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Closing the Loop: Pioneering Circular Economies in Sustainable Animal Production

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Foreword from the Organizing Chairman



Distinguished guests, esteemed colleagues, ladies and gentlemen,

It gives me great pleasure to welcome all of you to the 44th Annual Conference of the Malaysian Society of Animal Production (MSAP), held in the vibrant and culturally rich city of Kota Kinabalu, Sabah. This year's gathering marks yet another important milestone in our shared journey of advancing animal production science, innovation, and sustainable practices across Malaysia and the region. We are truly honoured by your presence and participation in this annual tradition of collaboration, learning, and exchange.

The theme of this year's conference, "Closing the Loop: Pioneering Circular Economies in Sustainable Animal Production", speaks directly to the evolving challenges and responsibilities we face in a rapidly changing world. It calls upon us as researchers, industry players, and policymakers to rethink and redesign our production systems to become more integrated, resource-efficient, and environmentally sustainable. Through the lens of circular economy, we aim to explore pathways where waste becomes resource, where innovation supports regeneration, and where sustainability is not just an ideal, but a measurable outcome.

This conference is the result of the close cooperation and dedicated effort of multiple institutions — namely Universiti Putra Malaysia (UPM), the Malaysian Agricultural Research and Development Institute (MARDI), the Department of Veterinary Services (DVS) Malaysia, DVS Sabah, Universiti Malaysia Kelantan (UMK), Universiti Malaysia Sabah (UMS), and Universiti Sultan Zainal Abidin (UniSZA). We are also deeply grateful for the support of our sponsors and partners from within the agriculture and animal production industries, whose contributions have made this event possible and impactful.

As we embark on this three-day journey of discovery and discussion, I encourage each of you to engage actively, share generously, and build new bridges of collaboration. Let us continue to push the frontiers of sustainable animal production — together — for the benefit of our communities, our environment, and future generations. Once again, welcome to Kota Kinabalu and to the 44th MSAP Annual Conference. I wish you all a fruitful and inspiring meeting.

DR. MOHD HISHAMMFARIZ MOHD AMIN
Organizing Chairman
44th MSAP Annual Conference

Category: Keynote address

Enhancing Livestock Productivity and Self-Sufficiency in Sabah: Strategic Imperatives for Sustainable Growth

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Abstract

Sabah holds significant untapped potential in Malaysia's livestock sector, backed by its Foot and Mouth Disease (FMD)-free status, vast agro-land and growing domestic protein demand. This paper presents a strategic roadmap to enhance livestock productivity and self-sufficiency through a comprehensive review of production data, consumption patterns and structural challenges across commodity types. Despite commendable performance in poultry, pork and egg production, Sabah faces critical gaps in beef self-sufficiency (9.3%), dairy processing infrastructure and downstream value chains. Key strategic initiatives under the 13th Malaysia Plan (RMK13) include large-scale ruminant-oil palm integration, dairy transformation and the development of a livestock biotechnology centre. These are reinforced by enablers such as smart farming adoption, local feed development, institutional coordination and private investment facilitation. A comparative analysis with national benchmarks highlights the need for localized, data-driven interventions that align with Sabah's demographic and dietary profile. The paper concludes with three imperatives: bridging upstream and downstream investments, optimising land and disease-free branding and investing in youth, innovation, and institutional capacity. Sabah is poised to lead livestock sector transformation through resilient, sustainable, and commercially viable pathways that support both food security and rural development.

Sabah memiliki potensi besar yang masih belum dimanfaatkan sepenuhnya dalam sektor ternakan Malaysia, disokong oleh status bebas Penyakit Kuku dan Mulut (FMD), keluasan tanah pertanian yang luas, serta permintaan protein domestik yang semakin meningkat. Kertas ini membentangkan hala tuju strategik bagi memperkasa produktiviti dan tahap sara diri ternakan menerusi analisis menyeluruh terhadap data pengeluaran, corak penggunaan serta cabaran struktur mengikut jenis komoditi. Walaupun pencapaian dalam pengeluaran ayam, babi dan telur adalah memberangsangkan, Sabah masih berdepan jurang kritikal dalam sara diri daging lembu

(9.3%), infrastruktur pemprosesan tenusu dan rantaian nilai hiliran. Inisiatif utama di bawah Rancangan Malaysia Ke-13 (RMK13) merangkumi integrasi ternakan-rumpun sawit berskala besar, transformasi industri tenusu dan pembangunan pusat bioteknologi ternakan. Pendekatan ini disokong oleh pemerkasaan penggunaan teknologi pintar, pembangunan sumber makanan tempatan, penyelarasan institusi dan galakan pelaburan swasta. Perbandingan dengan penanda aras nasional menunjukkan keperluan kepada campur tangan berasaskan data dan berfokus tempatan yang selari dengan profil demografi dan pemakanan rakyat Sabah. Kertas ini merumuskan tiga keutamaan: menyatukan pelaburan huluan dan hiliran, mengoptimumkan tanah serta penjenamaan status bebas penyakit dan melabur dalam pembangunan modal insan, inovasi serta keupayaan institusi. Sabah bersedia memimpin transformasi sektor ternakan melalui pendekatan yang berdaya tahan, lestari dan bernilai komersial demi menjamin keselamatan makanan dan pembangunan luar bandar secara mampan.

Category: Ruminant Production
PLE_01

Research Progress on Breeding and Reproduction of Dairy Goats in China: A Review

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Abstract

The global dairy goat industry is developing rapidly and with an estimated population of more than 200 million dairy goats. Goat milk is increasingly favored by consumers, and dairy goat farming has brought considerable profits to farmers in China. At present there are more than 50 famous varieties and breeds of dairy goats in the world, the use of these breeds for pure breeding and crossbreeding in many countries and regions had also produced new breeds adapted to local ecological environments. With the progress of modern molecular technology and reproductive technology, the breeding technology of dairy goats has made great progress. In addition to traditional breeding methods, advanced breeding methods such as molecular marker assisted selective breeding, genomic selective breeding, nuclear transfer and transgenic technology are widely used. Estrus synchronization (ES), artificial insemination (AI) and embryo transfer (ET) have been increasingly adopted in the intensive production system of dairy goats. The multiple ovulation and ET (MOET) program combined with ES and AI significantly increase annual genetic progress by decreasing the generation interval. The technique of sexed semen to produce more progeny of the desired sex based on X and Y sperm physical, physiological, and immunological characteristics is a revolutionary technology for goat breeding. Sexed sperm sorting technology greatly reduces farm costs and increases milk production. Moreover, the use of sexed semen increases herd genetic gain compared with use of normal semen. The effects of diet and nutrition on ovarian function cannot be ignored, and the effects of protein and energy levels on reproduction have been proved, although the exact mechanisms between ovarian function and dietary composition are obscure. Reproduction in goats regarded as seasonal, the estrus is affected by many factors such as photoperiod, breed, and climate, and among which photoperiod is the crucial factor. The reproductive physiology of seasonal reproduction in goats has been extensively studied, especially the pineal gland and the hypothalamus-pituitary-ovarian (HPO) axis involved in the conversion of light signals to reproductive signals, as well as hormone secretion characteristics. In the non-breeding season, hormone schemes based on progesterone and eCG is a common method to induce estrus and ovulation. Induction of estrus at different locations and time varied with photoperiod, nutrition and buck effect etc.. Although the reproductive performance is not as good in the non-breeding season as in the breeding season, these estrus induction

programs are still effective, trying to guarantee milk long-term availability satisfying the year-round market demands. This presentation will summarize the progress in breeding and reproductive technologies and management of dairy goats and illustrate the future perspectives of breeding and reproduction research in the goat industry.

Category: Sustainable livestock & feed production
PLE_02

Sustainability in Dairy Farming: Embracing Circular Economy Practices

Dato Yap Yun Fook

Evergreen Livestock Sdn Bhd

Abstract

Sustainability in dairy farming is increasingly recognized as a vital component in mitigating environmental impacts while ensuring economic viability. Embracing circular economy practices within the dairy farming sector offers innovative solutions to the growing challenges of waste management, resource depletion, and greenhouse gas emissions. This presentation explores the integration of circular economy principles in dairy farming, focusing on reducing waste, maximizing resource efficiency, and promoting environmental responsibility. It highlights strategies such as the recycling of organic waste into valuable resources like biogas and compost, reducing water and energy consumption through closed-loop systems, and improving soil health by utilizing manure as a natural fertilizer. Furthermore, the adoption of sustainable packaging for dairy products and the reduction of plastic waste contribute to the broader goal of minimizing environmental footprints. The experiences from farms that have successfully implemented circular economy practices demonstrate the potential benefits in terms of cost savings, enhanced productivity, and reduced ecological impact. The role of policy support and innovation in facilitating this transition is also discussed, emphasizing the need for collaboration among farmers, industry stakeholders, and government bodies. Ultimately, the presentation argues that the shift towards a circular economy in dairy farming is not only an ethical and environmental necessity but also a practical approach to achieving long-term sustainability, economic resilience, and a more sustainable food system.

Keyword: *circular economy, dairy farming*

Category: Sustainable livestock & feed production
PLE_03

Circular Economy in Livestock Reproduction: The Philippine Strategies

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Abstract

The circular economy in livestock reproduction presents a transformative approach to sustainable agriculture, optimizing resource efficiency, reducing waste, and fostering regenerative systems. In the Philippines, where swamp buffaloes dominate the livestock industry, strategic adoption of artificial insemination (AI) and embryo transfer (ET) has significantly contributed to the genetic improvement of buffalo populations, enhancing milk and meat production. These advancements have led to increased farm productivity, higher farmer income, and the establishment of Dairy Boxes, which serve as processing and retail hubs for buffalo dairy and meat products.The expansion of dairy and meat buffalo populations through reproductive biotechnologies has further enabled circular economy principles in waste management. The utilization of manure for vermicast production supports organic fertilizer development, improving pasture productivity while reducing reliance on synthetic fertilizers. Additionally, the conversion of agricultural waste into silage creates a sustainable feed system that maximizes available resources and minimizes waste generation. These integrated practices promote both environmental sustainability and economic resilience in livestock farming. By closing resource loops, optimizing breeding efficiency, and enhancing waste management, the Philippine livestock industry exemplifies the circular economy model in livestock reproduction. This approach mitigates environmental impact, supports climate resilience, and strengthens local agricultural value chains. The successful integration of AI and ET with sustainable waste utilization strategies presents a replicable framework that can be adopted across various agricultural landscapes, contributing to global efforts toward sustainable food production. This presentation highlights the successes, challenges, and future directions of the circular economy in Philippine livestock reproduction, emphasizing its role in fostering a regenerative, efficient, and productive agricultural sector.

Category: Farm management
PLE_04

Waste to Wealth – ASEAN FUTURE

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Abstract

The Waste to Wealth model is a transformative, sustainable circular economic framework that turns waste into wealth of health, wealth of environment, and wealth of social economy. It redefines waste not as a problem, but as a valuable resource for creating sustainable solutions in energy, agriculture, and food systems across Asia. Anchored on three interconnected pillars—Waste to Energy, Waste to Feed, and Waste to Healthy Soil—this model demonstrates how environmental liabilities can be converted into regenerative assets that promote public health, ecological balance, and inclusive economic growth. 1. Waste to Energy: Organic and biomass waste such as food residues, chicken manure, and palm by-products are converted into renewable energy sources like biogas, bio-coal, and electricity using proven technologies such as anaerobic digestion, carbonisation and gassification. This reduces greenhouse gas emissions and supports energy security. 2. Waste to Feed: Agricultural and food industry by-products are transformed into high-protein animal feed through bioconversion (e.g., black soldier fly larvae, microbial fermentation), enhancing food system resilience and reducing reliance on imported feed. 3. Waste to Healthy Soil: Organic waste is processed into bio-organic fertilizers and soil enhancers using microbial and composting methods, restoring degraded lands, boosting productivity, and reducing chemical inputs—thereby improving food safety and ecosystem health. Enabling the Waste to Wealth Model: Holistic Approach: Integrates waste, energy, food, and agriculture systems to achieve circularity and long-term sustainability. Practical and Commercialized Model: Designed for scalable, field-level application, adaptable to various industries and communities. Proven Technology: Based on technologies with demonstrated success in pilot and commercial settings, ensuring feasibility and investor readiness. Through strategic collaboration between government, private sector, and communities, the Waste to Wealth model offers a practical pathway to build a regenerative economy—empowering Asean to lead a global transition toward sustainability and circularity.

Category: Ruminant production
PLE_05

Integrated Beef Cattle Development as a Contributor to The Increase in the National Self-Sufficiency Level

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Abstract

Malaysia's beef industry faces challenges, as indicated by the Self-Sufficiency Level (SSL) decline from 18.9% to 14.7% between 2021 and 2022. This decreases, coupled with rising per capita beef consumption (5.5 kg/year to 6.9 kg/year), highlights the country's reliance on beef imports. The growth in the beef market is driven by population growth, which increases the total beef consumption. The current situation emphasizes the need for strategies to boost local beef production and reduce import dependency. This paper explores the role of integrated cattle farming under oil palm plantations as a strategic approach to enhance the country's SSL in beef production. Examining current production systems and integrating upstream and downstream activities such as breeding, feeding, processing, and marketing. The study identifies key factors that influence the success of cattle integrated in oil palm plantation models. The analysis utilizes both qualitative and quantitative data, including case studies from existing integrated cattle operations in Sawit Kinabalu Farm Products Sdn Bhd. The findings reveal that cattle-oil palm integration significantly contributes to national beef production with minimal interference to palm oil yield, indicating a synergistic relationship. The study concludes that this model presents a viable strategy to support Malaysia's goal of increasing its national SSL in beef production and offers policy intervention and investment strategies for scaling and supporting integrated livestock-plantation systems nationwide.

Category: Sustainable livestock & feed production
PLE_06

A Journey Towards Sustainable Animal Feed, Pet Food and Aviation Fuel (SAF) Producer

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Abstract

The rendering industry in Malaysia is an essential component of the nation's agricultural and food processing infrastructure, playing a pivotal role in converting animal by-products and organic waste into valuable secondary products. Primarily, it supports the animal feed industry by producing protein-rich meals and rendered fats, which are used extensively in livestock, poultry, and aquaculture feed formulations. These rendered materials offer a sustainable and cost-effective alternative to plant-based or synthetic ingredients, thereby reducing dependency on imported feed components and strengthening local food production systems. In Malaysia, where the consumption of meat and seafood continues to rise, the volume of by-products generated from slaughterhouses, meat processing plants, and food industries has increased correspondingly. Without proper management, these by-products pose significant environmental and health risks. Rendering provides a practical and environmentally sound solution to this challenge by transforming potentially harmful organic waste into safe, usable commodities. Through heat treatment, grinding, and separation processes, the rendering industry ensures the elimination of pathogens and the production of stable, high-quality feed ingredients. Beyond its role in waste reduction and resource recovery, the Malaysian rendering sector also contributes to the broader goals of environmental sustainability. By diverting organic waste from landfills and reducing methane emissions, rendering operations help to mitigate the impact of the livestock industry on climate change. Furthermore, the industry aligns with Malaysia's circular economy strategy by closing the loop in the agricultural value chain—turning waste into wealth. The rendering industry must, however, navigate a range of challenges. These include maintaining compliance with national food safety regulations, meeting halal certification requirements, managing odor and emissions, and addressing public misconceptions about the safety and quality of rendered products. Innovations in processing technology, improved traceability systems, and increasing awareness of sustainability are helping to reshape the industry's image and expand its market potential.

Category: Sustainable livestock & feed production
PLE_07

The Development of the Broiler and Layer Poultry Industry: Challenges and Opportunities Towards a Circular Economy

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Abstract

The broiler and layer poultry industry plays a crucial role in global food security by providing affordable protein sources. However, this industry faces significant challenges, such as environmental impact, resource inefficiency, and waste management. The rapid growth of poultry production has led to concerns over sustainability, including the depletion of natural resources, water pollution, and greenhouse gas emissions. In response to these challenges, the concept of a circular economy (CE) offers a promising framework to create a more sustainable poultry industry. This paper explores the challenges and opportunities associated with integrating circular economy principles into the broiler and layer poultry sector. It discusses key areas where circularity can be applied, such as waste reduction, resource optimization, and the reuse of by-products, including poultry litter and feathers. Moreover, it highlights innovative practices like nutrient recycling, renewable energy adoption, and sustainable feed production. The opportunities within the poultry sector's transition towards a circular economy are significant, offering economic, environmental, and social benefits. By adopting CE practices, the industry can reduce waste disposal costs, enhance productivity, and minimize its environmental footprint. The paper also examines the role of technology, policy, and industry collaboration in facilitating this transformation. Finally, it outlines the need for strategic planning, stakeholder engagement, and investments to overcome the barriers that hinder the widespread adoption of circular economy practices. This paper aims to provide a comprehensive understanding of the potential for circular economy integration in the poultry industry, offering insights into how this shift can help address existing challenges while creating sustainable growth opportunities for the future.

Keyword: *Poultry, circular economy, productivity*

Category: Animal breeding & genetics
PLE_08

Precision Genetics: Enhancing Small Ruminant Productivity for a Sustainable Future

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Introduction

The global demand for animal protein is projected to increase by 70% by 2050 due to population growth and changing dietary preferences (Mottet et al., 2017). Small ruminants, including sheep and goats, play a crucial role in global food security, providing essential protein sources, income, and livelihood for millions worldwide, particularly in developing regions (Montossi et al., 2021). As global demand for animal protein escalates alongside concerns about climate change and resource limitations, there is an urgent need to enhance productivity while minimizing environmental impacts. Precision genetics, integrated with emerging precision livestock farming (PLF), offers promising solutions for the sustainable intensification of small ruminant production systems (Figure 1). This paper explores the integration of cutting-edge genetic selection methods with real-time monitoring technologies to optimize the productivity, health, and welfare of small ruminants while reducing their environmental footprint.

Genomic Selection and Marker-Assisted Breeding

Genomic selection represents a paradigm shift in small ruminant breeding programs. Unlike traditional breeding that relied solely on phenotypic evaluation and pedigree information, genomic selection utilizes genome-wide DNA markers to predict breeding values with higher accuracy and at earlier ages (Rupp et al., 2016). Recent advancements in high-throughput genotyping platforms have significantly reduced costs, making genomic selection increasingly accessible for small ruminant industries. Studies by Daetwyler et al. (2012) demonstrated that genomic selection can increase genetic gain in sheep breeding programs targeting traits with low heritability, such as disease resistance and feed efficiency. The implementation of whole-genome sequencing and selection has accelerated genetic progress for economically important traits in small ruminants. Genome-wide association studies (GWAS) have identified key markers associated with economically important traits in small ruminants. For instance, Brito et al. (2017) identified several

quantitative trait loci (QTLs) associated with parasite resistance in sheep, enabling marker-assisted selection for this critical adaptation trait. Similarly, Alberto et al. (2018) mapped genomic regions controlling milk production traits in dairy goats, providing valuable tools for improving milk yield and composition. A study by Meuwissen et al. (2016) reviewed that 15-25% increases in accuracy for various livestock species when using genomic selection, with greater relative gains for traits with lower heritability.

Integration of Phenomics and Real-Time Monitoring

The integration of genomic information with high-throughput phenotyping (phenomics) creates powerful synergies for precision breeding. Advanced sensors and monitoring systems now enable continuous collection of phenotypic data at unprecedented scales. These technologies provided continuous data streams that revealed previously undetectable phenotypic variations, improving the precision of genetic evaluations. González et al. (2018) demonstrated that automated monitoring systems coupled with machine learning algorithms could predict feed efficiency, allowing for real-time selection decisions. Real-time monitoring of health, feed intake, and growth allows for precise adjustments, improving feed efficiency and reducing methane emissions per unit of product. For example, automated weighing systems and health sensors have been shown to reduce total emissions by up to 6.8% in certain livestock systems (Papakonstantinou et al., 2024). Quantifying the energy intake of grazing animals has recently become feasible through the use of modern sensor technology, which has the potential to accelerate the next generation of precision livestock management, resulting in gains in both welfare and production (Suparwito et al., 2021). Wearable biosensors represent another frontier in precision small ruminant management. Caja et al. (2020) observed the rumen-based sensors that continuously monitor rumen pH and temperature in small ruminants, enabling early detection of digestive disorders and selection for animals with superior digestive efficiency. These sensors and accelerometers track activity patterns, enabling early detection of health issues and oestrus cycles (Si, 2024). These technologies, when integrated with genomic information, allow for more precise selection decisions based on real-time physiological responses to environmental conditions.

Environmental Sustainability and Methane Mitigation

Enteric methane emissions from small ruminants contribute significantly to greenhouse gas emissions from agriculture. Precision genetics offers promising avenues for mitigating these emissions. Genomic studies by Pickering et al. (2015) identified heritable variation in methane production among sheep, with genomic markers explaining approximately 14% of the phenotypic variation. When coupled with portable methane measurement devices, these genomic tools enable selection for reduced methane emission intensity without compromising growth or reproductive performance. Additionally, precision feeding systems guided by genetic information about individual nutritional requirements can optimize resource use efficiency. Sonea et al. (2024) demonstrated that genetic factors significantly influence feed formulation strategies, as the genetic makeup of dairy goat breeds impacts milk production, composition, and overall productivity. Selective breeding for low methane-emitting traits has demonstrated significant

potential. For instance, a study in New Zealand successfully bred sheep that produce up to 13% less methane per kilogram of feed over three generations, without compromising productivity (Hickey et al., 2022). This heritable trait enables cumulative reductions in greenhouse gas emissions over time.

Economic Implications and Future Directions

The economic implications of implementing precision genetics in small ruminant systems depend on local conditions and production contexts. The integration of precision genetics with Precision Livestock Farming (PLF) technologies in small ruminant systems presents significant economic opportunities alongside key future directions for sustainable livestock development. Precision genetics utilizing genomic selection and marker-assisted breeding enables the identification and propagation of animals with superior traits such as disease resistance, reproductive efficiency, and feed conversion. This leads to improved productivity, lower mortality, and optimized resource use, which directly enhances profitability for producers (Knight, 2019). Emerging technologies such as gene editing may complement traditional breeding approaches by allowing precise introduction of beneficial alleles while maintaining genetic diversity (Proudfoot et al., 2015). Additionally, the integration of genomic information with big data analytics and artificial intelligence promises to enhance the predictive capacity of genetic models and facilitate real-time decision-making. PLF technologies complement these genetic strategies by allowing real-time monitoring of animal health, nutrition, and behaviour through wearable sensors, automated feeding systems, and environmental control units. These tools minimize waste, reduce labour costs, and allow for timely interventions, all of which contribute to improved economic performance. For instance, smart health monitoring reduces treatment costs by enabling earlier disease detection and reducing the need for broad-spectrum interventions (Caja et al., 2020).

