriks, W. H.; van der Poel, A. F., 2008: Effects of extrusion processing on nutrients in dry pet food. *Journal of the Science of Food and Agriculture*., **88**, 1487–1493.

Trần, Q. Đ., 2008: *Extrusion processing: effects on dry canine diets*. Wageningen Institute of Animal Sciences, Wageningen.

Traughber, Z. T.; He, F.; Hoke, J. M.; Davenport, G. M.; de Godoy, M. R. C., 2020: Chemical composition and in vitro fermentation characteristics of legumes using canine fecal inoculum. *Translational Animal Science*., **4**, txaa200.

Valdés, F.; Villanueva, V.; Durán, E.; Campos, F.; Avendaño, C.; Sánchez, M.; Domingoz-Araujo, C.; Valenzuela, C., 2022: Insects as Feed for Companion and Exotic Pets: A Current Trend. *Animals*., **12**, 1450.

Vale, S. R.; Glória, M. B., 1997: Determination of biogenic amines in cheese. *Journal of AOAC International*., **80**, 1006–1012.

van Boekel, M. A. J. S., 2006: Formation of flavour compounds in the Maillard reaction. *Biotechnology Advances*., **24**, 230–233.

van Bree, F. P. J.; Bokken, G. C. A. M.; Mineur, R.; Franssen, F.; Opsteegh, M.; van der Giessen, J. W. B.; Lipman, L. J. A.; Overgaauw, P. A. M., 2018: Zoonotic bacteria and parasites found in raw meat-based diets for cats and dogs. *Veterinary Record*., **182**, 50–50.

van der Spiegel, M.; Noordam, M. Y.; van der Fels-Klerx, H. J., 2013: Safety of novel protein sources (insects, microalgae, seaweed, duckweed, and rapeseed) and legislative aspects for their application in food and feed production. *Comprehensive Reviews in Food Science and Food Safety*., **12**, 662–678.

van Huis, A., 2020: Insects as food and feed, a new emerging agricultural sector: A review. *Journal of Insects as Food and Feed*., **6**, 27–44.

Vasanthan, T.; Gaosong, J.; Yeung, J.; Li, J., 2002: Dietary fiber profile of barley flour as affected by extrusion cooking. *Food Chemistry*., **77**, 35–40.

Veldkamp, T.; van Duinkerken, G.; van Huis, A.; Lakemond, C.; Ottevanger, E.; G.;, B.; van Boekel, M., 2012: Insects as a sustainable feed ingredient in pig and poultry diets - a feasibility study. *Wageningen UR Livestock Research*., 62.

Venter, C. S.; Vorster, H. H.; Cummings, J. H., 1990: Effects of dietary propionate on carbohydrate and lipid metabolism in healthy volunteers. *The American Journal of Gastroenterology*., **85**, 549–553.

Vieira, P. de F., 1980: Efeito do formaldeído na proteção de proteínas e lipídios em rações para ruminantes.

Viera, S., 2010: *Consumo e preferência alimentar dos animais domésticos* First. Londrina PR.

Wang, J.; Johnson, L., 1992: Luminal polyamines substitute for tissue polyamines in duodenal mucosal repair after stress in rats. *Gastroenterology*., **102**, 1109–1117.

Wang, S.; Ai, Y.; Hood-Niefer, S.; Nickerson, M. T., 2019: Effect of barrel temperature and feed moisture on the physical properties of chickpea, sorghum, and maize extrudates and the functionality of their resultant flours—Part 1. *Cereal Chemistry*., **96**, 609–620.

Wen, X.; Wang, L.; Zheng, C.; Yang, X.; Ma, X.; Wu, Y.; Chen, Z.; Jiang, Z., 2018: Fecal scores and microbial metabolites in weaned piglets fed different protein sources and levels. *Animal Nutrition*., **4**, 31–36.

Willett, W.; Rockström, J.; Loken, B.; Springmann, M.; Lang, T.; Vermeulen, S.; Garnett, T.; Tilman, D.; DeClerck, F.; Wood, A.; Jonell, M.; Clark, M.; Gordon, L. J.; Fanzo, J.; Hawkes, C.; Zurayk, R.; Rivera, J. A.; Vries, W. D.; Sibanda, L. M. et al., 2019: Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet*., **393**, 447–492.

Wolever, T. M.; Bolognesi, C., 1996: Prediction of glucose and insulin responses of normal subjects after consuming mixed meals varying in energy, protein, fat, carbohydrate and glycemic index. *The Journal of Nutrition*., **126**, 2807–2812.

Wolter, R.; Pereira do Socorro, E.; Houdre, C., 1998: Foecal and ileal digestibility of diets rich in wheat or tapioca starch in the dog. *Recueil de Medecine Veterinaire (France).*

Wośko, S.; Serefko, A.; Socała, K.; Szewczyk, B.; Wróbel, A.; Nowak, G.; Wlaź, P.; Poleszak, E., 2014: An anti-immobility effect of spermine in the forced swim test in mice. *Pharmacological reports: PR.*, **66**, 223–227.

Yamashita, H.; Fujisawa, K.; Ito, E.; Idei, S.; KAWAGUCHI, N.; Kimoto, M.; Hiemori, M.; Tsuji, H., 2007: Improvement of Obesity and Glucose Tolerance by Acetate in Type 2 Diabetic Otsuka Long-Evans Tokushima Fatty (OLETF) Rats. *Bioscience, Biotechnology, and Biochemistry*., **71**, 1236–1243.

Zanotto, D. L.; Belaver, C., 1996: Método de determinação da granulometria de ingredientes para uso em rações de suínos e aves. *Comunicado Técnico EMBRAPA – Suíno e Aves.*, 1–5.

Zeng, M.; Morris, C. F.; Batey, I. L.; Wrigley, C. W., 1997: Sources of Variation for Starch Gelatinization, Pasting, and Gelation Properties in Wheat. *Cereal Chemistry*., **74**, 63–71.

Zicker, S. C., 2008: Evaluating Pet Foods: How Confident Are You When You Recommend a Commercial Pet Food? *Topics in Companion Animal Medicine*., Controversies in Small Animal Nutrition, **23**, 121–126.