Conclusion

Precision genetics, enhanced by integration with emerging PLF technologies, offers a promising pathway toward sustainable intensification of small ruminant production systems. By enabling more accurate selection decisions, facilitating early intervention for health and welfare issues, and optimizing resource use efficiency, these technologies can help meet increasing global demand for animal protein while minimizing environmental impacts. However, realizing this potential requires investments in research infrastructure, capacity building, and policy frameworks that support equitable access to these technologies across diverse production systems.

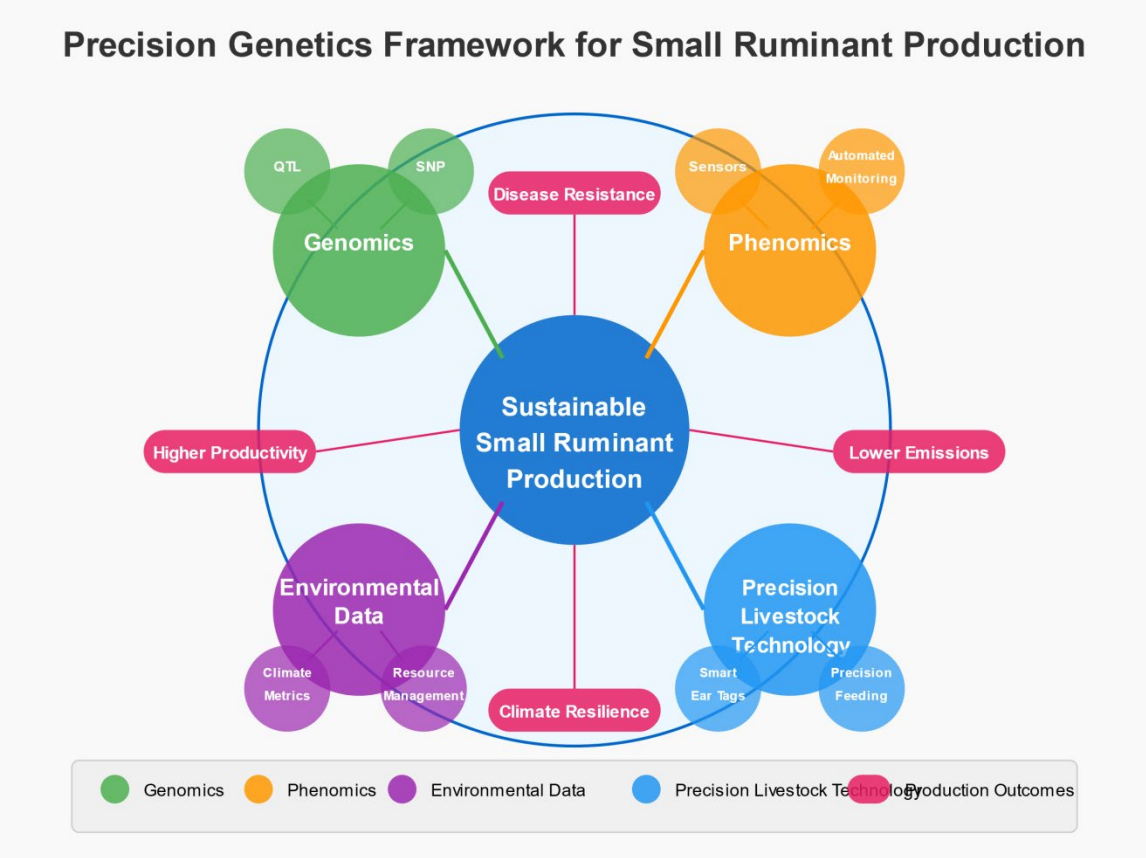


Figure 1. Conceptual framework illustrating the integration of genomics, phenomics, and precision livestock technologies for sustainable small ruminant production.

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Category: Food / feed safety
ORL_01

Pathogen Control for Food Safety in Poultry Production

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Abstract

Food safety in poultry production is a major global issue that needs a combined and thoughtful approach to control harmful pathogens. This presentation explores how sustainable farming practices can improve productivity while also supporting animal health and protecting the environment. A key focus is on keeping poultry gut health in good condition, which helps reduce diseases and lowers the need for antibiotics. This also helps prevent antimicrobial resistance (AMR), a growing health concern. The presentation discusses strategies such as managing gut health and using antibiotics responsibly. By combining sustainable farming with strong pathogen control, we highlight how to improve poultry performance, provide safe and nutritious food for people, and protect the environment. The presentation also shares useful ideas and proven methods that help make poultry products safer, reduce AMR risks, and build a stronger, more reliable food system. The presentation covers practical approaches, including alternative feed additives, all aimed at enhancing food safety, limiting AMR development, and ensuring long-term sustainability in poultry farming.

Keywords: *Environmental; Sustainability; Poultry; Pathogen Control; AMR; .*

Category: Sustainable livestock & feed production
ORL_02

Sustainability in the Animal Nutrition Industry

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Abstract

The global emphasis on sustainability and environmental, social and governance (ESG) criteria is reshaping the agri-food sector, driving a critical shift toward more responsible and resilient business practices. This presentation explores how agri-food companies are navigating this transformation by aligning profitability with long-term environmental and social goals. It highlights emerging regulatory frameworks, evolving consumer expectations and cutting-edge innovations that are redefining sustainable agriculture. Particular attention is given to the role of ESG integration as both a strategic imperative and a competitive advantage. Through a series of case studies, the discussion illustrates practical approaches adopted by industry leaders to embed ESG values across the supply chain — from production and sourcing to distribution and marketing. These examples demonstrate measurable benefits such as improved resource efficiency, enhanced brand trust, and risk mitigation. By examining current trends and real-world applications, this presentation provides valuable insights for stakeholders seeking to future-proof their agri-food operations and contribute meaningfully to a more sustainable global food system.

Keywords: *Environmental; Sustainability; ESG.*

Category: Animal nutrition & feeding
ORL_03

Application of Organic Minerals in Poultry Nutrition

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Abstract

Effective mineral supplementation is key to improving poultry health, growth, and sustainability. With feed costs making up to 70% of production expenses, better nutrient absorption is critical. Trace minerals are essential to support animal growth and performance. Inorganic mineral supplementation has shown interaction with other feed ingredients such as antioxidants, vitamins and enzymes. This article highlights modern strategies in mineral management, focusing on organic trace minerals (OTMs) and introduces the Total Replacement Technology™ (TRT) approach. Compared to inorganic trace minerals (ITMs), OTMs are more bioavailable. They improve metabolism, immunity, and feed efficiency. Supported by over 1,200 trials and 233 peer-reviewed studies, OTMs are shown to be effective at 30–50% lower levels than ITMs. They also cause fewer negative interactions with other feed components like enzymes and vitamins. Based on research, OTMs can improve broiler growth, reduce mineral waste, and maximize meat quality. For laying hens, OTMs help to strengthen eggshell quality, also improve egg consistency. Using organic trace minerals also lowers mortality and supports environmental sustainability. The TRT program was introduced to completely replace ITMs with OTMs. This presentation will explain how this program has proven to maximize productivity, avoiding nutrient conflicts often seen with partial replacement, and is sustainable for modern poultry production.

Keywords: *Environmental; Sustainability; Poultry; Mineral; Organic Trace Mineral; Total Replacement Technology*

Category: Food/ feed safety
ORL_04

Ensuring Feed Safety: How Regulations Shape the Future of Animal Nutrition

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Abstract

Feed safety plays a pivotal role in safeguarding animal health, ensuring food safety, and protecting the environment. As the first critical link in the food chain, safe animal feed underpins the production of nutritious and contaminant-free food of animal origin. This presentation explores how regulatory frameworks are instrumental in setting and enforcing feed safety standards, while also guiding the future direction of animal nutrition. An effective regulatory framework ensures transparency, traceability, and accountability across the feed supply chain. Emerging regulatory trends - such as digital traceability, sustainability mandates, and the integration of the One Health principle - are reshaping the landscape of feed regulation globally. While these developments create opportunities for innovation, improved risk management, and global harmonization, they also bring challenges in terms of compliance complexity, resource allocation, and alignment across jurisdictions. This presentation highlights the critical role of collaboration among competent authorities, academia, industry players and international organizations in navigating these evolving demands. By fostering open dialogue and science-based policy development, the feed and livestock industries can proactively contribute to a resilient, safe, and sustainable food system.

Keywords: *Feed Safety; Food Safety; Regulatory Framework; Collaboration*

Category: Sustainable livestock & feed production
ORL_05

Harnessing Animal and Marine By-Products for Functional Applications: Advancing Health and Environmental Sustainability with Malaysia's Biological Resources

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Introduction

For centuries, humans have relied on animals and marine resources for sustenance, trade, and commercial processing, yet a significant portion is discarded as waste. With a growing emphasis on sustainability, industries are exploring innovative ways to repurpose these by-products into valuable functional ingredients. The circular economy and government incentives both promote resource efficiency and the adoption of green technologies, driving sustainable innovation. Advanced biotechnological approaches facilitate the extraction of bioactive compounds from fish waste, prawn heads, squids waste, crustacean wastes, sea cucumber by-products, and edible bird's nest (EBN) by-products, enhancing their nutritional value (Bhadange, Carpenter & Saharan, 2024). These by-products are nutrient-dense and rich in collagen peptides, omega-3 fatty acids, and other bioactive molecules, underscoring their potential as functional ingredients. By harnessing these underutilised resources, industries can improve animal nutrition, drive sustainable feed innovation, and contribute to environmental conservation through responsible resource management.

Keywords: *Animal waste valorisation, by-products utilisation, functional ingredients, Malaysia's biological resources, sustainable circular economy*

Discussion

Marine processing industries generate substantial waste, with fish processing discarding up to 70% of total fish weight, including scales, bones, and heads (Boronat et al., 2023). Scales from tilapia, sardine, and rohu alone contribute 7.2 to 12 million tonnes of waste annually. Additionally, prawn heads, squid by-products, mollusc waste, and crustacean waste further increase marine by-product accumulation. These residues are nutrient-dense, containing high levels of collagen peptides, omega-3 fatty acids, and other bioactive molecules, which make them valuable raw materials for aquaculture, poultry, and livestock feed. In animal nutrition, fishmeal enhances growth, while fish hydrolysates improve digestibility and gut health.

Similarly, sea cucumber processing discards, primarily internal organs, account for up to 50% of the total biomass and contain valuable bioactive compounds (Hossain et al., 2022).These by-products contain saponins, sulfated polysaccharides, and bioactive peptides with anticoagulant, anti-inflammatory, and wound-healing properties (Maskur et al., 2024). Sea cucumber extracts improve immune response, gut health, and growth performance in aquaculture and livestock, reducing antibiotic reliance. Their prebiotic potential supports beneficial gut microbiota, enhancing digestion and nutrient absorption.

Beyond marine by-products, EBN processing generates approximately 20% by-products, which are rich in sialylated mucin glycoproteins that support cognitive function, immune modulation, and gut health (Mun et al., 2024). Enzymatic hydrolysis and proteolytic fermentation enhance the bioavailability of EBN, expanding its applications in functional foods (Ter et al., 2024). Moreover, the prebiotic properties and bioactive compounds, particularly sialic acid, present in EBN by-products suggest potential benefits for livestock, such as improved gut health and immunity, thereby offering a sustainable approach to waste reduction and enhanced animal nutrition.

Conclusion

Valorising animal and marine by-products offers sustainability in animal nutrition. Advanced biotechnological processes transform these underutilised resources into nutrient-rich feed, maximising resource efficiency while enhancing livestock health.

Acknowledgement

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Category: Animal nutrition & feeding
ORL_06

Effects of Dietary Inclusion of Sericea Lespedeza Hay on Heat Energy and Ruminal Methane Emission by Growing Alpine Doelings and Katahdin Ewe Lambs

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Introduction

Sericea lespedeza (*Lespedeza cuneata*) is a perennial legume adapted to subtropical and temperate climates, which may be used for grazing, hay, and silage for ruminants (Pech-Cervantes,et al. 2021). Lespedeza is lower in nutritive value than alfalfa due to its higher concentrations of total fiber, lignin, and bioactive condensed tannins (CT) (Pech-Cervantes et al. 2021, Puchala et al. 2012). However, studies over the last 15–20 years have demonstrated the effectiveness of this forage to reduce gastrointestinal parasitic infections and prevent bloat in ruminants due to the presence of CT [1,4]. This has contributed to a renewed interest in the use of lespedeza as a medium-quality warm-season nutraceutical forage for livestock in different parts of the world (Pech-Cervantes et al. 2021, Mahachi et al. 2020).

Keywords: *Feed intake, Goat, Sheep*

Materials and Methods

Twenty-four Alpine doelings (initial body weight (BW) and age of 25.3±0.55 kg and 10.4±0.11 mo, respectively) and twenty-four Katahdin ewe lambs (28.3±1.02 kg and 9.6±0.04 mo, respectively) were used to determine effects of dietary level of Sericea lespedeza (*Lespedeza cuneata*; 10% condensed tannins) on heat energy and ruminal emission of the greenhouse gas methane determined with an open-circuit calorimetry system. Pens with Calan feeding gates were used in the study with four periods. Diets consumed *ad libitum* contained 75% coarsely ground hay with alfalfa (ALF), a 1:1 mixture of ALF and LES (ALF + LES), and LES. This study was conducted to investigate the effects of dietary concentrations of lespedeza and

alfalfa on heat energy and ruminal methane emission by growing Alpine doelings and Katahdin ewe lambs.

Results and discussion

Feeders were open 195 and 205 min/d for Alpine and Katahdin (SEM=9.8) and longer (P<0.05) for diets with lespedeza (159, 209, and 231 min/d for alfalfa, AL, and lespedeza, respectively). The rate of dry matter intake (DMI) was greater (P<0.05) for Katahdin vs. Alpine (10.2 and 6.1 g/min) and for alfalfa than for AL and lespedeza (11.1, 8.1, and 6.7 g/min, respectively). Heat energy was greater (P<0.05) in MJ/d for Katahdin than for Alpine (10.19 vs. 7.90) and similar among diets (9.20, 9.40, and 8.53; SEM=0.266), but values in kJ/kg BW0.75 were similar between animal types (560 and 579; SEM=8.4) and greatest (P<0.05) among diets for AL (563, 592, and 553 for alfalfa, AL, and lespedeza, respectively). Ruminal methane emission differed (P<0.05) between animal types in MJ/d (1.17 and 1.44), kJ/g DMI (1.39 and 1.23), and kJ/g average daily gain (ADG; 18.1 and 9.8 for Alpine and Katahdin, respectively). Regardless of period, diet did not impact methane emission in MJ/d or relative to DMI, BW, or ADG.

Conclusion

In conclusion, it is unclear why dietary inclusion of lespedeza did not reduce ruminal methane emission as in previous studies. Species differences in methane relative to DMI and ADG (i.e., lower for sheep than for goats) deserve further attention.

Acknowledgement

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Table 1. *P* values of breed, treatment, period, and their interactions on body weight, feed intake, and growth performance of Alpine doelings and Katahdin lambs

Item[1]	Breed[2]	Treatment[3]	Breed×treatment	Period[4]	Breed×period	Treatment×period	Breed×treatment×period
Body weight, kg	<0.01	0.18	0.49	<0.01	<0.01	<0.01	0.45
DMI, g/d	<0.01	0.20	0.35	<0.01	<0.01	0.49	0.21
DMI, % BW	0.09	0.62	0.72	<0.01	0.64	0.17	0.07
DMI, g/kg of $BW^{0.75}$	<0.01	0.47	0.59	<0.01	0.99	0.27	0.07
Average Daily Gain, g/d	<0.01	<0.01	0.33	<0.01	0.06	0.01	0.12
ADG:DMI	<0.01	<0.01	0.33	<0.01	0.02	0.11	0.48

[1] DMI = dry matter intake;
[2]Alpine doelings and Katahdin ewe lambs.
[3]Treatment consisted of three levels of 100% alfalfa hay, 50% alfalfa hay and 50% lespedeza hay, and 100% lespedeza hay, respectively.
[4]Periods consisted of four segments of 6, 6, 6, and 7 weeks, respectively.

Table 2. Effect of interactions between breed×treattent, breed×period and treatment×period on body weight, feed intake, and growth performance of Alpine doelings and Katahdin lambs

Item[1]	Interaction	Breed[2]			Treatment[3]				Period[4]				
		Alpine	Katahdin	SEM	Alfalfa	Alfalfa: Lespedeza	Lespedeza	SEM	1	2	3	4	SEM
Body weight, kg		33.7	45.3	1.04					30.5	37.0	42.7	47.9	0.75
	Alpine								27.6^{g}	31.8^{f}	35.9^{de}	39.5^{c}	1.05
	Katahdin								33.4^{ef}	42.1^{c}	49.5^{b}	56.3^{a}	
	Alfalfa								30.4^{j}	38.1^{efg}	45.0^{bc}	51.1^{a}	1.29
	Alfalfa: Lespedeza								30.5^{ij}	37.1^{fg}	43.0^{cd}	48.0^{ab}	
	Lespedeza								30.6^{hij}	35.7^{g}	40.2^{def}	44.7^{bc}	
DMI, g/d		1274	1817	51.1					1242	1635	1682	1623	43.9
	Alpine								1063^{a}	1361^{e}	1372^{de}	1300^{e}	62.0
	Katahdin								1420^{cde}	1909^{b}	1992^{b}	1946^{b}	
DMI, % BW									4.07^{b}	4.41^{a}	3.93^{b}	3.40^{c}	0.101
DMI, g/kg of $BW^{0.75}$		91.5^{b}	104.9^{a}	2.58					95.4^{b}	108.4^{a}	100.1^{b}	88.9^{c}	2.43
Average daily gain, g/d		88.1^{b}	180.3^{a}	5.00	159.4	132.2	111.0	6.13	154.4	158.8	126.1	97.5	7.08
	Alfalfa								167.3^{b}	204.1^{a}	137.5^{bcde}	128.7^{cde}	12.26
	Alfalfa: Lespedeza								146.9^{bcd}	168.8^{b}	124.7^{de}	88.2^{fg}	
	Lespedeza								149.1^{bcd}	103.4^{efg}	116.0^{def}	75.6^{g}	
ADG:DMI		0.07	0.10	0.003	0.10^{a}	0.084^{b}	0.079^{b}	0.004	0.12	0.10	0.08	0.06	0.005
	Alpine								0.093^{bc}	0.084^{cd}	0.073^{d}	0.038^{e}	0.0068
	Katahdin								0.147^{a}	0.108^{b}	0.086^{cd}	0.075^{cd}	

[1] DMI = dry matter intake; b; [2]Alpine doelings and Katahdin ewe lambs.
[3]Treatment consisted of three levels of 100% alfalfa hay, 50% alfalfa hay and 50% lespedeza hay, and 100% lespedeza hay, respectively.
[4]Periods consisted of four segments of 6, 6, 6, and 7 weeks, respectively.

Table 3. *P* values of breed, treatment, period, and their interactions on dry matter intake, energy expenditure, and methane emission of Alpine doelings and Katahdin lambs

Item[1]	Breed[2]	Treatment[3]	Breed×treatment	Period[4]	Breed×period	Treatment×period	Breed×treatment×period
DMI, g/d	<0.01	0.02	0.54	<0.01	0.67	0.32	0.68
Respiratory quotient	0.70	0.03	0.15	<0.01	0.39	0.17	0.99
EE, MJ/day	<0.01	0.06	0.23	<0.01	<0.01	0.69	0.80
EE, kj/kg of $BW^{0.75}$	0.13	0.03	0.32	<0.01	0.43	0.03	0.80
ME, l/day	<0.01	0.49	0.97	<0.01	0.42	0.77	0.49
ME/kg DMI	0.20	0.34	0.55	0.23	0.42	0.42	0.48
EE kj/kg of $BW^{0.75}$/HR	0.09	0.01	0.01	<0.01	0.54	0.13	0.78

[1] DMI = dry matter intake; EE= energy expenditure; ME = methane emission; HR = heart rate.
[2]Alpine doelings and Katahdin ewe lambs.
[3]Treatment consisted of three levels of 100% alfalfa hay, 50% alfalfa hay and 50% lespedeza hay, and 100% lespedeza hay, respectively.
[4]Periods consisted of four segments of 6, 6, 6, and 7 weeks, respectively.

Table 4. Effect interactions between breed×treattent, breed×period and treatment×period on dry matter intake, energy expenditure, and methane emission of Alpine doelings and Katahdin lambs

Item[1]	Interaction	Breed[2]			Treatment[3]				Period[4]				
		Alpine	Katahdin	SEM	Alfalfa	Alfalfa: Lespedeza	Lespedeza	SEM	1	2	3	4	SEM
DMI, g/d		914^{b}	1228^{a}	45.9	940^{b}	1133^{a}	1141^{a}	56.3	1113^{ab}	963^{b}	1212^{a}	996^{b}	50.2
Respiratory quotient					0.97^{b}	0.99^{ab}	1.00^{a}	0.007	1.03^{a}	0.97^{c}	0.96^{c}	1.00^{b}	0.007
EE, MJ/day		7.90	10.19	0.217					8.54	9.15	9.56	8.93	0.176
	Alpine								7.82^{ef}	8.09^{e}	8.16^{de}	7.53^{f}	0.249
	Katahdin								9.27^{c}	10.20^{b}	10.95^{a}	10.33^{b}	
EE, kj/kg of $BW^{0.75}$					563.0	592.5	553.3	10.28	631.9	595.5	557.8	493.3	8.05
	Alfalfa								636.8^{ab}	591.2^{c}	547.8^{de}	476.3^{h}	13.95
	Alfalfa: Lespedeza								669.0^{a}	608.0^{bc}	585.3^{cd}	507.6^{fgh}	
	Lespedeza								590.0^{c}	587.3^{c}	540.1^{ef}	495.9^{gh}	
Methane emission													
ME, l/day		29.7^{b}	36.3^{a}	1.28					29.3^{b}	32.3^{b}	40.0^{a}	30.5^{b}	1.30
EE kj/kg of $BW^{0.75}$/HR					6.23	6.69	6.16	0.133	6.34^{b}	6.72^{a}	6.46^{ab}	5.91^{c}	0.116
	Alpine				5.82^{d}	6.86^{a}	5.99^{cd}	0.189					
	Katahdin				6.64^{ab}	6.52^{abc}	6.32^{bcd}						

[1] DMI = dry matter intake; EE= energy expenditure; ME = methane emission; HR = heart rate.
[2]Alpine doelings and Katahdin ewe lambs.
[3]Treatment consisted of three levels of 100% alfalfa hay, 50% alfalfa hay and 50% lespedeza hay, and 100% lespedeza hay, respectively.
[4]Periods consisted of four segments of 6, 6, 6, and 7 weeks, respectively.

Category: Sustainable livestock & feed production
ORL_07

Circular Economies in Integrated Cattle-Oil Palm System

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Abstract

The circular economy promotes sustainability for the benefit of businesses, society and the environment. It fulfils 12 of the 17 Sustainability Development Goals as it encompasses recycling and regenerating resources for production and consumption as long as possible, hence extending the lifecycle of products with minimum waste. Its focus on resource efficiency, and waste reduction offers a crucial alternative for agriculture and food production amidst the depleting resources, deforestation and global warming commonly associated with conventional agriculture, particularly cattle and palm oil production. Relevant authorities, livestock farmers and planters are responding accordingly with sustainable practices, namely the Green Practices Guideline for Livestock Sector and Malaysia Sustainable Palm Oil (MSPO). The elements of good animal husbandry practices in an integrated cattle-oil palm system support oil palm's sustainability initiatives that aligned well with Circular Economy and Sustainable Development Goals. Systematic integrated cattle – oil palm has been proven compatible and is very much in congruence with circular economic features conceptually as well as operationally. While strategic 'insertion' allows smooth introduction of cattle into oil palm, strategic rotational grazing management provides a synchronised approach without jeopardising palm's operation and productivity. These strategies optimise the available resources that advocate recycling by-products and waste for the production of beef and palm oil within the same unit of land. It is a Zero-land beef production system that is devoid of deforestation. Palm's undergrowth vegetations, fronds and palm kernel cake provide complete ruminant nutritional requirements. Rotationally grazing cattle provides a biological weeding mechanism to reduce herbicide usage that contaminate water sources, while their solid and liquid wastes enrich soil's organic matter, restore fertility and structure to enhance its carbon sequestration capabilities. This integrated agri-food system offers a transformative lower carbon footprint of beef and palm oil while continuing to provide sustainable food security and livelihood for the country and our rural communities, respectively.

Category: Sustainable livestock & feed production
ORL_08

Integrating Circular Economy Principles in Agroecology-Based Food Systems

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Abstract

Animal-based food production and consumption have raised concerns from various aspects including animal health and welfare, food safety, environmental pollutions, ethics and overall sustainability. Agroecology offers an alternative approach to sustainable food systems that centers on thirteen principles pillared on recycling, input reduction, animal health, soil health, biodiversity, connectivity, synergy, economic diversification, social values and diets, co-creation of knowledge, land and natural resource governance, fairness and participation [1].

As defined by Stephen Gliessman (2018), agroecology is:

The integration of research, education, action and change that brings sustainability to all parts of the food system: ecological, economic, and social. It's transdisciplinary in that it values all forms of knowledge and experience in food system change. It's participatory in that it requires the involvement of all stakeholders from the farm to the table and everyone in between. And it is action-oriented because it confronts the economic and political power structures of the current industrial food system with alternative social structures and policy action. The approach is grounded in ecological thinking where a holistic, systems-level understanding of food system sustainability is required. [2]

Inherently, agroecology integrates the principles of circular and solidarity economy that provides a strong foundation for sustainable and ethical food systems promoting fairness and animal welfare-friendly products, which are increasing in demand among consumers and producers. FAO identified circular and solidarity economy, recycling and efficiency as three of ten key agroecological elements guiding the transition towards sustainable agriculture and food systems [3], incorporating food loss and waste (FLW) management for responsible production and consumption [4] to make animal-based food value chains shorter and more resource-efficient, Meanwhile, pivotal outcomes of five principles for agroecological livestock production are to achieve – *i) improved animal health; ii) reduced inputs; iii) reduced pollution*

by optimizing metabolism in the farming system; iv) enhanced diversity for greater resilience; and *v) preserved biological diversity.* [5]

In addition, a shift in production and consumption models from scale to scope is also suggested for an agroecology-based food system transformation, prompting a degrowth, where the reduction of meat, as well as fish and seafood consumption is regarded as the most useful path for sustainability [6]. By strengthening short food circuits, agroecology-based food systems could provide strong support for a sustainable increase in the productivity of food producers while maintaining a fair price for consumers and reducing negative impacts on the environment and animal health [7].

On the other hand, the intensification of livestock production could benefit from the application agroecological-based approach of various circular bio-economy strategies through improvement on livestock feeding practices and sustainable production system. For instance, adoption of dual-purpose cropping could enhance livestock nutrition, potentially produce high-quality feed, while enhancing crop yields and soil fertility by mulching crop residues [8]. Mixed-crop livestock systems such as current practice of integrating local cattle rearing in oil-palm plantations is a potential agroecological approach in Malaysia [9].

The willingness to adopt circular practices in livestock production, however, is also critically linked to the role of relevant policies and regulations, subsidies, and strategic investment in human and social capital [10]. Further, integrated systems through agroecology are known to be knowledge-intensive, requiring a transdisciplinary approach that must address the gaps in social dimensions and wholistic food system [11].

This paper highlights the systemic integration of circular economy principles in animal production and consumption value chains from the perspectives of agroecology-based food systems. Case studies and scenario analyses from published research articles are examined for evidence of circular economic integration in agroecology-based food systems focusing on animal-based production and consumption attributes.

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Category: Animal nutrition & feeding
ORL_09

Optimizing Ruminant Feed Efficiency: The Potential of Napier-based Forage Pellets

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Introduction

Forages play a crucial role in ruminant nutrition by providing essential fiber necessary for optimal rumen function and digestion. Among forage crops, Napier grass (*Pennisetum purpureum)* is widely cultivated in Malaysia due to its high yield and dry matter content, making it a cost-effective feed source for livestock. However, its nutritional value depends on proper management, particularly harvesting at the right maturity stage to maximize nutrient retention and support livestock growth and productivity.

The increasing demand for quality forage in Malaysia has been met with challenges such as limited grazing areas and insufficient supply of hay, silage, and other conventional forage products. Additionally, previous studies highlight a decreasing number of beef cattle farmers in the northern region, driven by limited feed resources and the rising cost of bran. (Kamarudin et al., 2025). To address this issue, alternative forage processing methods, such as pelletization, have been explored to enhance feed quality, improve nutrient availability, and optimize storage and transportation efficiency.

This study aims to evaluate the potential of Napier pellets as a sustainable and nutritionally balanced feed alternative for ruminants. The specific objectives are: (i) to analyze the nutritional composition of Napier pellets and (ii) to assess the growth performance of cows fed with pelletized Napier compared to fresh-cut Napier grass.

Keywords: *Napier grass (Pennisetum purpureum), Forage, Pelletization, Cattle feeding, Ruminant nutrition*

Materials and Methods

Fresh-cut Napier grass was harvested at 45 days of regrowth, chopped into 3-5 cm pieces, and fed directly to ruminants. Napier pellets were produced by sun drying the grass to 25%

moisture content, grinding it into 3 mm particle size, and pelletizing using a flat-die pelletizer with an 8 mm die.

The feeding trial was conducted at FGV Tawai, Gerik, Perak, using a completely randomized design with eight cows (four per treatment). The animals were divided into two treatment groups: (i) a control group fed fresh-cut Napier grass and (ii) a treatment group fed pure Napier pellets. The cows were fed at 3% of their body weight on a dry matter (DM) basis for 60 days. Body weight was recorded biweekly to monitor growth performance, while feed intake and feed conversion ratio (FCR) were also assessed. The nutritional composition of the feed, including crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), and total digestible nutrients (TDN), was analyzed using proximate analysis and fiber fractionation methods.

Results and Discussion

Table 1: Nutritional Composition of Fresh-Cut Napier and Napier Pellets

Nutrient content	Fresh cut Napier	SEM	Napier Pellet	SEM
DM (%)	18.70^{b}	±0.21	100.00^{a}	±0.00
Ash (%)	12.64^{a}	±1.17	13.03^{a}	±1.49
Organic Matter (%)	87.58^{a}	±1.63	86.97^{a}	±1.49
Crude Protein (%)	4.41^{b}	±1.01	13.19^{a}	±0.32
Crude Fat (%)	1.16^{a}	±0.10	0.88^{b}	±0.04
Crude Fiber (%)	43.91^{a}	±1.02	37.30^{b}	±0.59
Energy (kcal/kg)	3882.36^{b}	±12.47	4109.50^{a}	±36.55
NDF (%)	77.94^{a}	±0.80	77.67^{a}	±0.52
ADF (%)	52.98^{a}	±1.56	57.00^{a}	±1.01
ADL (%)	9.21^{a}	±0.28	18.53^{a}	±3.84
Nitrogen-Free Extract	37.48^{a}	±1.30	35.60^{b}	±1.37

Mean values in the same row with different superscripts (a, b) are significantly different with $p<0.05$ (ANOVA). Values are presented as mean ± standard error.

Conclusion

The findings highlight that pelletizing Napier grass improves its feeding value compared to fresh forage, reducing waste and enhancing nutrient availability. However, Napier Pellet alone remains nutritionally limited, requiring supplementation to optimize growth performance. This study underscores the benefits of Napier pelletization in enhancing livestock productivity and sustainable feed management in Malaysia.

Acknowledgement

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Category: Animal nutrition & feeding
ORL_10

AndroScope - CASA System to Go: Improving Breeding Quality in Livestock

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Abstract

CASA is Computer-Assisted Semen Analysis. CASA is a sophisticated technology used to assess the quality of semen in livestock breeding. It analyzes sperm motility, concentration, morphology, and other factors critical for fertility. The system uses a combination of video capture and artificial intelligence to measure sperm movement and health, helping to select the best quality semen for artificial insemination (AI).

The CASA system can improve breeding by increasing the precision. By accurately assessing semen quality, the CASA system enables more precise selection of superior sperm for breeding, leading to higher pregnancy rates and healthier offspring. Moreover, the CASA system can improve breeding by giving data-driven decisions. The system provides real-time data on sperm characteristics, allowing breeders to make informed decisions about which semen samples to use. Next, efficiency can be increased by using the CASA system. It reduces the need for manual analysis, which can be time-consuming and prone to human error. CASA systems speed up the selection process, increasing productivity for livestock operations.

AndroScope is a compact mobile CASA system that fits in any pocket. A mobile or "to-go" system suggests ease of use in field conditions. It provides portability and efficiency. Second is AI-Powered analysis that provides precise semen analysis to get verified accuracy. AndroScope analyses provide accurate data on sperm motility and concentration, as trials verified. The linear correlation of total and progressive motility measured with AndroVision® and AndroScope. An R^2 (coefficient of determination) of 1.0 means that there is a complete correlation between the methods. For the comparison of AndroVision® and AndroScope, $R^2 = 0.94$ for total motility and $R^2 = 0.97$ for progressive motility indicate high correlation between the measurement methods. This also applies to the measured sperm concentration, for which an R^2 of 0.93 was obtained. CASA system often uses AI and machine learning for precise sperm evaluation. Third is improved insemination success. Higher accuracy in selecting viable sperm leads to better fertility rates. Last but not least, livestock-specific optimization: the system is likely customized for cattle, swine, sheep, or other breeding animals.

When evaluating the AndroScope - CASA System in terms of subjective and objective approaches in livestock breeding, we can differentiate how semen analysis has traditionally been done versus how modern technology improves accuracy and reliability. The subjective approach relies on human judgment, experience, and manual techniques to assess semen quality. One of its limitations is less accuracy because human error and fatigue can reduce reliability. Traditionally done semen analysis is time consuming. Manual analysis takes longer, making large-scale breeding operations inefficient. The objective approach involves technology and automation to remove human bias and improve precision. Compared to traditionally done semen analysis, CASA system or AndroScope provides highly accurate data as AI and digital analysis reduce human error. It also provides faster processing. Large datasets can be analyzed in seconds, improving efficiency and faster decision-making can be done. Breeders can rely on precise data to select high-quality sperm for breeding.

The AndroScope - CASA System appears to be an advanced solution designed to boost the efficiency, accuracy, and success of artificial insemination in livestock breeding. By leveraging technology to better understand sperm quality, it allows for higher breeding standards, healthier animals, and more sustainable farming practices.

Category: Animal health
ORL_11

Impact of Methionine-Cysteine Inoculation in Broilers on Growth Performance and Haematological Indices in Mitigating Heat Stress

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Abstract

Heat stress is a problem in poultry production particularly broilers, it causes reduction in the feed intake, body weight gain, increased oxidative stress and impaired immune competence. This study evaluated the impact of intramuscular inoculation (IMI) of methionine-cysteine on heat-stressed broilers on growth and haematology. Twenty-five 1-day-old broiler chicks were sourced and allocated into five distinct treatment groups, each consisting of five birds. The first group served as negative control (NC), the second group were inoculated with 0.2ml/bird of normal saline positive control (PC), the third group were inoculated with methionine (MET), fourth cysteine (CYS), and the fifth with a combination of (MET + CYS), both groups were inoculated with 0.2ml/bird of each inoculum respectively. Birds were maintained in a controlled environment for 28 days, subjected to a high temperature of 39.6±1 °C and 55% relative humidity for 6 hours each day during the first 10 days. Feed and water were provided ad libitum. The methionine group exhibited a greater final body weight (1290.00g vs. 1236.67g, $P < 0.0336$) and average weight gain (1248.00g vs. 1187.67g, $P < 0.0133$), alongside a reduced feed conversion ratio (1.34 vs. 1.41, $P < 0.0095$) when compared to the NC. No significant effect was observed in feed intake ($P>0.9268$). The inoculation of CYS and its combination with MET resulted in enhanced lymphocyte levels (97.00% vs. 91.33%, $P < 0.0034$) for CYS and monocyte levels (8.00% vs. 3.00%, $P < 0.0050$) for MET+CYS compared to the negative control (NC). This suggests that MET inoculation has a positive influence on direct muscle deposition, as it improves feed conversion into body mass and protects the body via lymphocyte and monocyte enhancement. The IMI of methionine-cysteine effectively enhanced birds' responses to heat stress, leading to improvements in body weight, feed conversion efficiency, and immune system modulation in broilers.

Keywords: *Broiler, Cysteine, Heat Stress, Intramuscular, Methionine*

Category: Animal health
ORL_12

Prevalence and Molecular Detection of *Corynebacterium pseudotuberculosis* in Small Ruminants with Clinical Caseous Lymphadenitis in Besut, Terengganu

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Introduction

Caseous lymphadenitis (CLA), caused by zoonotic bacteria *Corynebacterium pseudotuberculosis* (*C. pseudotuberculosis*), is a major infectious disease affecting small ruminants in Malaysia [1]. CLA is characterized by abscess formation in the lymph nodes and internal organs of the affected small ruminants [2]. This study aims to determine the prevalence of CLA infections and molecularly detect the presence of *C. pseudotuberculosis* among clinically infected small ruminants.

Materials and methods

A total population of 100 small ruminants (50 goats and 50 sheep) from the Universiti Sultan Zainal Abidin (UniSZA) Pasir Akar Farm were examined to determine the clinical sign of CLA infections. Pus samples from the animals with abscess suggestive of CLA infections were collected aseptically from abscesses using sterile scalpel blade and container. The pus samples were then streaked on 5% sheep blood agar. Presumptive bacterial colonies were subjected to polymerase chain reaction (PCR) targeting *pld* (203 bp) and 16S rRNA genes (815 bp) for identity confirmation [2]. Bacterial isolates that carried both *pld* and 16S rRNA genes were confirmed to be *C. pseudotuberculosis*. Antimicrobial susceptibility testing (AST) was performed to evaluate the effectiveness of selected antibiotics against *C. pseudotuberculosis* isolates.

Results and discussion

The overall prevalence of CLA infections in UniSZA Pasir Akar Farm was 7% (7/100), with six cases (12%; 6/50) in sheep and one case in a goat (2%; 1/50). The PCR test confirmed the presence of *C. pseudotuberculosis* in all seven pus samples collected. Figure 1 shows the prevalence of CLA infections between goats and sheep in UniSZA Pasir Akar Farm.

Based on the results of the study, small ruminants at UniSZA Pasir Akar Farm have a 7% prevalence of CLA, which is caused by *Corynebacterium pseudotuberculosis*. The greater infection prevalence in sheep as opposed to goats raises the possibility that sheep are more vulnerable to CLA, which might be brought on by several variables such genetic susceptibility, variations in immunological response, or agricultural management techniques. To establish the presence of C. pseudotuberculosis in clinically infected animals, PCR has proven to be a quick, sensitive, and specific technique of detection. 48 hours after the sample was collected, *C. pseudotuberculosis* was confirmed. The isolates of *C. pseudotuberculosis* showed a moderate susceptibility to penicillin (57.1%) and a high degree of susceptibility to doxycycline (100%). The antimicrobial properties of doxycycline against *C. pseudotuberculosis*, may be attributed to its broad-spectrum action and great tissue penetration [3]. However, the considerable susceptibility to penicillin that has been reported suggests that some isolates may develop resistance.

Figure 2 shows the AST results, indicating that most of the isolates were susceptible towards doxycycline (100%) and penicillin (57.1%).

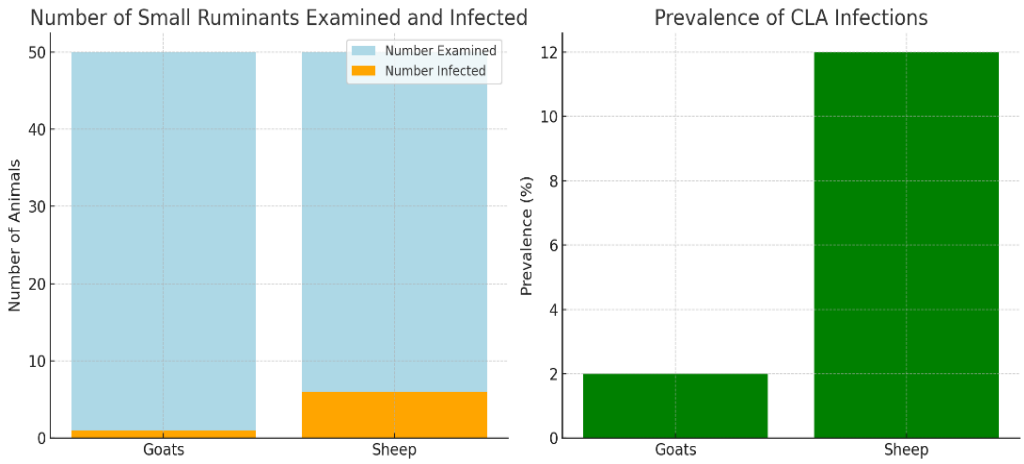


Figure 1. Prevalence of CLA infections between goats and sheep in UniSZA Pasir Akar Farm.

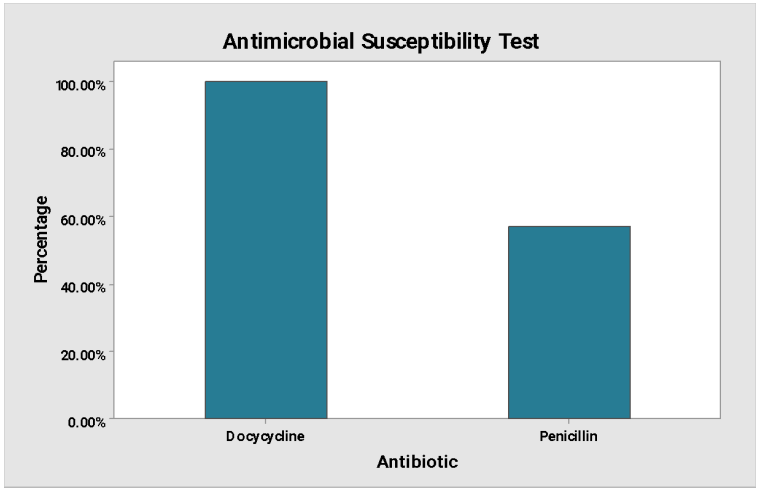


Figure 2. Comparison of antibacterial susceptibility

Conclusion

These findings highlight that superficial abscesses cases among goats and sheep of UniSZA Pasir Akar Farm were associated with *C. pseudotuberculosis* infections. A sustainable control strategy is highly recommended to mitigate the impact of *C. pseudotuberculosis* infections at UniSZA Pasir Akar Farm. Given the economic and health impacts of CLA, a sustainable control strategy is essential to mitigate the disease's effects. Regular monitoring, improved hygiene practices, and targeted treatment protocols should be adopted to reduce the incidence of CLA and improve animal health and farm farm-level prevalence study can serve as a baseline for monitoring changes in prevalence over time or in response to interventions.

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Category: Animal nutrition & feeding
ORL_13

In Vitro Evaluation of Herbal Additives on Rumen Fermentation and Digestibility in Dairy Cattle

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Abstract

Functional feeds are designed to enhance the performance, productivity, and health of ruminants. Herbal ingredients as feed additives are increasingly recognized for their potential benefits, especially in meeting consumer demands for products free from synthetic chemicals and can reduce methane gas production. This study aims to evaluate in vitro rumen conditions with the addition of coriander powder (*Coriandum sativum/*T1), white pepper (*Pipper ningrum Linn/*T2), and cinnamon (*Cinnamomum Burmannii/*T3) to a control feed (T0), focusing on fermentation, digestibility, and gas production. In vitro is used as a method to assess the utilization of herbs used as functional feed. The incubation media used are rumen fluid and McDougall's solution, placed in bottles and incubated in a water bath at 39-41°C for 72 hours. Rumen fluid was collected from Friesian Holstein cattle with a fistula at the Dairy Cattle Farm of the Bogor Agricultural University. The rumen fluid was taken and conducted in vitro in four treatments and four replications. The cattle were fed with 70% elephant grass (*Pennisetum purpureum*) obtained from the field and 30% commercially obtained cattle concentrate. Coriander powder, white pepper powder, and cinnamon powder were obtained from the local supermarket. Variables in this study were gas production, methane gas emissions, dry matter digestibility (DMAT), organic matter digestibility (OMC), ammonia concentration, VFA concentration (total and partial), total bacterial, total protozoa, pH, Gas rate, and methane. The results showed no significant differences (P>0.005) in rumen pH, ruminal NH3, dry matter digestibility (DMD) and organic matter digestibility (OMD), methane production, total VFA, and partial VFA, but significantly increased (P<0.05) protozoa populations. The conclusion was the addition of coriander powder, white pepper, and cinnamon effectively increased the

digestibility of dry matter (DMC) and organic matter (OMC), which were more easily degraded. It also enhanced the total gas production rate and reduced methane emissions.

Keywords: *herbal additives, methane, ruminants, dairy cattle*

Category: Ruminant production
ORL_14

Growth Performance of Holstein Friesian Dairy Heifers in Malaysia

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Introduction

Today's successful dairy operation recognizes that raising dairy heifers is an important investment for the future. Raising your own dairy replacement heifers offer several benefits, including greater genetic control, better understanding of the heifer's background, and potential cost savings compared to importing or buying them locally. It also allows for a more gradual and desired introduction of new genetics and reduces the risk of disease propagation into the herd. Commonly, the main goal for managing replacement heifers is to freshen them (calf down) between 22 and 24 months of age, to reduce expenditures and to increase total milk production. Focus should be on growing heifers with an adequate rate of gain without excessive body condition. This can be accomplished through good nutrition and sound animal management practices. This paper aims to assess the growth performance of Holstein Friesian heifers born and raised under the Malaysian climate, with optimum feeding and environmental management.

Keywords: *dairy cow, growth performance, heifer, Holstein-Friesian*

Materials and methods

Data was collected from ANGKASA-KOMARDI Farm in Projek Pertanian Moden, Kluang, Johor. In April 2022, fifty (n=50) heads of imported Holstein-Friesian bred heifers from Australia were brought in and raised under free stall pens housing system. Data on the body weight of heifers were collected/recorded soon after birth and on monthly basis subsequently. A 2-month pre-weaning stage was adopted, during which the calves were primarily fed a milk replacer diet. Specially formulated concentrate diet and Napier grass were introduced at the age of 6 weeks for the heifers. The specially formulated concentrate diet is made up of Soyabean Meal, Wheat Pollard, Rice Bran, Corn, Palm Kernel Expeller and Vitamin Pre-Mixed (13.1 MJ/Kg DM of Metabolisable Energy and 20.13% Crude Protein content). The

daily amount of concentrate offered to the growing heifers are calculated based on the requirement to achieve heifer body weight at breeding (13-15 months of age) of 55% of the mature body weight. Napier grass were offered *at libitum*. The body weight data set was collected from 11 Holstein Friesian heifers. Descriptive analysis (mean values and standard deviations for sample) was performed using Microsoft Excel version 2402.

Results and discussion

The bred Holstein Friesian heifers started to calve down from October to December 2022. Thirty nine (n=39) Holstein Friesian calves were successfully born with the ratio of 22 males and 17 females. The pre-weaning calf mortality rates were recorded at 55% and 29%, respectively for male and female calves. Table 1 presents the average body weight chart for Holstein Friesian heifers in Malaysia. The targeted 350 kg body weight at 15 months of age was not achieved and fall short of 100 kg. Several factors attributes to this, such as inadequate nutrition level during the critical pre-weaning stage [1], low quality of fodder and concentrate offered during the post-weaning rearing period [2]. The specially formulated concentrate was supplied by an outside vendor and such we could ascertain consistency in quality throughout the 27-month rearing period. Hot and humid tropical environmental factor could also affect feed intake and subsequently will effect body weight gain [3].

Table 1. Average Body Weight (kg) Chart for Holstein Friesian Heifers in Malaysia.

Parameters	Birth Wt	3-month	6-month	9-month	12-month	15-month	18-month	21-month	24 month	27-month
Attained	31.9	51.7	103.4	135.2	199.5	246.2	286.8	321.7	327.8	349.9
Standard Deviation	3.1	5.4	10.7	17.9	23.8	31.8	33.6	37.1	49.5	41.2
Australian Standard	36.1	105.0	168.0	231.0	294.0	357.0	420.0	483.0	546.0	580.0

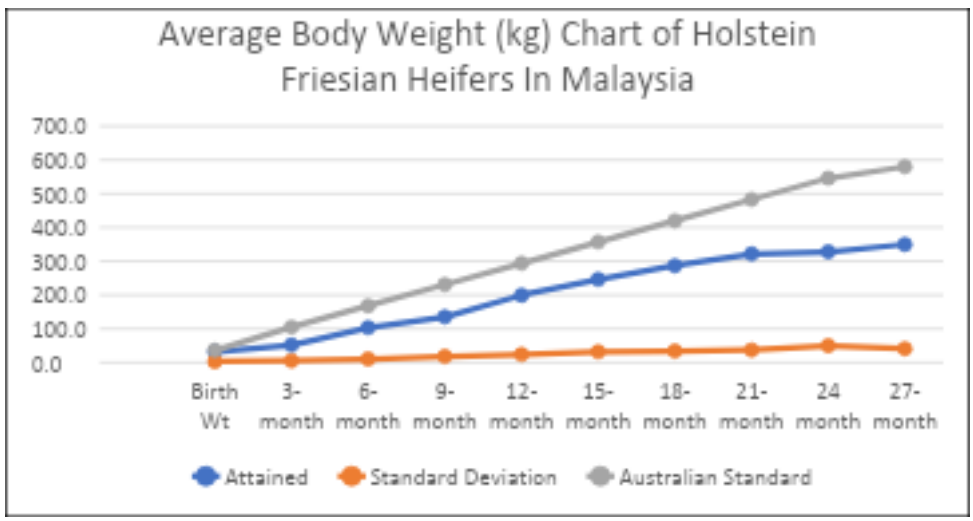


Figure 1. Average Body Weight (kg) Chart of Holstein Friesian Heifers in Malaysia

Conclusion

In summary, the results show that there is potential for the growth performance of Holstein-Friesian heifers to be improved. Findings from this study have contributed to a better understanding of the growth performance of Holstein Friesian heifers under Malaysian climate conditions. A 3-month pre-weaning period may be an option for improvement as compared to the 8-weeks being currently practised. This study also highlights the importance of the quality and quantity of fodder and concentrate offered to growing dairy heifers.

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Category:Non-ruminant production
ORL_15

Ecoenzyme: A Natural Supplement and Disinfectant for Poultry Efficiency: A Systematic Literature Review

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Abstract

The poultry industry seeks sustainable methods to enhance production efficiency while reducing reliance on traditional, and potentially harmful, additives and disinfectants. Profit inefficiencies in poultry egg production can arise from factors such as larger stock sizes, limited access to extension services, inadequate livestock insurance, and suboptimal biosecurity practices. This systematic literature review aims to evaluate the role of ecoenzymes in improving poultry production, focusing on technical, allocative, and economic efficiencies and their impact on feed conversion ratios (FCR), biosecurity, and profitability, while also examining the influence of various farm characteristics on profit efficiency. A systematic literature review was conducted, analyzing studies that investigated the effects of ecoenzyme supplementation on poultry. Data was extracted from relevant articles focusing on FCR, weight gain, biosecurity measures, production costs, and profit margins. Key parameters and findings were synthesized to assess the potential of ecoenzymes in modern poultry management. Studies suggest that ecoenzyme supplementation, particularly in drinking water, can lead to improved FCR and weight gain in poultry. Ecoenzymes also exhibit potential as natural disinfectants, contributing to enhanced biosecurity and reduced reliance on chemical disinfectants. Analysis of profit efficiency determinants revealed that factors like stock size, access to extension services, livestock insurance, and biosecurity measures are negatively correlated with profit inefficiency, while the age of poultry farmers has a positive association. Ecoenzymes present a promising natural supplement and disinfectant for poultry production, potentially enhancing economic viability through improved FCR, reduced production costs, and enhanced biosecurity. However, further research is needed to quantify these benefits across various production systems and scales, particularly focusing on optimal dosages and long-term effects on poultry performance and profitability. Future studies should

compare functional models related to technical, allocative, and economic efficiencies when using ecoenzyme-supplemented drinking water against plain water.

Keywords: *Poultry Management, Biosecurity, Ecoenzyme, Production Efficiency, Profitability*

Introduction

The growth and quality of poultry livestock are improved by feed additives, which are necessary for the production of nutritious chicken meat. Due to their organic acid content, eco-enzymes are a natural feed additive that can boost poultry production (Palupi *et al.,* 2024). Humans have been able to obtain enough meat and eggs from the chicken industry, which is a significant source of food (Zhang *et al.,* 2023). Figure 1 shows that during the past few decades, the consumption of poultry products has increased significantly worldwide.

The public's growing desire for animal protein sources encourages innovation in the development of livestock breeds with high productivity and quick growth rates (Ay *et al.,* 2024). Microbiological problems in the water supply system can be successfully addressed by routinely cleaning the waterlines in livestock houses, particularly poultry houses. Waterlines are frequently cleaned using physical and chemical techniques, primarily by flushing and applying various chemical disinfection compounds, either separately or in combination, such as hydrogen peroxide, acidifiers, chlorine preparations, and other materials. While physical flushing is quick and easy, it requires regular repetition, has low biofilm removal from the waterline, high utility costs, labor problems, and effluent discharge and decrease the number of dangerous bacteria in the cecum. According to Byrd *et al.* (2003), broiler flocks with drinking water treated with chlorate have lower levels of *Salmonella* contamination. Nevertheless, animals are harmed by the byproducts of traditional chlorinated disinfectants (Ou *et al*., 2011; Srivastav *et al.,* 2020; Meng *et al.* 2023).

The study conducted by Li *et al.* (2023) showed that optimization of drinking water disinfection procedures could reduce farm's blue and gray water footprints and lowered water stress and pollution loads in aquatic environments, indicating that Slightly acidic electrolyzed water (SAEW) is an ideal disinfectant for the drinking water of layinghens. Compared to traditional pipe cleaning using chemical disinfectants to soak and flush pipes, adding SAEW to drinking water showed superior antimicrobial efficacy while saving cost and energy and improving defecation rates. The cost-effective method reduced static water consumption by 19.05% and 7.77% respectively compared to traditional disinfection methods without affecting egg quality. SAEW is a beneficial substitute for cleaning water intended for chicken farming, its minimal byproducts, energy savings, production ease, and effectiveness as an antibacterial are all attributes that are valued. It's suggested that the concentration of SAEW in the water of the hens should be 0.3 milligrams per liter on a regular basis in order to maintain adequate hygienicness.

Specifically, the potential of econzymes to enhance disease prevention and hygienic practices in natural disinfectants and drinking water is being more actively considered. When applied to cages, ecoenzymes can function as natural disinfectants, they eliminate microorganisms like flies, bacteria, and fungus. As a result, they are ideal for use as natural

pesticides and cleansers. Chandra *et al.* (2020), Megah *et al.* (2008) and Mavani *et al.* (2020), environmentally friendly enzymes can also be employed as natural disinfectants and as a solution to clean water sources and animal cages in a sustainable manner. Several significant benefits exist in the use of ecoenzymes in farm water for chickens, as well as in the disinfestation of agriculture. By enhancing the efficiency of the digestive system, Eco-enzyme can enhance the growth and nutrient absorption capacity in chickens (Dewi *et al.,* 2015). The antibacterial and antifungal properties of the organic acids in Ecoenzyme contribute to the health of chickens and reduce the frequency of disease (Fati et al., 2024).

Ecoenzymes facilitate growth without the risk of antibiotic resistance, they are also a natural alternative to antibiotics. This is of special significance when there is a desire to reduce the modern way of raising poultry. Ecoenzymes stimulate growth without any risks that the population will develop resistance to antibiotics and are thus considered as the natural equivalent to antibiotics. Since attempts to use fewer antibiotics, this is particularly important in modern chicken agriculture (El-Hack *et al.,* 2022), it can lower operating costs by reducing chemical disinfectants and veterinary treatments that result from disease control because these are not cheap for chicken raisers.

Materials and Methods

The primary goal of this SLR is to assess the value of ecoenzyme in increasing the efficiency of poultry production, including its impact on the FCR, growth, safety, and profitability. The review also aims to compare ecoenzyme utilization with traditional methods of disinfection and feed supplementation. Peer-reviewed articles published between 2015–2025. Studies focusing on ecoenzyme applications in poultry farming (e.g., drinking water supplementation or disinfectants). Articles reporting measurable outcomes such as FCR, weight gain, biosecurity improvements, or economic analysis. Studies conducted on poultry species (broilers, layers, and so on). Studies unrelated to poultry farming or ecoenzyme applications. Articles not published in English. Opinion pieces, reviews without experimental data, or articles lacking quantitative metrics.

The search strategy for this systematic literature review involves utilizing multiple academic databases to ensure comprehensive coverage of relevant studies. The databases selected for this review include Scopus, PubMed, Google Scholar, and ScienceDirect, as they provide access to high-quality peer-reviewed articles across various disciplines. To locate relevant literature, specific keywords were employed, including ecoenzyme, poultry feed supplement, biosecurity, production efficiency, feed conversion ratio, and profitability. These keywords were selected to describe research that focuses on the utilization of environmental enzymes in chicken farming and the impact that this has on production metrics and economic viability.

The first step in the study selection process will be to carry out a screening of titles and abstracts in the found publications to eliminate those studies that do not fit the pre-defined inclusion and exclusion criteria. Articles selected as relevant by their titles and abstracts during the first search will then be retrieved in more detail to make a second eligibility check through a full paper to see its applicability to the research objectives and quality of its methodology. Articles meeting all inclusion criteria and providing sufficient data for a detailed analysis will comprise the final selection.

A detailed assessment of the included studies' quality will be conducted using a checklist that takes into account multiple factors that are important in the design of research, including the presence of randomised controlled trials, the sample size is appropriate, the statistics are significant, and the study's overall relevance to the research question is stated. The most important method for data analysis is narrative synthesis, which summarizes the results of all included studies. If there is sufficient comparable quantitative data, such as increases in feed conversion ratio (FCR), a meta-analysis can be used to pool the results and draw more informed conclusions

The results are reported in thematic sections covering the following topics: the economic impact of using ecoenzymes in chicken farming; their functionality in terms of biosecurity and disinfection effectiveness; and their effects on feed efficiency and growth behavior. Visual aids such as flowcharts, tables, and graphs will be used to improve the information's accessibility and clarity. Ecoenzymes have the potential to increase FCR, lower feed costs, and improve biosecurity in chicken production, according to the review's final summary of the major takeaways from the examined literature. While indicating that ecoenzymes present an economically viable alternative to traditional methods, it will also acknowledge the need for further long-term studies to validate these findings. Recommendations for future research will include investigations into optimal dosages for different poultry species and explorations of the scalability of ecoenzyme production for commercial farming operations (Table 1).

Discussions

Previous Research Results SLR Method (Systematic Literature Review) (Table 2)

An Economic Evaluation was Performed on Enhanced Biosecurity Strategies Implemented Across Three Different Types of Chicken Farms Situated in Northern Vietnam

According to Tung *et al.* (2020) the entire amount spent to get the finished product is known as the cost of production for broilers, breeding eggs, or day-old chicks. These expenses consist of the cost of breeding eggs and chicks, the cost of food and medication, labor costs, housing depreciation, etc. While fixed costs stay the same over time and are not affected by variations in output levels, variable costs fluctuate in response to changes in the quantity of outputs generated. Across all farm types, model farms with the adoption of the Enhanced Biosecurity Practices (EBP) had lower overall production costs than control farms. In both broiler and breeder farms, feed costs made up the largest portion of the overall cost. Variable cost formed a large part of total cost. The proportion of variable costs to overall costs.

MLE represents Maximum Likelihood Estimates of the Stochastic Frontier Profit Function

The results show the relative influence of various inputs on chicken egg production. The coefficients for all significant factors were positive, with the exception of feed, which had a negative coefficient. The estimated labor variable was found to be statistically significant at the 1% level. Among these factors, age emerged as the only positive and statistically significant coefficient, achieving significance at the 5% level. Furthermore, the coefficients for

stock size, access to extension services, livestock insurance, and biosecurity protocols were all negative and statistically significant at the 1% level. The lambda (λ) estimate of 2.2057 is statistically significant at 5%, indicating profit inefficiency among chicken egg growers in southwest Nigeria. It suggests that variances in farm earnings were mostly due to differences in farming techniques. As a result, profit may be maximized by minimizing inefficiencies among chicken growers. The estimate for labor (X4), which has a coefficient of 0.6446, seems to be the most significant factor influencing profit efficiency. This indicates that a 10% rise in labor costs results in a 6.4% reduction in profits from egg production.

Stock size, access to extension services, livestock insurance, and biosecurity practices all have negative and significant coefficients, indicating that increasing stock size, access to extension services, livestock insurance, and greater levels of biosecurity activities reduce profit inefficiencies. Furthermore, a positive and statistically significant association was discovered between the age of the chicken farmer and profit inefficiency (Akintunde *et al*., 2018).

Feed efficiency and growth performance

The growth performance and feed efficiency of the experimental hens aged 4-14 weeks. The starting live weight ranged from 100 to 107 g/head, however the probiotics (PRO) treatment resulted in a greater ultimate weight compared to the other treatments. Supplemented diets did not substantially affect average daily feed consumption compared to the control diet. Chickens fed PRO had a greater average daily increase (13.31 g/head/day) compared to the control (Cont) group (12.55 g/head/day). PRO and multivitamins (VIT) had higher feed conversion ratios (3.02 kg/kg growth and 3.04 kg/kg gain, respectively) than organic acids (OA) (3.27 kg/kg gain) and Cont (3.28 kg/kg gain) (Thuy *et al.,* 2025).

Conclusion

Enhancing FCR using ecoenzymes can result in lower feed expenditures per unit of weight increase, which is crucial for profitability in chicken farming. Even little improvements in FCR can result in considerable savings for large-scale enterprises. Incorporating ecoenzymes into chicken diets, particularly through drinking water, or for disinfectant, may not result in immediate substantial improvements in feed conversion ratios, but it may lead to long-term better health and efficiency. More study is needed to properly understand their long-term effects on poultry performance and economic viability. The analysis can be conducted to compare two functional models regarding technical efficiency, allocative efficiency, and economic efficiency of the production factor of drinking water consumption with the addition of ecoenzyme against a control treatment, which is water without the addition of ecoenzyme.

Acknowledgement

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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Table 1. Information from a few chosen research summarized in an organized table

Study	Year	Ecoenzyme Source	Application Method	Outcomes Measured	Key Findings
Palupi *et al.*	2024	Fruit peels	Drinking water	FCR, weight gain	Improved FCR by 10%, weight gain +15%
Ay *et al*.	2024	Organic waste	Disinfectant + water	Biosecurity improvements	Reduced *Salmonella* contamination
Thuy *et al.*	2024	Miana leaf-based	Drinking water	Growth performance	Higher ADG; lower feed cost

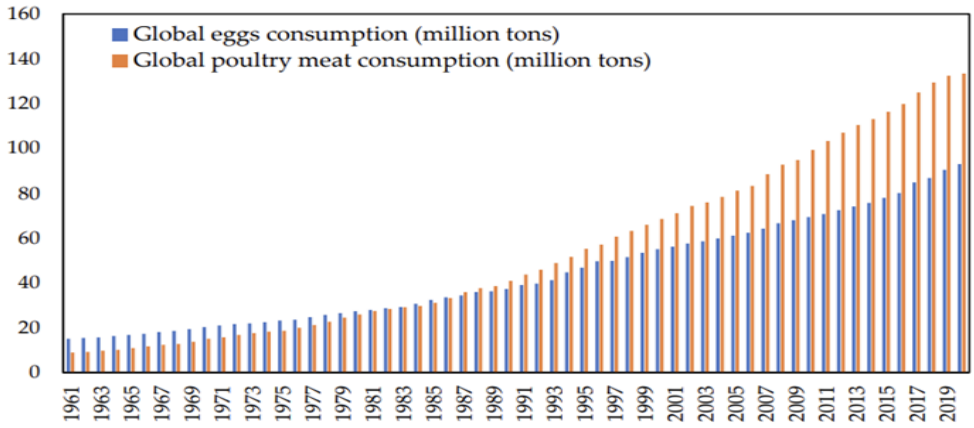


Figure 1. Consumption of eggs and poultry meat worldwide
Source: Our World in Data (Zhang *et al.*, 2023)

Table 2 Growth performance and feed efficiency of the hens in the trial, Estimations of the stochastic frontier profit function's maximum likelihood, and Economic performance comparison of two farm groups

Items						
Initial weight (4 weeks age), g	103.30	100.80	101.70	107.50	2.65	0.33
Final weight (14 weeks age), g	981.60b	1032.00a	1000.00b	987.70b	10.41	0.04
ADG, g/head/day	12.55b	13.31a	12.83ab	12.57ab	0.24	0.04
ADFI, g/head/day	41.17	40.31	39.04	41.16	2.01	0.75
FCR, kg feed/kg gain	3.28al	3.02b	3.04b	3.27a	0.06	0.02

Variables	**Parameters**	**Coefficients**	**Std. Error**	**t-ratio**
Technical Efficiency Model				
Constant	**β0**	**1.8213*** **	**0.6771**	**2.69**
Feed (kg) (X1)	**β1**	-0.0498	0.0571	-0.87
Vaccines and drugs (X2)	**β2**	0.0277	0.0516	0.54
Stock of birds (X3)	**β3**	0.0235	0 .0358	0.66
Labour (X4)	**β4**	**0.6446 *** **	**0 .0418**	**15.43**
Inefficiency Function Model				
Constant	**Δ0**	-0.0679	0.2034	0.33
Age (years)	**δ1**	**0.0067****	**0.0030**	**2.18**
Female Gender	**δ2**	0 .0054	0.0536	0.10
Education (years)	**δ3**	-0.0306	0.0218	-1.40
Experience (years)	**δ4**	-0.0031	0.0047	-0.67
Household size	**δ5**	-0.0234	0 .0148	-1.58
Stock size	**δ6**	**-0.0004*****	**0.00002**	**-18.79**
Access to Extension services	**δ7**	**-0.1405*****	**0.0492**	**-2.85**
Access to Credit	**δ8**	0.0262	0.0459	0.57
Livestock Insurance	**δ9**	**-0.5603*****	**0.1538**	**-3.64**
Biosecurity Practices Index	**δ10**	**-0.3907*****	**0.1379**	**-2.83**

Items						
Initial weight (4 weeks age), g	103.30	100.80	101.70	107.50	2.65	0.33
Final weight (14 weeks age), g	981.60b	1032.00a	1000.00b	987.70b	10.41	0.04
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FCR, kg feed/kg gain	3.28al	3.02b	3.04b	3.27a	0.06	0.02

Variables	**Parameters**	**Coefficients**	**Std. Error**	**t-ratio**
Diagnostic Statistics				
%				
Sigma-square	**δ^2**	**0.4163**	**0.0529**	**0.31**
Lambda (λ)		**2.2057****	**0.8011**	**2.05**
Log likelihood function	**-199.63**			
LR Test	**21.9**			
Mean Profit Efficiency	**0.86**			

Items	Broilers		Parent stocks		Hatcheries	
	Treatments (100 kg live weight)	Controls	Treatments (100 breeding eggs)	Controls	Treatments (100 DOC)	Controls
Total production	5,636	5,470	638	647	1,029	922
Variable expenses	4,299	4,897	365	487	717	792
Total production expenses	4,488	5,146	395	543	725	808
Net Benefit (1 – 2)	1,336	573	272	161	312	129
Profit margin ((1-3))x100)) (%)	25.6	6.3	61.1	19.1	41.9	14.1

Note: Significance levels: *p<0.10, **p<0.05, ***p<0.01. Field survey data compared Treatments (100 kg live weight), with Enhanced Biosecurity Practices (EBP) groups with negative control groups. ADG=average daily growth, FCR=feed conversion ratio. Groups: Control (Cont), PRO (probiotics), VIT (multivitamins), OA (organic acids). Means with different superscripts are significantly different (P≤0.05). (Akintunde *et al.,* 2018; Tung *et al.,* 2020; Thuy *et al.,* 2025)

Category: Animal welfare
ORL_16

Transitioning Frameworks and Implementation Advancement for Cage-Free Egg Production in Malaysia

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Abstract

Malaysia's egg production landscape is undergoing a significant transformation as it moves toward cage-free system. This transition is driven by growing awareness on animal welfare, sustainability, and also the changing consumer expectations. This presentation outlines the development of policy frameworks and implementation strategies aimed at supporting a national shift to cage-free egg production. Drawing from global best practices and local realities, it explores how regulatory policies, stakeholder collaboration, and capacity-building initiatives play a central role in enabling change. Key themes include harmonizing welfare standards, incentivizing producers, and engaging civil society organizations in advocacy and support. Challenges such as infrastructure costs, knowledge gaps, and market readiness are addressed, alongside practical solutions like phased transition models and training programs. The presentation also highlights recent progress in industry adoption and the alignment of Malaysia's policy frameworks with international welfare benchmarks. Ultimately, the framework presented offers a structured, inclusive, and actionable roadmap for transitioning to a more humane and sustainable egg industry in Malaysia.

Category: Animal welfare
ORL_17

Scientific and Ethical Perspectives on Cage Free Egg Production: Lessons From India and Beyond

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Abstract

The growth of cage-free egg production in India has been driven by consumer demand for traditional, healthier, organic eggs alongside the need to include improved welfare for animals in the foodchain system. This demand is now magnified by the corporate requirements for cage-free eggs, driven by public commitments and demand. The general public associates brown eggs with the term's organic, cage free, backyard and healthier. We will delve into the scientific basis for cage free housing systems as a better welfare alternative to conventional caged systems. The caged egg industry is well organized and established in the country with robust support for producers and supply routes to every corner with coordinated/controlled prices. A similar support system is yet to be developed for the cage-free sector. We will also discuss these challenges and solutions that are being addressed by the cage-free sector through establishment of a Cage Free and Free Range Producers association (CFFRPPA) for better coordination, a cooperative to streamline production and supply from small producers, and skill building in the support ecosystem.

Category: Animal welfare
ORL_18

Challenges and Opportunities in Expanding Cage-Free Egg Production in Viet Nam

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Abstract

In the year 2023 Viet Nam had over 82.7 million hens and produced approximately 8.7 billion eggs. The country ranks 125th in the world for total eggs consumed per person, at approximately 75 eggs per year. The Viet Nam egg industry is a combination of smallholder farms and a limited number of large suppliers/producers. There is no data on egg production systems, however field visits indicate that most hens are being raised in battery cages. There are opportunities to expand cage-free production in Viet Nam as there are growing demands from food businesses and individual consumers. However, as the production volume is quite small and producers are still at the learning stage, the high production cost subsequently leads to higher prices. It has always been challenging to convince buyers to pay higher prices. To reduce the investment, producers have converted battery cages, rearing barns and even broiler chicken houses to cage-free. The cage-free production has started in Viet Nam with a pilot farm of 6,000 birds in 2021. By 2024, there are around 120,000 birds and this number is expected to reach up to 200,000 this year. Local governments and NGOs like Humane World for Animals play key roles in supporting the cage-free movement in Viet Nam.

Category: Non-ruminant production
ORL_19

The Role of Malaysia Cage-Free Egg Production Organisation in Advocating for Cage-Free Egg Production in Malaysia

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Abstract

The Malaysia Cage-Free Egg Producer Organisation (MCFEPO) plays a pivotal role in transforming Malaysia's egg production landscape by championing humane and sustainable cage-free farming systems. As a national platform uniting producers, stakeholders, and partners, MCFEPO is committed to driving the country's transition towards cage-free egg production. This abstract outlines the organisation's multi-faceted initiatives, strategic partnerships, and measurable outcomes in supporting small and medium-scale producers to adopt welfare-compliant practices while meeting growing market expectations. Since its establishment, MCFEPO has forged strong collaborations with government agencies such as the Department of Veterinary Services (DVS), research institutions like Universiti Putra Malaysia (UPM), international NGOs including Humane World for Animals, and development-focused financial institutions like Agrobank. These partnerships have enabled the organisation to influence national policy development, deliver targeted farmer training, and establish demonstration farms that showcase the practical and economic benefits of cage-free systems. A core focus of MCFEPO's advocacy is the empowerment of smallholder and B40 farmers, who are often marginalized in sustainable agriculture transitions. The organisation has launched rural engagement programmes across Selangor, Negeri Sembilan, and northern Peninsular Malaysia to introduce cage-free farming principles to traditional producers. Initiatives such as barn walk-throughs, community dialogues, practical workshops, and exposure visits provide farmers with direct insight into welfare standards, affordable barn conversion models, and low-density flock management techniques. Beyond awareness-building, MCFEPO connects small producers with essential technical and financial support mechanisms. Working closely with Agrobank and government-linked agri-development funds, MCFEPO facilitated the issuance of a Sustainable-Linked Loan to a pioneer farm and continues to assist other financing applications. Complementing these efforts, the organisation offers one-on-one mentoring, technical assistance for barn retrofitting, pullet management, and certification readiness, particularly for producers targeting third-party humane certifications. Market engagement forms a parallel strategic pillar. MCFEPO collaborates with retailers, foodservice companies, and hotel groups to build sustained demand for cage-free eggs, ensuring stable market access for small producers. Partnerships with Humane World for Animals have catalysed cage-free sourcing commitments from major industry players such as AEON, Jaya Grocer, Hilton, Marriott, and Accor Hotels. The organisation also advocates for fair trade pricing, clearer labelling

standards, and transparent welfare claims to support equitable market participation for emerging producers. In conclusion, MCFEPO's integrated approach — aligning policy advocacy, capacity-building, financial access, and market development — is reshaping Malaysia's egg industry towards a more ethical and inclusive future. Sustained stakeholder collaboration and expanded scaling efforts remain crucial to achieving a truly cage-free Malaysia.

Category: Non-ruminant production
ORL_20

Marketing Cage-Free Eggs in Malaysia: Consumer Trends and Brand Positioning

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Abstract

As consumer preferences shift toward ethical and sustainable products across the world, cage-free eggs are emerging as a growing niche product in Malaysia's fresh food supply chain. Uncle Rani Chicken has been at the forefront of this transition, developing marketing strategies that not only educate consumers but also build brand loyalty. This presentation examines the key elements of successfully marketing cage-free eggs, including brand storytelling, welfare certifications, and digital engagement. It explores consumer behavior patterns based on market research, identifying gaps in awareness, price sensitivity, and trust in claims. Strategies such as transparent supply chain, strategic partnerships, brand value, and use of environment-friendly packaging have been employed to differentiate cage-free products in a competitive market. The presentation also highlights how collaborations with hotels, grocers, and food service providers can amplify reach and visibility. By aligning values-driven messaging with consumer expectations, Uncle Rani Chicken is positioning itself as a leader in ethical food branding. The insights shared will guide other producers and marketers in capturing this evolving segment effectively.

Category: Non-ruminant production
ORL_21

Empowering B40 Smallholders in Cage-Free Egg Production: Enhancing Livelihoods and Driving Sustainable Food Systems

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Abstract

Empowering low-income (B40) smallholder farmers is critical to achieving both food security and equitable economic development in Malaysia. Global Varsity Group Sdn Bhd ("Varsity") has pioneered a grassroots initiative aimed at integrating B40 communities into the cage-free egg production sector. This presentation highlights the design, implementation, and outcomes of a scalable model that enables smallholders to adopt humane and sustainable poultry practices. Key components include low-capital infrastructure kits, hands-on training in bird management and welfare, and cooperative marketing strategies that connect farmers directly to ethical consumers. The initiative also emphasizes the use of locally sourced feed and environmentally friendly housing designs. By addressing access to finance, veterinary support, and market information, Varsity's program has helped farmers enhance their livelihoods while contributing to a more resilient food system. Early results show increased household income, improved animal welfare, and strengthened community engagement. The presentation concludes with recommendations for public-private collaboration to replicate and expand the model nationwide, promoting inclusive participation in Malaysia's cage-free movement.

Category: Animal nutrition & feeding
ORL_22

Effects of Palm-Based Feed Formulation on Performance, Milk Production and Composition in Lactating Dairy Cows

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Abstract

Oil palm by-products, such as palm kernel expeller (PKE) and palm stearin (PS), have the potential to serve as cost-effective alternatives for partially replacing conventional feed ingredients in dairy cow diets. However, the optimal inclusion levels of PKE and PS in dairy cow diets remain inadequately studied, with limited research on their impact on performance. Therefore, this study aims to investigate the effects of including PKE and PS in feed formulation on performance and milk composition in lactating dairy cows. A comparison study was conducted on dairy cows fed a BASAL concentrate (control diet) and MPOB concentrate (containing 50% PKE and 2% PS). A total of eight mid-lactating, multiparous Jersey-Friesian crossbred dairy cows (185 ± 15.0 days in milk) were randomly assigned a 2 x 2 Latin square experimental design (4 cows/treatment) with three 21-day periods of 14 days of adaptation followed by 7 days of sampling. Dairy cows received the concentrate diet in mash form at a milk yield-to-concentrate ratio of 2:1 twice daily at 06:30 h and 15:30 h, and Napier grass was offered *ad libitum* throughout the day. Data on performance, milk production, and composition were analyzed using the T-test procedure in SAS, with statistical significance determined at $P < 0.05$. The results indicated that the dry matter intake (DMI) of dairy cows was not significantly affected (P=0.192) by the dietary treatments. Dairy cows fed with BASAL and MPOB concentrate had a DMI (as a percentage of body weight) of 2.88 and 2.74, respectively, with no significant differences observed between treatments (P=0.238). Nonetheless, no significant differences were detected between BASAL and MPOB-fed dairy cows in body weight gain (P=0.112), milk yield (P=0.571), and feed conversion ratio (P=0.530). The chemical composition of milk, including total solids, solid non-fat, ash, protein, fat, and lactose in the BASAL or MPOB treatments, exhibited no significant differences (P > 0.05). This study demonstrated that the optimal inclusion of PKE and PS in dairy diets is a viable alternative to imported conventional feed ingredients, contributing to sustainable milk production.

Category: Sustainable livestock & feed production
ORL_23

From Dirt to Living Soil: How Livestock Build Resilient Soil

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Abstract

The health of soil plays a critical role in ensuring sustainable agricultural systems, yet modern farming practices have led to widespread soil degradation. "From Dirt to Living Soil: How Livestock Build Resilient Soil" explores the transformative role of livestock in regenerating and maintaining healthy soils. This paper examines how livestock can improve soil structure, enhance biodiversity, and contribute to carbon sequestration when integrated into regenerative farming practices. Understanding the symbiotic relationship between livestock and soil can address critical environmental challenges, such as erosion, nutrient depletion, and reduced water retention. The paper outlines key mechanisms by which livestock, including grazing animals, can stimulate the natural processes of soil regeneration. This includes their role in nutrient cycling, the restoration of organic matter, and the enhancement of soil microbial life. Furthermore, it highlights the importance of rotational grazing and holistic management techniques, which not only reduce the negative impacts of overgrazing but also encourage the development of deeper, more resilient soils. The concept of "living soil" is discussed in relation to the importance of maintaining soil as a dynamic ecosystem, where microorganisms, fungi, and plant roots interact to create a balanced and healthy environment. Through our experience, the paper emphasizes the potential of livestock as part of a holistic approach to sustainable agriculture. In doing so, it presents an alternative to conventional practices that contribute to soil depletion, offering a vision of how livestock, when managed responsibly, can help regenerate soils and improve the resilience of agricultural ecosystems in the face of climate change.

Keywords: *Soil, regeneration*

Category:
ORL_24

Breaking the Cycle: Transforming Malaysia's Pig Farming Through Sustainable Practices and Disease Resilience

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Introduction

Malaysia's pig farming sector, a vital contributor to food security and rural livelihoods, faces mounting pressures from environmental degradation, disease outbreaks, and tightening regulatory demands. The industry, valued at RM2.5 billion annually and supplying over 95% of domestic pork, has been destabilised by African Swine Fever (ASF) and Porcine Reproductive and Respiratory Syndrome (PRRS), exposing critical gaps in biosecurity and farm management (DVS, 2023; Wong et al., 2022). Concurrently, environmental concerns—including waste pollution, antibiotic overuse, and greenhouse gas emissions—threaten the sector's long-term viability amid Malaysia's climate commitments. This study employs sustainability transition theory to analyse pathways for systemic transformation, proposing integrated solutions that balance economic resilience with ecological and health imperatives. Key strategies include: (1) advanced biosecurity protocols to mitigate disease risks, (2) circular economy adoption (e.g., waste-to-energy systems, nutrient recycling) to reduce environmental footprints, and (3) policy-driven incentives to align industry practices with national sustainability goals. By bridging technological, managerial, and regulatory interventions, this paper outlines a roadmap for transitioning Malaysia's pig farming sector toward a more sustainable and disease-resilient future.

Keywords: *Pig farming, sustainability transition, disease resilience, circular economy, Malaysia*

Materials and methods

This study analyses Malaysia's pig farming challenges using multiple data sources. Government reports and case studies on biogas and smart feeding systems provided baseline industry data. Field interviews with farmers, processors, and officials captured practical insights. A simplified SWOT-PESTEL framework evaluated both farm-level operations and external factors like policies and market conditions. Historical disease data helped model outbreak risks, while cost-benefit analyses assessed technology feasibility. The mixed-method approach combines empirical data with stakeholder perspectives. This ensures practical, scalable solutions tailored to Malaysia's diverse pig farming operations, from large commercial farms to smallholders.

Results and discussion

Malaysia's pig farming sector faces complex sustainability challenges that require balanced environmental, economic, social, and regulatory solutions. Environmentally, farms must address critical waste management issues through biogas systems that convert manure into renewable energy and water recycling technologies to reduce consumption (MARDI, 2022). Strategic farm placement away from water sources and residential areas helps minimise pollution risks while preventing deforestation and land degradation.

Economically, the industry struggles with volatile feed costs, prompting a shift toward local feed ingredients and alternative protein sources like insect-based feeds to reduce import dependence. Market instability and disease outbreaks, such as African Swine Fever, further threaten profitability, making modern technologies like automated feeding systems essential for improving efficiency and animal health.

Socially, pig farms face community opposition due to odour and pollution concerns, requiring better zoning and waste treatment systems. Religious sensitivities in this majority-Muslim nation also necessitate careful farm location planning and cultural awareness. Regulatory compliance remains challenging, with farms needing to meet strict biosecurity standards from the Department of Veterinary Services (DVS) and environmental regulations, including penalties for pollution and relocation requirements near water catchment areas.

Moving forward, sustainable pig farming in Malaysia depends on stronger government policies, including the enforcement of Pig Farming Areas (PFAs) and incentives for modern farming practices. Wider adoption of renewable energy (solar, biogas), research into genetic improvements and alternative feeds, and improved disease management through better farm zoning are crucial (Abullah & Ho, 2023). Additionally, simplifying certification programs like MyGAP could encourage more farms to meet sustainability standards, ensuring long-term industry resilience.

Conclusion

Malaysia's pig farming industry requires modernisation to achieve long-term sustainability. The sector must adopt technological solutions, implement stronger policies, and secure financial assistance to simultaneously address food security, farmer livelihoods, and environmental protection. These improvements will benefit all stakeholders across the supply

chain. Several critical measures can drive this transformation. First, enhanced biosecurity protocols combined with digital livestock tracking systems could significantly reduce disease outbreaks. Second, waste-to-energy conversion technologies should be implemented in designated Pig Farming Areas to manage environmental impacts. Third, small-scale farmers need targeted support through financial subsidies and cooperative farming models to overcome cost barriers. Finally, streamlined certification processes and tax incentives would encourage the wider adoption of sustainable practices. For these solutions to succeed, coordinated action is essential. Government agencies must strengthen the enforcement of zoning regulations while providing clear policy guidance. Technology providers should develop affordable, scalable solutions suitable for farms of all sizes. Most importantly, farmers themselves need training and support to transition to more sustainable methods. Through this collaborative approach, Malaysia can build a resilient pig farming sector that balances economic viability with environmental responsibility and social acceptability. The path forward is clear - what's needed now is the collective will to implement these necessary changes.

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Category: Animal health
ORL_25

A Survey on Antibiotic Usage in MyGAP Poultry Farms Across Malaysia

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Abstract

Antimicrobials are widely utilized in livestock farming, particularly through incorporation in animal feed and water. A key public health concern arising from this practice is the emergence of antimicrobial resistance. In Malaysia, there remains a significant knowledge gap regarding the extent and patterns of antimicrobial use in poultry farms. This study aimed to identify the most commonly used antibiotics and their usage trends. A survey was carried out across 278 Malaysian Good Agricultural Practices (myGAP) certified poultry farms between 2015 and 2017. Findings revealed that antibiotics were used for disease prevention (100%), treatment (25%), and growth promotion (0.4%). The primary method of administration was via drinking water. A total of 36 antimicrobials from 13 different classes were reported, with enrofloxacin being the most frequently used (86%), followed by amoxicillin (62%), tylosin (29%), colistin (26%), tilmicosin (26%), and fosfomycin (21%). These insights are expected to inform the development of more responsible antibiotic use strategies in animal agriculture and veterinary oversight via prescription. Establishing a national antimicrobial use monitoring program is recommended to quantitatively track antimicrobial usage.

Keywords: *antibiotics, antimicrobial usage, poultry farming, Malaysia*

Category: Non-ruminant production
ORL_26

Decoding Chicken Diversity by Connecting External Traits with Internal Metabolic Profiles

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Abstract

Chicken meat plays a critical role in the global food supply due to its affordability, high protein content, and wide consumer acceptance. However, the increasing prevalence of mislabeling and fraudulent practices involving chicken breeds presents a major challenge to food authenticity and safety. Food fraud, especially involving the misrepresentation of commercial broilers as premium village chickens, undermines consumer trust and has economic and ethical implications. Differentiating chicken breeds with precision is essential for ensuring product integrity, protecting consumers, and supporting regulatory enforcement. This study employed an untargeted metabolomics approach to profile the metabolite composition of five chicken breeds reared under standardized conditions in Malaysia, namely Akar Putra (AP), native Village Chicken (VC), COBB (C), Sasso (S), and Hubbard (H). All birds were raised in controlled environments and slaughtered at their respective market ages. Lyophilized meat and liquid serum samples (n=10 per breed) were analyzed using liquid chromatography-tandem mass spectrometry (LC-MS/MS). A total of 121 significant metabolites were identified in meat and 36 significant metabolites in serum. Statistical analyses revealed clear metabolic differences across breeds, with VC exhibiting the highest number of potential biomarkers in both matrices. Seven unique biomarkers were identified in VC meat, including adenosine diphosphate, adenosine triphosphate, decanoylcarnitine, ergothioneine, azelaic acid, a carbohydrate, and an isomer of methylhistidine. In serum, six breed-specific biomarkers were detected, including azelaic acid, acetyl-β-methylcholine, 4-phenolsulfonic acid, taurocholic acid, carnitine, and a secondary bile acid. Furthermore, significant associations were found between the identified biomarkers in both meat and serum with various phenotypic traits, including body length, wing span, shank length, chest circumference, live weight, carcass weight, breast weight, and abdominal fat. Overall, this study reinforces the potential of

metabolomics as a powerful tool for breed authentication, supporting traceability and combating food fraud in the poultry industry.

Keywords: poultry, metabolomics, biomarkers, correlation, food fraud

Category: Non-ruminant production
ORL_27

Beyond the Cage: Innovative Housing Equipment for Layer Success

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Abstract

The evolution of the global egg industry is accelerating towards higher animal welfare and sustainability benchmarks, with cage-free production emerging as the new norm. However, transitioning from conventional systems to cage-free housing presents multiple challenges, from behavioral management to biosecurity and productivity. This presentation by Vencomatic Group introduces a range of advanced housing equipment and integrated systems that offer practical, welfare-focused solutions to ensure the success of layer operations beyond cages. At the heart of these innovations is a commitment to bird-centric design and engineering excellence. The Bolegg Gallery promotes natural movement and reduces keel bone damage, along with the Vencobelt and Prinzen ensure efficient and hygienic egg collection. These technologies collectively contribute to healthier birds, improved egg quality, reduced environmental impact, and operational efficiency. Drawing from field data and real-world implementations across Asia and Europe, this session will share outcomes from farms that have adopted Vencomatic's systems, with results showing improved laying performance, lower mortality, and better adaptability to certification frameworks such as HFAC, Beter Leven, and EU directives. Special attention is given to retrofitting strategies for conventional farms, enabling practical pathways for progressive producers. With shifting consumer expectations and evolving regulatory frameworks, innovation in housing is essential, not optional. This presentation will offer insights, data, and tools to empower stakeholders across the value chain to move confidently toward a more humane, resilient, and successful future in egg production.

Category: Animal nutrition & feeding
ORL_28

Influence of Degradation Rates and Roughage-To- Concentrate Ratio in Total Mixed Ration on *In Vitro* Gas Production at Different Incubation Times

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Introduction

The degradation rates of carbohydrates, including starch, neutral detergent fiber (NDF), sugars, and pectin, exhibit distinct ruminal degradation and fermentation characteristics (Nozière et al., 2011). For example, starch degradation rates influence the starch digested in various gastrointestinal sections, impacting nutrient absorption, rumen fermentation patterns, fiber digestibility, and microbial protein synthesis (Ørskov, 1986; Nocek and Tamminga,1991). Examining the roughage-to-concentrate (R:C) ratio in ruminant diets is crucial for promoting animal health, productivity, and ecological sustainability (Faría-Mármol et al., 2002). In addition, R:C ratio influences to rumen pH, fermentation patterns, microbial populations and fiber digestion (Wanapat et al., 2014). This study aimed to assess the effects of slowly and rapidly degradable feedstuffs and determine the optimal R:C ratio in a total mixed ration (TMR) on *in vitro* gas production.

Keywords: feedstuffs, degradation rate, roughage-to-concentrate ratio, *in vitro* gas production

Materials and Methods

A 3 × 3 factorial design included three degradation rates (control, rapidly degradable and slowly degradable) and three R:C ratios (40:60, 50:50 and 60:40). Cassava chips were the rapidly degradable feed, and rice straw was the slowly degradable feed. Samples were analyzed for proximate analysis (AOAC, 1990). NDF and acid detergent fiber (ADF) followed Van Soest et al. (1991). The remaining feed was used as substrates for *in vitro* gas production estimation (Menke and Steingass, 1988).

Results and Discussion

TMRs with rapidly degradable feedstuffs across all R:C ratios exhibited higher organic matter (OM) content. Conversely, TMRs incorporating goat pellets at all R:C levels resulted in increased crude protein (CP) content. Goat pellets and slowly degradable feedstuffs at 40:60 and 50:50 R:C ratios improved ether extract (EE) levels. TMRs with slowly degradable feedstuffs at 50:50 and 60:40 R:C ratios showed the highest levels of NDF and ADF. Overall, TMRs varied in chemical composition across treatments, yet remained within the recommended protein requirements for growing goats.

Higher gas production during early and late incubation may link to variations in fiber and carbohydrate content in different diets. Gas production peaked at 2 h in the TMR with goat pellets at a 40:60 R:C ratio. At 4 h, increased gas was noted in diets with goat pellets at 40:60 and rapidly degradable feedstuffs at 40:60, 50:50, and 60:40 ratios. The 60:40 diet also showed improved output at 6 and 12 h. By 24 h, the highest production occurred in TMRs with rapidly degradable feedstuffs at 40:60 and 60:40 ratios, while greatest gas production at 48 h happened across all diets with rapidly degradable feed. This suggests that using high fermentation rate feedstuffs enhances low forage NDF content effects on ruminal fermentation, as higher concentrate levels provide available energy, promoting microbial activity and increasing degradability (Polyorach et al., 2014).

The TMR with a 60:40 R:C ratio of rapidly degradable feedstuff consistently showed enhanced gas kinetics, yielding the highest gas production and soluble gas fraction (a), with an insoluble fraction gas production rate constant (c) of 0.09%/h (Table 1). Results suggest that reducing NDF and ADF levels could further improve gas production potential (|a| + b), as lower NDF and ADF typically enhance fermentation kinetics (Kotarski et al., 1992).

Conclusion

In conclusion, a rapidly degradable feedstuff with a 60:40 R:C ratio in TMR could enhance cumulative gas production during each incubation period and improve gas kinetics.

Acknowledgement

The authors would like to thank the Ministry of Education, Youth and Sports (MoEYS) of Cambodia, Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), and Universiti Putra Malaysia (UPM) for financial support, and Department of Animal Science, Faculty of Agriculture, UPM for the research facilities.

Table 1. Effects of degradable feedstuffs and R:C ratios on gas kinetics of TMR

Feed types[1]	R:C[2]	Gas kinetics[3]			
		a	b	c	|a| + b
Goat pellet	40:60	-3.67^{ab}	54.95^{c}	0.06^{b}	51.28^{b}
	50:50	-5.36^{bc}	56.36^{bc}	0.05^{c}	51.01^{b}
	60:40	-5.15^{abc}	52.95^{cd}	0.05^{cd}	47.80^{bc}
Cassava chip	40:60	-6.43^{c}	62.87^{a}	0.07^{b}	56.45^{a}
	50:50	-5.92^{c}	61.14^{ab}	0.07^{b}	55.22^{a}
	60:40	-9.53^{d}	64.74^{a}	0.09^{a}	55.21^{a}
Rice straw	40:60	-3.42^{a}	54.48^{c}	0.04^{d}	51.05^{b}
	50:50	-5.18^{abc}	52.49^{cd}	0.04^{d}	47.31^{bc}
	60:40	-4.76^{abc}	48.56^{d}	0.03^{e}	43.80^{c}
SEM		0.60	1.78	0.01	1.40
Comparison					
Degradable feedstuffs		<0.001	<0.001	<0.001	<0.001
Goat pellet		-4.72^{a}	54.75^{b}	0.06^{b}	50.03^{b}
Cassava chip		-7.29^{b}	62.92^{a}	0.08^{a}	55.63^{a}
Rice straw		-4.46^{a}	51.84^{b}	0.04^{c}	47.39^{b}
R:C ratio		0.001	0.39	0.49	0.03
40:60		-4.51^{a}	57.43	0.06	52.93^{a}
50:50		-5.49^{ab}	56.67	0.06	51.18^{ab}
60:40		-6.48^{b}	55.42	0.06	48.94^{b}
Interaction		<0.001	<0.001	<0.001	<0.001

$^{a-e}$ Value on the same row with different superscripts differ ($p<0.05$); [1]Feed type= control diet, rapidly and slowly degradable feedstuff; [2]R:C= roughage-to-concentrate ratio; [3]a = volume of gas produced from immediate soluble fraction; b = volume of gas produced from insoluble fraction; c = gas production rate constant from insoluble fraction; |a| + b = potential extent of gas production; SEM = standard error of the mean.

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Category: Sustainable livestock & feed production
ORL_29

Assessment of Constraints, Solutions, and Opportunities in Camel Farming in Northern Oman: A Step Toward Sustainable and Circular Livestock Systems

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Introduction

Camel farming has remained an integral part of food security, cultural heritage and socioeconomic life in arid regions like Northern Oman for centuries, yet it faces persistent sustainability challenges. The importance of camel rearing in this region can be understood from the fact that without the camel, the rural life in this area would be abandoned (Abdallah and Faye, 2013; Al-Wahaibi et al., 2023). Though the importance of the camel cannot be overlooked as it is regarded as dairy, meat, fur/wool producing and racing animal, yet, no proper attention has been paid towards the research in camel husbandry. Oman has diverse topography and climatic conditions, which further influence camel productivity and management. There is no baseline data available regarding the camel production challenges in Oman. However, few systematic studies have been conducted to evaluate husbandry and management practices including (feeding, breeding, health, etc.) In the context of sustainable agriculture, the present study was conducted in camel farming communities of the Sultanate of Oman. The objective of this study was to assess the key constraints, identify existing management practices, and explore practical opportunities to improve camel farming sustainability in Northern Oman using both field-level data and farmer perspectives.

Keywords: Camel farming, sustainable livestock systems, arid regions, Oman, rural livelihoods

Materials and methods

The study was conducted across eight governorates of Northern Oman: Al Batinah North, Al Batinah South, Al Buraimi, Al Dhahirah, Ad Dakhiliyah, Muscat, Ash Sharqiyah North, and Ash Sharqiyah South. A total of 100 camel farmers (n=100) were surveyed using structured questionnaires and interviews, while milk and feed samples were collected to evaluate nutritional and health management. Descriptive statistics was performed using Microsoft Excel.

Results and discussion

The results revealed that the key constraints were high feed costs (21.7%), lack of veterinary services (12%), disease outbreaks (12%), water scarcity (10.2%), and labour shortages (9.6%). Despite challenges, over 80% of farmers had more than 10 years of experience, and young farmers (21-30 years old) were particularly active in most of the governorates like Al Batinah, Al Buraimi, Al Dhahirah, Al Dakhiliyah and Ash Sharqiyah (Table 1).

Table 2 Age of camel farmers in difference governorates of North Oman (%)

Governorate	ABN	ABS	ABR	ADH	ADK	MCT	ASN	ASS
Under 20 years	12.50	0.00	0.00	16.67	0.00	0.00	0.00	0.00
21-30	37.50	20.00	100.00	33.33	50.00	0.00	28.57	28.57
31-40	12.50	40.00	0.00	50.00	25.00	0.00	14.29	42.86
41-50	25.00	20.00	0.00	0.00	0.00	0.00	0.00	14.29
51-60	12.50	0.00	0.00	0.00	25.00	100.00	57.14	14.29
Above 60	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00

ABN (Al Batinah North), ABS (Al Batinah South), ABR (Al Buraimi), ADH (Al Dhahirah), ADK (Ad Dakhiliyah), MCT (Muscat), ASN (Ash Sharqiyah North), and ASS (Ash Sharqiyah South)

Although the primary purpose of rearing camels in the region was family tradition (40.22%), followed by interest in animal husbandry (16.30%), yet profit potential (13.04%) was also among the motivations for rearing camels (Figure 1).

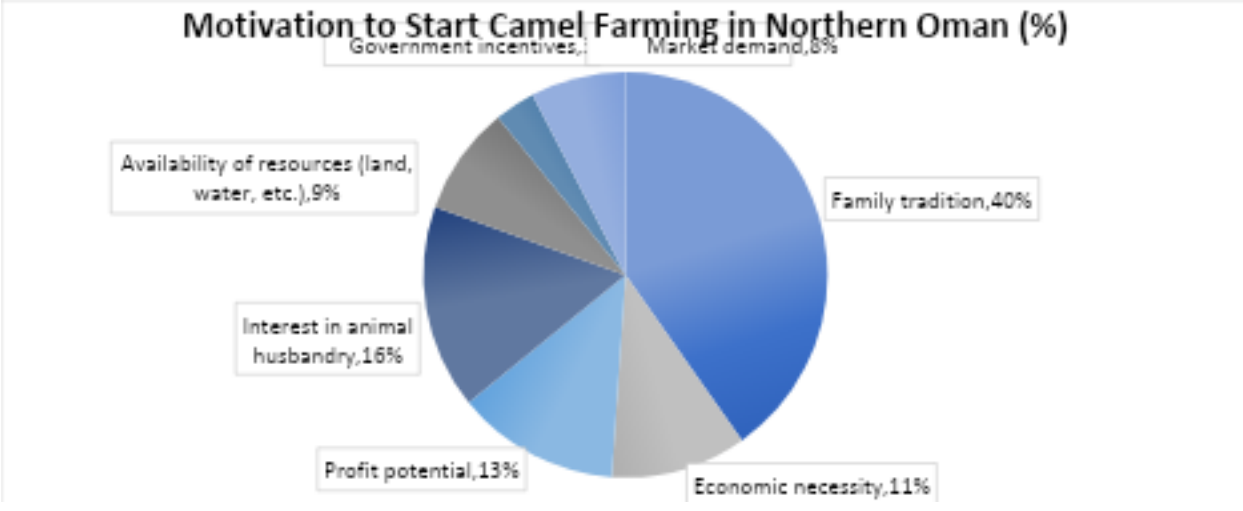


Figure 1. Key motivations for individuals to start camel farming in North Oman

Conclusion

The study concludes that camel farming in Oman, if aligned with circular practices, has strong potential to transition from a traditional system to a sustainable and regenerative livestock model.

Acknowledgement

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Category: Animal health
ORL_30

Emulsion-Based *Melastoma malabathricum* Extract Against Bovine Mastitis-Causing Bacteria

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Introduction

Melastoma malabathricum (MM) from the family of *Melastomataceae* is a native plant in Southeast Asia. MM can be found throughout Malaysia, Indonesia, China, Taiwan, Australia and the South Pacific Ocean. The plant is a small shrub that commonly grows wild along roadsides and waste land [1]. MM has been used traditionally for various treatments such as, diarrhea, wounds, scars, and dysentery [2]. MM is a traditional herb with recognized antibacterial and anti-inflammatory properties [3, 4].

Mastitis is the most frequently diagnosed disease of dairy cattle responsible for major economic losses. To date, antibiotics are the most common treatment for this disease. However, the use of antibiotics is reported to be the main contributor to milk contamination and frequent use of this therapy will lead to microbial antibiotic resistance. Furthermore, the antibiotic withdrawal time and mastitis therapy will cause a huge loss of profit to dairy farmers. Therefore, alternative plant-based treatments should be explored to replace the use of

antibiotics. The objective of the study was to evaluate the efficacy of emulsion-based MM extract against bovine mastitis-causing bacteria.

Material and methods

Fresh MM leaves were collected from the Malaysian Agricultural Research and Development Institute (MARDI) Headquarters at the location of longitude 101° 41' 26.2284", latitude: N 2° 59.8573', respectively. The plant was deposited at Universiti Putra Malaysia (UPM) with the voucher number SK3338/18. MM crude extract was carried out by mixing 5% of powdered leaves in distilled water and shaking the mixture at 200 rpm. Prior to the experiment, the crude extract was emulsified using edible oil. The emulsion was then subjected to a time-kill assay against mastitis-causing bacteria.

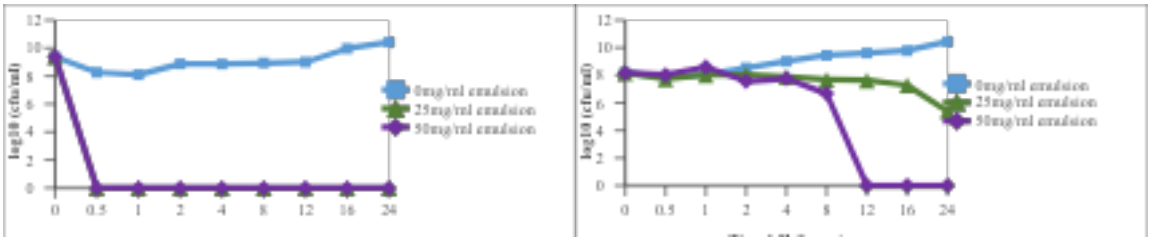
Results

The time-kill assay results showed a reduction in viable colonies from the initial inoculum (Figure 1). Most Gram-positive bacteria, *Staphylococcus aureus* (SA), *Staphylococcus uberis* (SU), and *Streptococcus agalactiae* (RK3C), were killed within the first half hour (0.5h) of incubation time with the emulsion. *Staphylococcus chromogenes* (SCG), *Pseudomonas aeruginosa* (PA), *Klebsiella pneumonia* (HS09A), and *Escherichia coli* (GN9B) recorded >24h, 4h, 24h, and 24h incubation time of killing, respectively in 25 mg/ml extract. However, by increasing the extract concentration to 50 mg/ml, SC, PA, RK3C, and HS09A were killed earlier in 12h, 0.5h, 8h, and 12 h, respectively. Emulsion of 50 mg/ml effectively controlled the viability of all mastitis-causing bacteria in the study.

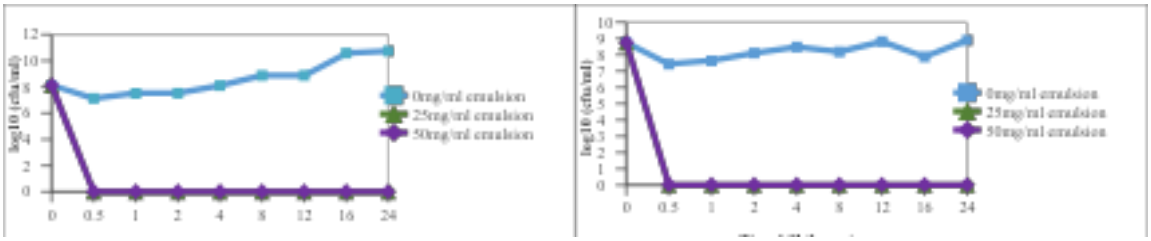
Discussion

The time kill assay concluded that all mastitis-causing bacteria can be killed within 12 h using 50 mg/mL emulsion-based MM extract. In other words, emulsion-based MM extract exhibits great potential as a plant-based substitute for mastitis drugs with the recommended dosage of 50 mg/mL at the frequency of 12 to 24 hourly treatments. The leaves of MM have been reported to contain flavonoids as their major constituent compared to other plant parts of MM [5]. Many of the flavonoid compounds identified in the extracts possess not only antibacterial properties but also exhibit anti-inflammatory effects [6,7].

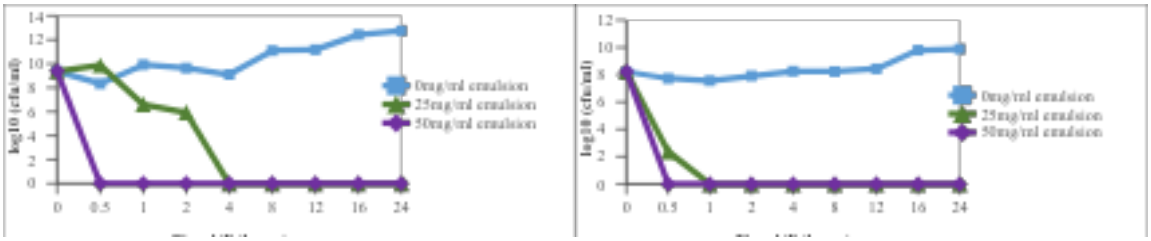
Plant-based antimicrobials, which have varied modes of action by multiple active compounds, are less likely to encourage resistance in bacteria as compared to antibiotics that mostly have isolated active compounds [8]. Interestingly, plants can modulate the immune response, apoptosis, and signal transduction from time to time, as they can prevent protein interaction. [9]. Bacteria have difficulties developing resistance to the complex phytochemicals in plant extracts, and plants' phytochemicals adapt to survive the environmental changes. These actions contribute to reducing antimicrobial resistance development.



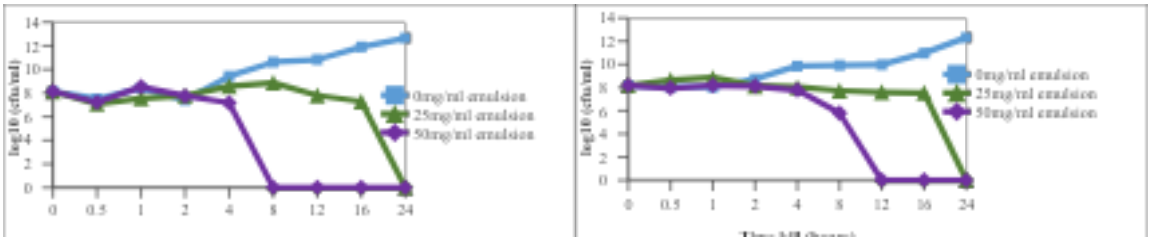
(a) *Staphylococcus aureus* (SA) (b) *Staphylococcus chromogenes* (SCG)



(c) *Staphylococcus haemolyticus* (SH) (d) *Streptococcus uberis* (SU)



(e) *Pseudomonas aeruginosa* (PA) (f) *Streptococcus agalactiae* (RK3C)



(g) *Klebsiella pneumonia* (HS09A) (h) *Escherichia coli* (GN9B)

Figure 1: Time kill curves of 25mg/ml and 50mg/ml of emulsion-based *Melastoma malabathricum* (MM) extract against selected mastitis-causing bacteria. (a) *Staphylococcus aureus* (SA); (b) *Staphylococcus chromogenes* (SCG); (c) *Staphylococcus haemolyticus* (SH); (d) *Streptococcus uberis* (SU); (e) *Pseudomonas aeruginosa* (PA); (f) *Streptococcus agalactiae* (RK3C); (g) *Klebsiella pneumonia* (HS09A); (h) *Escherichia coli* (GN9B)

Conclusion

The findings suggest that emulsion-based MM extract is a potential antibacterial agent for bovine mastitis. The study bridges the gap between MM's established medicinal benefits and practical use in the veterinary context.

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Category: Animal nutrition & feeding
ORL_31

Black Soldier Fly Larvae (BSFL) as Feed Supplementation on Quail's Growth Performance, Carcass Quality and Meat Composition

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Abstract

Black soldier fly larvae (BSFL) is an innovative protein source for quail feed supplementation. This study was designed to evaluate the effect of BSFL supplementation in commercial diet on growth performance (Feed Intake, FI; Body Weight Gain, BWG; Feed Conversion Ratio, FCR) and quail carcass quality (body composition and nutritional composition). A total of 80 one-week-old Japanese quail were randomly assigned to 4 different dietary treatments with 4 replicates of 5 birds each. Treatments included a control diet, T1 (0% BSFL), and 10%, 15%, and 20% inclusion rates (T2 - T4, respectively). From week 5 onwards, 15% BSFL supplementation significantly led growth ($p<0.05$), while 20% gave the lowest growth in quail. In feed composition, crude fibre shows a positive correlation with protein ($r=0.96$) and fat ($r=0.56$). Body weight changes in week 2 until 4 showed no significant difference ($p>0.05$), likely due to quails still adjusting to BSFL nutrients. For growth performance; FI, BWG, FCR does not showed significant differences ($p>0.05$). Body composition that involves more muscle movement like wings, thighs, and feet showed significant increases ($p<0.05$) in weight. Meat with 15% BSFL might appear pale, soft, and exudative (PSE) due to elevated L, a*, b* values, and water holding capacity. Meat nutritional composition shows no significant difference ($p>0.05$). In conclusion, this study reveals that the optimal inclusion rate of BSFL with commercial feed is 15% and BSFL provide a better growth performance and good quail meat quality.

Category: Animal nutrition & feeding
ORL_32

Growth Performance of Ayam Saga Fed Diet Containing Different Levels of Flax Seed

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Introduction

Incorporating omega-3 fatty acids (FA) into chicken feed have gained attention due to their potential to improve consumer health. Omega-3 FA-rich diets have been shown in numerous studies to bring blood pressure and cholesterol down to normal levels. Flaxseed is one of the plant-based sources of omega alpha-linolenic acid (ALA), making it a promising source of omega-3 FA. It has been demonstrated that adding flaxseed to poultry diets enhances the nutritional content of chicken eggs and meat [1, 2]. However, adding flaxseed as an omega-3 source might have an effect on the performance of the chickens. Reduced growth has been linked to higher flaxseed inclusion levels, potentially as a result of anti-nutritional factors (ANFs), primarily phytic acid and cyanogenic glycosides [3, 4]. The objectives of this study were to investigate and compare the effect of feeding different levels of ground flaxseeds on the growth performance of Ayam Saga. Ayam Saga is a chicken breed introduced by the Malaysian Agricultural Research and Development Institute (MARDI) to meet the demand for chicken meat and eggs.

Keywords: Ayam Saga, growth performance, flaxseed

Materials and methods

A total of 100 Ayam Saga (aged 7 weeks) were used in the experiment, with 4 treatments and 5 replications per treatment. Birds were fed with corn-soy based diet (T1), and diets with inclusion of 6.25% (T2), 7.50% (T3) and 8.75% ground flaxseed (T4). All feeds were formulated to be isocaloric (metabolizable energy ~12 MJ/kg) and isonitrogenous (crude protein ~19.0%). The birds were reared in 2-tier battery cages, with feed and water available *ad libitum*. The initial weight (IW) of the birds was taken on the first day of the experiment by group weighing, according to the treatments and replications. Subsequently, birds were weighed according to the diet group fortnightly, as well as at the end of the experiment (final weight, FW). Feed intake (FI) per group of replications was measured fortnightly. Based on the weight and FI data, weight gain (WG) and feed conversion ratio (FCR) were calculated.

All data were subjected to statistical analysis using one way analysis of variance. Then, Duncan's Multiple Range Test (DMRT) was used to compare the significant differences between treatments using SAS version 9.4. Significance was set at $P < 0.05$.

Results and discussion

Results have shown that the inclusion of ground flaxseed in the diets of Ayam Saga significantly influenced growth performance of the birds including WG, FI and FCR (Table 1). The control group, receiving 0% flaxseed in the diet recorded the highest WG (689.80 g), while increasing flaxseed levels beyond 6.25% decreased both WG and FI. Group T4 showed the lowest WG (93.22 g) and FI (0.41 kg), with poorer FCR (4.53), indicating inefficient feed utilization at high flaxseed levels. These findings are consistent with previous studies that reported reduced growth performance at higher flaxseed inclusion levels due to the presence of anti-nutritional factors (ANFs), particularly cyanogenic glycosides and phytic acid [5, 6]. Gopinger et al. [5] observed that broilers fed diets with 10% flaxseed experienced significantly reduced weight gain and feed efficiency, attributing the effects to reduced palatability and the presence of ANFs. However, the group receiving 6.25% flaxseed (T2) showed a relatively good performance, with weight gain (670.40 g) comparable to the control, and the best FCR (3.27). This aligns with findings by López-Ferrer et al. [2], who suggested that low to moderate flaxseed inclusion can be beneficial, enriching meat with omega-3 fatty acids without compromising growth. However, feeding Ayam Saga at high level of flaxseed may adversely affect growth performance, as also reported by Zulkifli et al. [7], who noted negative impacts on feed intake and body weight in chickens fed high flaxseed diets. Therefore, based on previous findings that flaxseed can increase n-3 fatty acids in chicken meat [8], high levels of flaxseed in the diet can negatively impact growth performance and nutrient digestibility due to ANFs contain in the seed.

Table 1. Performance of Ayam Saga fed diet containing different levels of grounded flaxseed (0% (T1), 6.25% (T2), 7.50% (T3) and 8.75% flaxseed (T4))

Treatment	Weight gain	Feed intake	FCR
T1	$689.80^{a} \pm 43.0$	$2.72^{a} \pm 0.14$	$3.95^{b} \pm 0.30$
T2	$670.40^{a} \pm 59.6$	$2.17^{b} \pm 0.05$	$3.27^{c} \pm 0.30$
T3	$411.20^{b} \pm 41.5$	$1.36^{c} \pm 0.12$	$3.32^{c} \pm 0.12$
T4	$93.22^{c} \pm 16.02$	$0.41^{d} \pm 0.02$	$4.53^{a} \pm 0.67$

^{a,b,c,d} Means with different superscripts within the same columns differ significantly at $P<0.05$.

Conclusion

In conclusion, Ayam Saga can tolerate low levels of flaxseed in the diet without adverse effects on growth performance, although feeding high levels may offer nutritional benefits such as increased omega-3 content, it can negatively impact feed intake, weight gain, and feed efficiency due to the presence of anti-nutritional factors.

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Category: Sustainable livestock & feed production
ORL_33

Short-Term Effects of Fruiting Vegetable Seed Priming on Germination Using Vermicompost Tea

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Introduction

Vermicompost tea is environmentally friendly organic fertiliser suitable for use to enrich nutrients in plant media as it is rich in bioactive compounds that are available in simpler structure for easy absorption by plants. Meanwhile seedling stage is an important phase in crop cultivation as it greatly influences the success of plant growth and productivity (Irsa et al. 2021). Potential of vermicompost tea in increasing the growth of various types of plants has been researched widely. However, specific studies on its influence on seed germination efficiency based on seed type are still limited especially for vermicompost produced of cattle manure in which precautions need to be taken to reduce impact due to existence of pathogenic microorganisms. Therefore, an experiment at seed germination stage is very important to obtain initial information regarding appropriate dosage of vermicompost tea for usage as organic fertiliser. This research aims to determine the suitable vermicompost tea concentration for optimal germination of selected fruiting vegetable seeds.

Keywords: *vermicompost tea, seed germination, organic fertiliser, cattle manure*

Materials and methods

African Night Crawler (ANC) vermi worms (Figure 1) were used to decompose cattle manure. The vermicompost tea was obtained and diluted at various concentrations for germination study. Three types of fruiting vegetable seeds, namely okra (*A. Esculentus*), eggplant (*S. Melongena*) and white radish *(R. Sativus*) were tested using vermicompost tea using a non-factorial complete randomised design. A total of 10 sets of vermicompost tea concentrations and 1 control set in triplicates were tested using petri dishes (Figure 2).



Figure 1. *African Night Crawler worms*



Figure 2. Petri dish germination of fruiting vegetable seeds

Vermicompost tea concentrations used were 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%. Plumule emergence data, plant height and number of leaves were recorded for 14 days. A total of 15 vegetable seeds were placed in each petri dish.

Results and discussion

The study showed insignificant effects on plumule emergence of seeds against all vermicompost tea concentrations tested as all vegetable seeds began to show plumule emergence on the third day. Approximately 95% of seeds used germinated successfully. The study also exhibited significant effects of vermicompost tea on the number of leaves of all seedlings studied. Average number of leaves produced was consistent, 2.00 pieces for all treatments with vermicompost tea concentrations 50% and less and increasing leaf area across experimentation period. The early growth phase of the plant to allocate the nutrients absorbed to the development of the root system and stem extension and relatively short observation period may have suppressed increment of leaves (Zubair et al. 2020). Treatment sets with 60% and above vermicompost tea concentration showed retarding reactions thus no real leaf formed.

Analysis also showed that the concentration of vermicompost tea had a significant influence on plant height of the seeds tested. Each type of fruiting vegetable seed showed a different response to the concentration of vermicompost tea which is likely due to the specific physiological mechanism for each species to absorb and use the available nutrients. Okra seeds showed significant increase in growth with optimal concentration determined at the 40%, with an increase of almost five times compared to the control. This indicates okra has a good ability to use nutrients from vermicompost tea rich in gibberellin hormones, cytokinins, and auxins for its vegetative growth (Ravindran et al. 2016, Mehdi et al. 2018). Auxins can induce cell elongation and increase stem growth. In addition, the auxin hormone in vermicompost also plays a role in stimulating plant height. Meanwhile, gibberellins can increase plant height and stimulate stem elongation and cell division. Eggplant seeds showed optimal growth at a concentration of 90% although the increase in growth was not as significant as okra. The analysis results showed eggplant required a higher concentration of vermicompost tea to achieve optimal growth. This difference may be related to the specific morphological and physiological characteristics of plant species to absorb nutrients. Meanwhile, white radish seeds showed an optimal response at a lower concentration of

vermicompost tea (20-30%), with the height of the plant germination obtained between 9.67-9.75 cm.

The use of vermicompost tea can have a positive effect on vegetative growth using a higher dose of vermicompost tea. However, plant species factors can influence the dose requirements for physiological growth of a plant. Growth decreased for all type of seeds at highest concentrations. The decrease observed as higher concentrations may indicate the presence of osmotic stress or toxicity due to excessive doses of vermicompost tea. This emphasises the importance of setting the correct dose according to the specific characteristics and needs of the plant. Nutrients in vermicompost tea can increase the availability of organic matter to plants, thus having a positive effect on plant growth. Okra, eggplant and white radish seeds showed a relatively stable growth pattern at concentration of 30-40%, 20-60% and 10-40% respectively. All vegetable seeds without vermicompost tea (control) produced the lowest growth, proving the need to use vermicompost tea to have a positive effect on plant growth, although each type of vegetable seed showed an optimal response at different concentrations.

Table 1. Comparison of vegetable seed height against vermicompost tea concentration

Concentration of vermicompost tea	Plant height (cm)		
	Okra (*A. Esculentus*)	Eggplant (*S. melongena*)	White radish (*R. sativus*)
0% (Control)	1.54± 0.12	2.17 ± 0.14	6.96 ± 0.12
10%	6.08 ± 0.11	2.17 ± 0.19	8.63 ± 0.12
20%	6.38 ± 0.13	3.21 ± 0.12	9.67 ± 0.18
30%	7.21 ± 0.15	3.17 ± 0.11	9.75 ± 0.16
40%	9.00 ± 0.13	3.67 ± 0.16	9.58 ± 0.12
50%	8.46 ± 0.14	3.17 ± 0.19	9.00 ± 0.14
60%	5.75 ± 0.12	3.17 ± 0.21	6.92 ± 0.13
70%	2.46 ± 0.21	2.63 ± 0.15	4.08 ± 0.12
80%	1.29 ± 0.17	1.29 ± 0.20	1.42 ± 0.11
90%	1.58 ± 0.16	1.50 ± 0.18	1.33 ± 0.17
100%	1.38 ± 0.20	1.01 ± 0.14	1.96 ± 0.12

Conclusion

The vermicompost tea study exhibited insignificant effects on time of plumule emergence of okra, eggplant and white radish seeds despite significant influence obtained for plant height and quantity of leaf. A significant impact of vermicompost tea of cattle manure use was found on okra, eggplant and white radish seeds for plant height and quantity of leaf parameters despite inhibition of growth at higher concentration of vermicompost tea. Hence, it is appropriate to introduce a more dilute concentration of vermicompost tea in general such as 10-40% to avoid plant retardation, osmotic stress and wastage of nutrient resources.

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Category: Non-ruminant production
ORL_34

Building Malaysia's First Cage-Free Aviary: Challenges, Innovations, and the Road Ahead

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Abstract

TC Poultry Farm pioneered Malaysia's first cage-free aviary, marking a major milestone in the country's shift toward a more humane egg production system. This presentation shares the practical journey of planning, building, and operating the aviary. From concept to execution, the farm faced challenges related to infrastructure modification, staff retraining, and adjusting flock management to suit cage-free conditions. Notable innovations included the use of modular aviary systems, enhanced lighting and ventilation, and automated nest box technology. These upgrades have shown to improve bird welfare and productivity but required significant capital and operational adaptation. Regulatory compliance and certification processes were also navigated during the setup. The presentation highlights lessons learned in balancing animal welfare with farm efficiency, and the evolving market demand towards cage-free eggs. Key takeaways include the importance of data monitoring, bird behavior management, and consumer education to ensure cage-free systems viable. TC Poultry's experience offers a replicable model for producers aiming to enter the cage-free segment while maintaining sustainability and profitability.

Category: Non-ruminant production
ORL_35

Global Market Trends and Consumer Engagement in Cage-Free Egg Production

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Abstract

The cage-free egg market has experienced significant growth, driven by increasing consumer demand for ethically produced food products. Companies are capitalizing on this trend, reporting robust sales and market expansion. Strategic in-store signage, targeted advertisements, and clear labelling have contributed to this success. In-store signage effectively educates consumers on the benefits of cage-free eggs, leading to informed purchasing decisions. Advertisements highlight the ethical advantages of cage-free eggs, resonating with a growing segment of health-conscious and environmentally aware consumers. Additionally, transparent labelling practices ensure that consumers can easily identify and trust cage-free products, further driving market growth. The findings suggest that these marketing strategies not only boost sales but also shift consumer preferences towards more humane and sustainable food choices.

Category: Sustainable livestock & feed production
ORL_36

Sustainability and Environmental, Social, and Governance (ESG) in Cage-Free Egg Production: Impact on Industry and Compliance

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Abstract

Cage-free egg production is gaining traction in Malaysia as consumer demand for ethical and sustainable food sources increases. This shift aligns with global sustainability and Environmental, Social, and Governance (ESG) frameworks, which emphasise animal welfare, environmental stewardship, and corporate accountability. This paper explores the implications of sustainability and ESG principles on Malaysia's cage-free egg industry, examining its impact on regulatory compliance, market competitiveness, and industry best practices. Sustainable cage-free egg production necessitates adherence to welfare standards that reduce stress and improve poultry health, translating to enhanced productivity and consumer trust. However, transitioning from conventional battery cages to cage-free systems presents operational challenges, including higher production costs, biosecurity risks, and land use considerations. Additionally, compliance with evolving national and international regulations, such as Malaysia's Good Agricultural Practices (MyGAP) and global sustainability benchmarks, requires significant investment in infrastructure and management practices. From an ESG perspective, cage-free egg production contributes to sustainability through reduced reliance on antibiotics, improved manure management, and lowered greenhouse gas emissions compared to intensive systems. Socially, it fosters ethical labour practices and meets growing consumer expectations for humane food production. Governance considerations include transparent reporting on animal welfare, supply chain traceability, and stakeholder engagement to align with responsible business practices. This paper underscores the need for supportive policies, financial incentives, and technological innovations to facilitate the sustainable growth of Malaysia's cage-free egg sector. As ESG compliance becomes increasingly integral to market access and investment in spite of considerable pushback from vested interests, integrating sustainability-driven approaches will enhance industry resilience while addressing ethical concerns and environmental impacts. The paper concludes with recommendations for policymakers, producers, and stakeholders to advance sustainability in Malaysia's poultry industry.

Category: Non-ruminant production
ORL_37

Corporate Transitions Towards Cage-Free Egg Supply Chains: Tracking 2025 Commitments and Market Implications in Malaysia

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Abstract

The global movement toward cage-free egg production is rapidly influencing corporate procurement policies, particularly within the hospitality and food service sectors. This shift is driven by heightened consumer awareness, global animal welfare standards, and increasing demand for sustainable and ethically sourced food products. In Malaysia, numerous international and local corporations have pledged to transition to 100% cage-free egg sourcing by 2025, aligning with global supply chain reforms and ESG (Environmental, Social, and Governance) expectations. This presentation tracks the progress of these commitments and evaluates their implications for Malaysia's egg industry. Companies with active and public cage-free commitments include Sheraton Imperial Kuala Lumpur Hotel, Courtyard by Marriott Setia Alam, Four Points by Sheraton Puchong, Le Meridien Putrajaya, Aloft Kuala Lumpur Sentral, Moxy Putrajaya Hotel, The Ritz-Carlton Langkawi, Aloft Langkawi Pantai Tengah, DoubleTree by Hilton Melaka, W Kuala Lumpur, Putrajaya Marriott Hotel, Sodexo Malaysia Sdn Bhd, and Convex Malaysia Sdn Bhd. While awareness and corporate intention have grown significantly, the local supply of certified cage-free eggs remains insufficient. Producers face challenges in scaling up cage-free systems, achieving third-party certifications such as Humane Farm Animal Care (HFAC), and maintaining pricing stability. These constraints risk creating supply bottlenecks as the 2025 deadline approaches. Nonetheless, the corporate transition is catalyzing a broader industry transformation. Early adoption by premium hotel chains and service providers is setting new market expectations and nudging local producers toward more humane housing systems. The presentation explores how this movement may influence regulatory developments, investment in cage-free infrastructure, and long-term competitiveness of Malaysia's egg sector. With fewer than 12 months remaining before key 2025 targets mature, urgent multi-stakeholder coordination is required to bridge the gap between policy, corporate pledges, and on-the-ground implementation.

Category: Non-ruminant production
ORL_38

The Future of Layer Industry in Malaysia: Trends, Challenges, and Opportunities

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Abstract

There are 5 layer parent stock companies operating in Peninsular Malaysia with a total female population of 793,252 birds. The principal breed used is Lohmann Brown, which accounts for almost 40% of the total parent stocks. The day-old pullet production in 2024 has reached 44.4 million birds and projected in 2025 to be 56.7 million birds. The projection production for 2025 was 43.24 million eggs per day. A total of 1,648 million eggs were exported mainly to Singapore as table eggs, accounting for 13% of the year's production and the export value was RM526 million. One of the issues faced by egg producers is to comply with local authority requirements in changing land conditions (Tukar Syarat Tanah) and Planning Approval (Kebenaran Merancang), where each local authority has the power to manage land use in their respective districts. In such situations, land enforcement is different between each local authority. Another issue is labor shortage, especially for manual tasks like handling and packaging. Though automation can reduce reliance on labor but it comes with high upfront investment costs. Occasionally, the government decides to execute price control for eggs as it becomes the cheapest source of protein for Malaysians, even though the cost of egg production is above the controlled egg price. Despite the challenges, the future of layer chicken farming in Malaysia appears promising, driven by strategic investments, technological advancements, and supportive government policies. With its halal certification and increasing global demand for poultry, Malaysia is in a prime position to expand its poultry exports, particularly to Middle Eastern and Southeast Asian markets. Developing designer eggs, such as specific nutrient-enriched, cage-free layer eggs and free range layer eggs, offers significant opportunities for differentiation and capturing higher margins.

Keywords : *Poultry, Layer, Local authority*

Category: Non-ruminant production
ORL_39

Differentiation of Malaysian Village Chicken and Hisex Tinted Eggs Based on Egg White Composition Using FTIR Spectroscopy and Chemometric Analysis

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Abstract

Accurate identification of egg types is essential to ensure fair market practices and maintain consumer trust. However, it can be challenging to differentiate between Malaysian village chicken eggs and Hisex Tinted eggs because they share similar physical traits that can be influenced by environmental factors. Traditional methods are often unreliable and inconsistent due to environmental variability, making it necessary to use more robust techniques. The aim of this study was to differentiate these egg types by analyzing the egg white composition using Fourier-transform infrared (FTIR) spectroscopy coupled with chemometric analysis. Egg samples were collected from Malaysian village chickens and Hisex Tinted, and the egg whites were subjected to FTIR analysis. Principal component analysis (PCA), orthogonal partial least square discriminant analysis (OPLS-DA), and hierarchical cluster analysis (HCA) were employed to identify the molecular differences. PCA demonstrated a clear separation between the two egg types, with PC1 explaining 79.8% of the variance and PC2 accounting for 10.5%. The OPLS-DA model confirmed the accuracy by achieving an excellent classification performance with R2X of 0.957, R2Y of 0.992 and Q2 of 0.98, indicating reliable differentiation based on the secondary structures of protein in the egg whites. HCA dendrograms further validated the clustering patterns and clearly showed the separate groups for each egg type. These findings showed that FTIR spectroscopy is a reliable and non-destructive method for differentiating between Malaysian village chicken eggs and Hisex Tinted eggs. It provides a consistent alternative to traditional techniques, enhancing product transparency and quality assurance in local markets.

Category: Animal nutrition & feeding
ORL_40

Effect of Phytogenic Supplementation on the Carcass Characteristics of Broiler Chickens Exposed to Heat Stress

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Abstract

Phytogenics are known to mitigate the negative effects of high temperatures on livestock by enhancing their antioxidant capacity, improving gut health, and modulating the immune system. High temperature affects the production performance of broiler chickens; hence, this can be mitigated by using phytogenics. This study evaluated the effect of three phytogenic supplements (*Adansonia digitata*, *Capsicum annuum,* and *Lippia javanica)* on heat-stressed broiler chickens reared under the deep litter system in a 6-week trial. A total of 144 one-day-old Cobb 500 broilers were used in the experiment. The birds were assigned to four treatments [i.e., *C. annum, L. javanica, A. digitata, and control (untreated tap water*)] in a Completely Randomised Design, and each treatment (36 birds) was replicated three times. Results showed that phytogenic supplementation caused an increase ($p<0.05$) in carcass weight and yield, dressing out percentage, and wholesale cuts weight for birds supplemented with *C. annuum* followed by *A. digitata* compared with the control group. Broilers supplemented with *L. javanica* had significantly ($p<0.05$) lower carcass and wholesale cut weight but significantly ($p<0.05$) higher dressing out percentage and wholesale cut yield than the control group. Birds supplemented with *C. annuum* had significantly lower abdominal fat than other treatment groups. Supplementation of *C. annuum* and *A. digitata* improved carcass weight and yield.

Category: Animal breeding & genetics
POS_01

A Preliminary Study of SNPs in *DGAT1* and *PRL* Genes in Dairy Cattle

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Introduction

Increasing milk production has long been a primary goal within the dairy industry. One approach to achieving this is through the study of candidate genes associated with milk production. Genes such as *DGAT1* and *PRL* have been shown to significantly affect milk quality. The *DGAT1* gene encodes an enzyme essential for mammary triglyceride synthesis. A well-known polymorphism in the *DGAT1* gene, K232A, has been identified as a key factor influencing milk content [1]. Apart from *DGAT1*, *PRL* gene is also known to affect milk production. The *PRL* gene encodes prolactin, a hormone that plays a critical role in maintaining lactation and synthesizing key milk components, including proteins and lipids [2]. Polymorphisms, such as single nucleotide polymorphisms (SNPs) in specific genes may contribute to variations in the genome, potentially influencing milk production [3]. SNPs located within exons can alter protein structure and function, affect gene expression levels, and impact the animal's physiological metabolism. Thus, this preliminary study was conducted to screen for SNPs in the *DGAT1* and *PRL* genes of dairy cattle from a small farm in Melaka.

Materials and Methods

A total of 10 blood samples were collected from dairy cattle and DNA was successfully extracted from these samples. PCR amplification of exon 8 of the *DGAT1* gene and exon 4 of the *PRL* gene was carried out. The resulting single-band PCR products were then sent for DNA sequencing. DNA sequence results were screened for SNPs using Sequencher and MEGA-7 software. Subsequently, allelic and genotypic frequencies for both genes were calculated.

Results

Figure 1 (a) represents the SNPs identified in *DGAT1* gene for three different samples. The adjacent SNPs in exon 8 of the *DGAT1* gene influence the resulting amino acid. Specifically, when the SNPs are a combination of G and C (as seen in sample 1), the amino acid produced

will be Alanine (A). In contrast, when the SNPs are a combination of A and A (sample 2), the resulting amino acid will be Lysine (K).

In exon 4 of the *PRL* gene (Fig. 1 (b)), the SNP at the specific location can either be a G or A, or a heterozygous AG. However, this is a synonymous SNP, meaning it does not alter the amino acid, maintaining Leucine (L) as the encoded amino acid

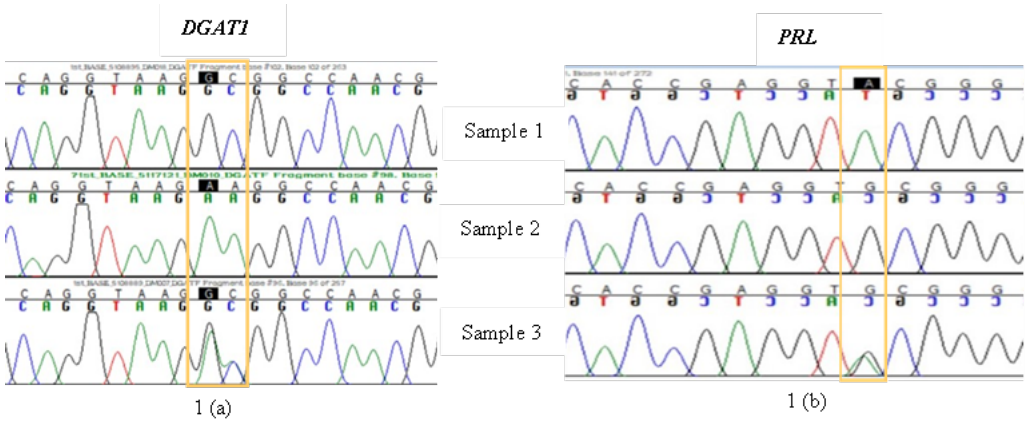


Figure 1. (a) SNPs in exon 8 *DGAT1* gene in three different samples. (b) SNP in exon 4 *PRL* gene in three different samples.

All 10 samples were screened for SNPs in both genes and subsequently, the genotypic and allelic frequencies were calculated (Table 1).

Table 1. Genotypic and allelic frequencies of SNPs in exon 8 *DGAT1* gene and exon 4 *PRL* gene.

Gene	Genotypic frequencies			Allelic frequencies	
DGAT1	KK	KA	AA	K	A
	0.30	0.40	0.30	0.50	0.50
PRL	AA	AG	GG	A	G
	0.10	0.30	0.60	0.25	0.75

Discussion

In *DGAT1*, the frequencies for KK, KA and AA genotypes were 0.30, 0.40, and 0.30, respectively. Cattle with the KK genotype are known for producing milk with high fat and protein content, making them valuable for dairy operations focused on premium milk products. The AA genotype is associated with higher milk yield, ensuring greater overall production per cow. Meanwhile, the KK genotype contributes to both higher average milk production and an

increase in the protein level, making these animals ideal for maximizing both quantity and quality in milk production. Each of these genetic traits plays a crucial role in optimizing dairy farm efficiency and product quality. A study conducted in New Zealand proved that the *DGAT1* gene can influence the level of milk production in cows [4]. The results of the study also found that the *DGAT1* gene was able to increase the protein and fat content of milk with the presence of SNPs in the gene.

As for the *PRL* gene, the frequencies for AA, AG and GG genotypes were 0.10, 0.30 and 0.60, respectively. Based on several studies conducted in the *PRL* gene, there are SNP changes in this gene that cause different milk production rates in each dairy cow [5, 6]. The GG genotype is more dominant and produces higher average milk production as well as higher protein levels. Thus, cattle with GG genotype in exon 4 of the *PRL* gene is more favorable for better milk production.

Conclusion

Both *DGAT1* and *PRL* genes are integral to the regulation of milk production and its overall composition, making them important targets for improving dairy farming practices. This preliminary study can assist farmers in selecting cattle for breeding that can enhance both the quantity and quality of milk, thereby helping to improve dairy industry in Malaysia. Future studies should consider using more samples from different breeds and location for a more accurate outcome.

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Category: Animal health
POS_02

Characterisation of Vaginal Microbiota of Dorper Ewes During Gestation Period

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Introduction

In 2023, Malaysia recorded a population of 338,260 goats and 141,029 sheep [1]. The growing demand for lamb and mutton has increased interest in sheep farming, with a 20% rise in slaughter rates since 2021. To meet market demand, various imported sheep breeds including Dorper, Santa Ines, Barbados Blackbelly, and Marado Nova are systematically reared under local production systems. The Dorper was introduced around 2010 and is highly valued for its adaptability, high carcass yield, early maturation, and high pregnancy rates [3]. However, breeding efficiency remains a challenge despite advancements in nutrition, hormone induction, and assisted reproductive technologies (ART), which often add costs without significantly improving pregnancy rates. Recent studies highlight the reproductive microbiota's role in maintaining health and supporting pregnancy. While research has identified dominant bacterial species in ewes' vaginal microbiomes, the reproductive microbiota remains an emerging field with potential implications for pregnancy success and lamb health [2,3]. Dysbiosis during gestation influences fetal growth and increases the risk of abortion. Understanding these microbial interactions could improve breeding strategies and enhance reproductive outcomes in small ruminants. Hence, this study aimed to investigate the composition and diversity of reproductive microbiota of Dorper ewes throughout the three trimesters of gestation.

Materials and Methods

Ewes were reared in a fully confined system within designated pens (1.2 m^2/ewe) and were daily fed *Brachiaria humidicola* (5 kg) supplemented by commercial concentrates (350 g) per ewe. Microbiota were sampled from the vagina of 15 healthy ewes at each trimester.

Results and Discussion

Samples were processed using a procedure adapted to published protocols [2,4]. A combination of cultured-based isolation and 16S rRNA gene sequencing was used to

characterise microbiota communities. Repeated-measures ANOVA and microbial diversity indices were applied to evaluate microbial load and taxonomic shifts across trimesters.

Table 1. The mean value ± standard deviations (S.D) of bacterial loads in the vagina during 1st, 2nd and 3rd trimester

Trimester	Mean ± S.D
1st	$2.587\times10^{8} \pm 5.23\times10^{7a}$
2nd	$2.082\times10^{8} \pm 1.62\times10^{8a}$
3rd	$1.870\times10^{10} \pm 1.85\times10^{10b}$

*Different letters indicate significant differences (P<0.05) between the rows.

The bacterial load remains relatively stable throughout the 1st and 2nd trimesters, with no statistically significant difference. However, there was a substantial increase in the bacterial load during the 3rd trimester as shown in Table 1. Finally, the sharp rise in bacterial count during the 3rd trimester suggests microbial shifts, possibly due to hormonal changes, increased mucus production, or aggression in the immune response. The total bacterial load was counted regardless of the phyla or microbiota species, which was further determined by phenotypic and genetic approaches. The abundance of the microbiota may comprise a diverse population of the microbiota. Nevertheless, the high or low population diversity does not determine the beneficial or detrimental effects on the reproductive tract environment; it depends on the circumstances [4].

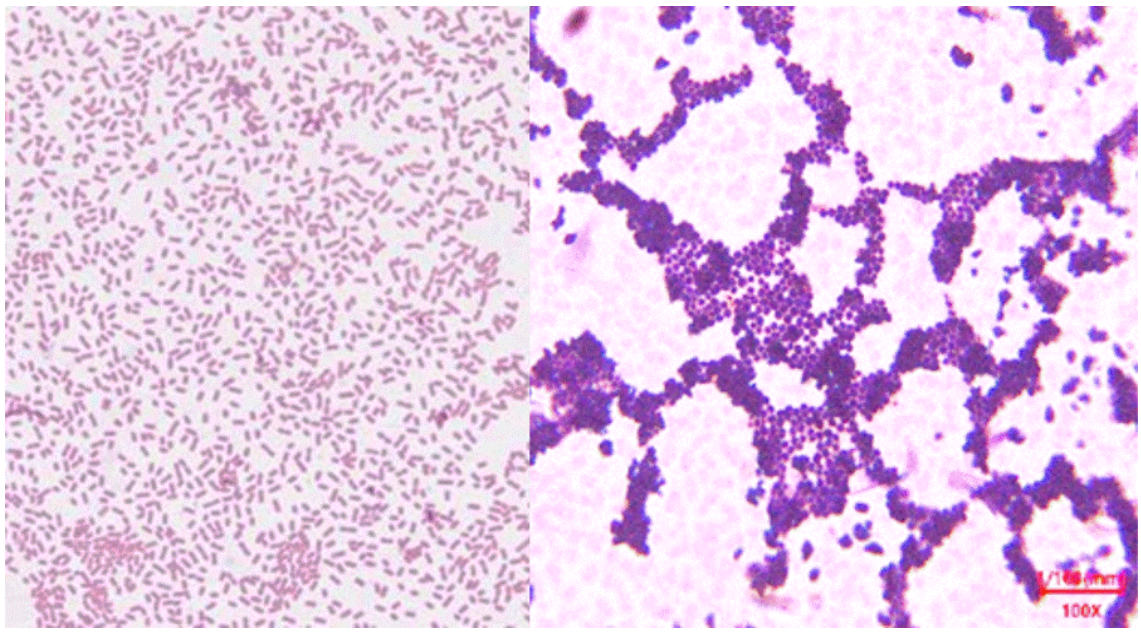


Figure 1. Gram-stained microscopic images of two bacterial phyla commonly found in the vaginal microbiota of ewes. (Left: Gram-negative, Right: Gram-positive).

Fig. 1 shows that Gram-negative bacteria are characterised by rod-shaped (bacilli) morphology and a pink-stained appearance due to the thin peptidoglycan layer in their cell walls. These bacteria can be clustered in the Pseudomonadota phyla. Some of the bacteria

in this phylum, such as *Escherichia* and *Pseudomonas*, can be commensal or opportunistic pathogens in the vaginal environment. Meanwhile, the gram-positive bacteria are characterised by cocci morphology in clusters and a deep purple-stained appearance due to a thick peptidoglycan layer (Fig.1). This group can be predicted from *Staphylococcus* and *Lactobacillus*, which play crucial roles in maintaining vaginal health by producing lactic acid and inhibiting pathogenic overgrowth. However, the abundance of genera *Lactobacillus* in the ewes significantly maintains the pH of the vagina near neutral, postulating a similar condition in the uterus [5]. These bacteria species are clustered in the Bacillota phyla, which is dominantly found in the vagina of ewes.

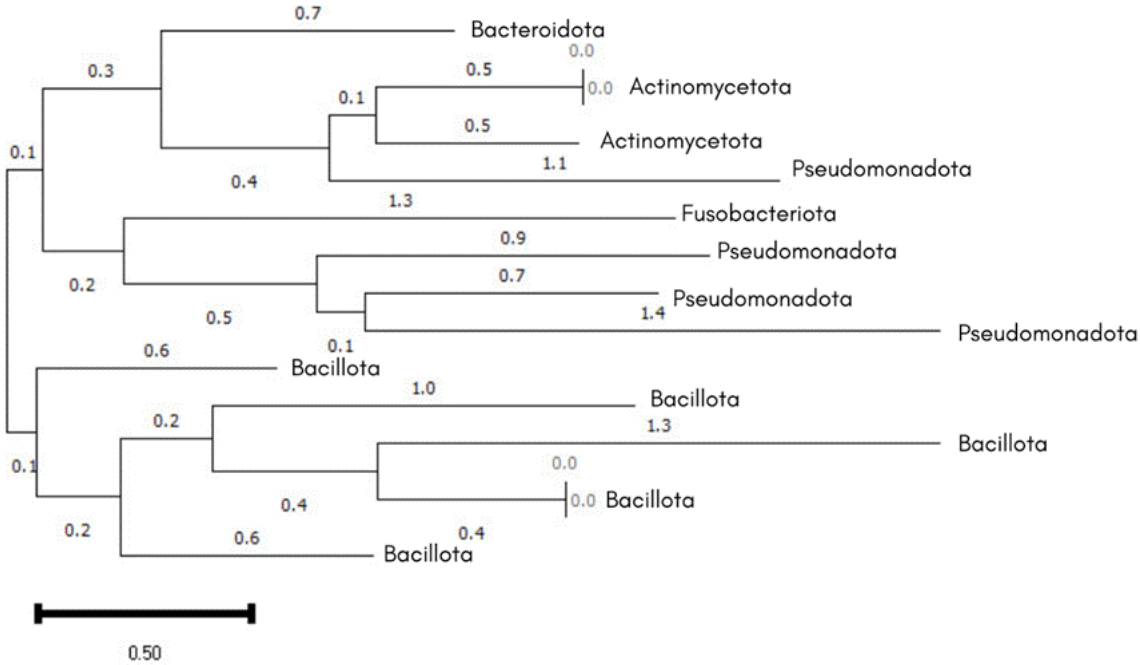


Figure 2. Phylogenetic tree of overall microbiota phyla associated with the studied samples. The scale bar denotes genetic distance with Bacillota, Pseudomonadota, Bacteroidota, Actinomycetota, and Fusobacteriota prominently represented.

Conclusion

Cluster analysis revealed distinct microbial taxa dominated by Bacillota, Pseudomonadota, Actinomycetota, Fusobacteriota, and Bacteroidota. Unexpectedly, an ewe experienced abortion had microbiota profiles associated with phyla Proteobacteria, which dominated the reproductive tract. Significant changes in microbial diversity were observed, particularly in the abundance of phyla Bacillota and Fusobacteriota in the third trimester compared to earlier trimesters. A similar finding was found in a previous study, where bacteria from Bacillota were relatively abundant (49.99%) in the reproductive tract in the early to last trimester [4]. Findings from this study implicate the reproductive microbiota in nurturing a favourable intrauterine environment, contributing to better pregnancy outcomes. Therefore, a recent study proposes a fundamental insight into reproductive microbiota during gestation, where further

reproductive hormone incorporation may correlate with the roles in improving reproductive management.

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Category: Animal health
POS_03

Immune Enhancement Effects of Fermented Seaweed on Rats

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Abstract

Seaweed contains immune enhancing polyphenolic bio ingredients such as *p*-coumaric acid, rosmarinic acid, and ellagic acid, offering protection against infectious diseases. Fermentation and extraction of seaweed make these bio ingredients more accessible, likely enhancing their effectiveness. Poultry, especially in tropical countries like Malaysia, are highly susceptible to infectious diseases due to high humidity. Antibiotics are usually used to treat these infections, but this may lead to antibiotic resistance, posing a potential health risk to humans. This study investigates the immune enhancing effects of fermented seaweed on a small animal model. Rat models were used to determine efficacy and effective doses before scaling to larger animals like poultry. Fermented seaweed from *Kappaphycus sp.* was provided by Dr. Shaiful Adzni Sharifudin from MARDI. The study employed methods adapted with minor modifications from Kim et al. (2022). Five-week-old male Sprague-Dawley rats (200g) were divided into three groups (n=5 per group): A control group of untreated rats, a group treated with fermented seaweed extract (50mg/kg/day) and a group treated with unfermented seaweed extract (50mg/kg/day). Dosages were administered via oral gavage for two weeks. Blood, liver, and spleen were collected for immunoglobulin analysis and histopathological examination. Statistical significance was determined using Student's t-test ($p<0.05$). IgG and IgM levels were significantly higher ($p<0.05$) in rats dosed with fermented seaweed extract compared to the untreated and rats dosed with unfermented seaweed extract, indicating immune enhancement. No toxicity signs were visualised in the liver, kidney nor spleen through histopathology morphological observations. In conclusion, fermented seaweed extract was found to enhance immunity in rats. Further studies can explore its effects in poultry

Category: Animal nutrition & feeding
POS_04

Powering Ruminants: Protected Fat from Black Soldier Fly Larvae Oil

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Abstract

Black soldier fly larvae (BSFL) offer a sustainable feed option for ruminants, providing a rich source of both protein and fat. The extracted oil from BSFL is particularly valuable due to its high concentration of lauric acid, a fatty acid with natural antimicrobial properties. However, directly adding this oil to ruminant diets can disrupt digestion. To overcome this, a processing method is needed that delivers the beneficial fatty acids without affecting the rumen's delicate balance. A protected fat supplement is specifically designed to bypass rumen fermentation and release the nutrients in the small intestine, thus enhancing the nutritional intake of dairy ruminants. This study was conducted to develop a formulation of a protected fat supplement from BSFL oil and to assess its impact on milk production and nutritional quality in dairy goats. The product was synthesized by saponifying BSFL oil with calcium oxide at 80°C and 500 rpm, followed by overnight drying. A feeding trial was conducted with three treatments of dairy goats: (T1) BSFL protected fat, (T2) commercial protected fat, and (C) control – no protected fat. The volume of milk production was measured daily, and milk quality was measured and compared on a weekly basis. The results showed that T1 demonstrated a 19.53% increase in milk production, whereas T2 showed a 6.32% increase compared to the control group. The overall milk production did not demonstrate a statistically significant difference ($P > 0.05$) across all treatments. Conversely, significant variations ($P < 0.05$) were identified in milk quality, with particular emphasis on total solids and total fat content. This research has successfully shown that a protected fat supplement produced from BSFL oil significantly enhances milk production and nutritional quality in dairy goats, without any adverse effects thus can be considered as promising sustainable alternative for ruminant farming.

Category: Animal nutrition & feeding
POS_05

Omega Fatty Acids Composition of Village Chicken Fed Varying Levels of Flaxseed Oil

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Introduction

Omega fatty acids are indispensable fatty acids, meaning that it cannot be produced in the body and must be taken from food. Two main types of omega fatty acids are omega-3 (Alpha-linolenic, Eicosapentaenoic and Docosahexaenoic) and omega-6 (Linoleic and Arachidonic). Of these two fatty acids, omega-3 is more vital and should be focused on as its intake is very low in human. Fortifying chicken meat to optimize omega fatty acid consumption in humans has captured the interest of nutritionists lately. With the increasing awareness and health consciousness among Malaysians in particular, this approach seems to be a great alternative to ensure the desirable proportion for omega intake in human is adequately rectified. Omega-3 is important for various health functions, including brain development and cognitive functionality, as well as reducing inflammation and heart-related diseases. Flaxseed oil, known to be one of the richest omega-3 Alpha-linolenic (ALA) sources, containing around 50% of ALA may be used in enhancing the ALA composition in the chicken meat [1]. Composition of poultry meat fatty acids and lipid can be enhanced or changed by manipulating the dietary intake of the chicken. Thus, the objective of this study is to evaluate the omega fatty acid contents of breast and thigh of village chicken muscle fed with varying levels of flaxseed oil inclusion.

Keywords: *chicken meat, flaxseed oil, omega fatty acids, village chicken*

Materials and methods

The chicken breed used in this study is the slow growing chicken, village chicken breed developed by Malaysian Agricultural Research & Development Institute (MARDI) known as Ayam Saga. A total of 120 all male Ayam Saga aged 7 weeks were randomly distributed and assigned to 4 dietary treatments containing few levels of flaxseed oil (FO), with 5 replicates for each treatment and 6 birds in each replicate. The treatments were the control basal corn-soybean diet with no added FO (T0-control), basal diet with 2.5% FO (T1), basal diet with 3.0% FO (T2) and basal diet with 4.0% FO (T3). All feeds were formulated to contain 19% CP and 12 MJ/kg of energy following the nutritional guideline endorsed by MARDI. The chickens were fed with these experimental diets for 5 weeks starting from the age of 7 weeks until 12 weeks (age of slaughter). Water and feed were given *ad libitum* with weight of the birds were measured every fortnightly to measure the growth parameters. At the age of 12 weeks, 3 birds from each replicate were sacrificed and muscle samples of breast and thigh were collected for lipid and fatty acid analysis. Lipid was extracted using the common Folch solution of 2 methanol: 1 chloroform and the determination of the lipid weight was done by separating and filtering the lipid using the solvent and drying it in rotavapour to obtain crude lipid. Quantification of fatty acids were conducted using gas chromatography and all data obtained were analysed with General Linear Model (GLM) analysis of variance using SAS version 9.4.

Results and discussion

Omega-3 fatty acids (ALA) were detected in all dietary treatments in the thigh and breast muscles, except for the control breast. Breast muscle is mainly composed of the phospholipid type of lipids, which is usually associated with the EPA and DHA fatty acids. The ALA was not detected in the control diet chicken, however, as flaxseed oil was supplemented into the diet, the ALA was found in the breast muscle of the village chicken. Many authors have reported the same findings in which the addition of flaxseed oil did increase the accumulation of ALA in the muscles of chicken [2]. Higher ALA was recorded as higher FO insertion was administered ($p<0.05$) in the thigh muscle (Table 1). Similar trend was also noted for the breast muscle but it was insignificantly different. The ALA in thigh muscle increased around 4 folds higher when fed with flaxseed oil (Table 2). Chicken thigh is known to contain more triglyceride fraction of lipid in the form of ALA fatty acids [3], hence higher accumulation of this fatty acids in this muscle [4]. In breast and thigh muscles, highest ALA concentration was noted when chickens fed with 3.0% of FO, which is 69.63 mg/100g and 289.62 mg/100g respectively.

The linoleic acid (LA) increases as higher FO was added in the breast muscle, but it decreases in the thigh muscle. The transformation of LA to its longer derivatives, arachidonic acid (AA) was also demonstrated in both muscles. The AA concentration also however showed a decreasing trend, similar to LA when higher FO was administered. This could be attributed to that higher ALA was incorporated in this muscle thus reducing the elongation of LA to AA as ALA and LA uses the same enzyme to elongate their chain to its longer component [5].

Table 1. Omega fatty acids composition in breast muscle (mg/100g fresh weight) of Ayam Saga.

Treatment	Fatty acids		
	Linoleic Acid	Alpha-Linolenic Acid	Arachidonic Acid
T0	293.92 ± 26.05	0.00	282.55 ± 25.03[a]
T1	333.39 ± 8.50	59.32 ± 3.66	306.30 ± 5.44[a]
T2	342.44 ± 27.05	69.63 ± 5.25	298.36 ± 24.07[a]
T3	301.96 ± 31.04	65.22 ± 7.94	89.77 ± 8.95[b]
p-values	0.4794	0.4726	<0.0001

[a,b] Means with different superscript within the same column differs significantly (p<0.05)

Table 2. Omega fatty acids composition in thigh muscle (mg/100g fresh weight) of Ayam Saga.

Treatment	**Fatty acids**		
	Linoleic Acid	Alpha-Linolenic Acid	Arachidonic Acid
T0	476.62 ± 23.66	55.48 ± 1.30[b]	317.02 ± 10.10[a]
T1	431.46 ± 13.59	279.80 ± 9.70[a]	289.06 ± 9.74[ab]
T2	439.85 ± 16.01	289.62 ± 10.50[a]	279.16 ± 10.65[ab]
T3	407.78 ± 23.42	281.84 ± 16.79[a]	257.68 ± 13.63[b]
P-values	0.1098	<0.0001	0.0043

[a,b] Means with different superscript within the same column differs significantly (p<0.05)

Conclusion

In this experiment, it was found that inclusion up to 3.0% of flaxseed oil in the diet of Ayam Saga is sufficient enough to enrich the breast and thigh muscle of this village chicken with omega-3 ALA.

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Category: Ruminant production
POS_06

Analysis of Chemical Composition and Milk Production in Dairy Buffaloes in Malaysia

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Introduction

The dairy industry in Malaysia relies predominantly on cattle, but buffaloes are gaining attention due to their adaptability and nutritional benefits. Buffalo milk is characterized by its high fat and protein content, making it ideal for dairy processing. Goat milk, on the other hand, is valued for its digestibility and hypoallergenic properties (Meena et al., 2014). With increasing demand for diversified dairy products and nutritional alternatives, understanding these species' milk production dynamics and composition is essential for sustainable dairy farming. This study aims to provide a preliminary analysis of milk yield and composition in dairy buffaloes and goats, offering insights into their potential for commercial dairy production in Malaysia.

Keywords: *Dairy buffalo, milk composition, milk production, Malaysia*

Materials and Methods

A 15 mL raw milk sample was collected by hand milking at 3 pm once a week, before milking started for each buffalo. The milk samples were collected in the Falcon tube and stored at -80 °C until further analysis.

Results and Discussion

Milk production in dairy animals follows a typical lactation curve characterized by an initial rise, a peak, and a gradual decline as lactation progresses. Figure 1 illustrates the milk production trends in buffaloes from Day 14 to Day 152 postpartum (early to mid-lactation stage), showing distinct patterns for each species. Buffaloes exhibited higher milk yields throughout the study period, while goats had lower but proportionally similar trends. These findings align with previous research on ruminant lactation physiology, which suggests that

milk yield is influenced by factors such as genetic potential, nutrition, and mammary gland development (Strucken et al., 2015).

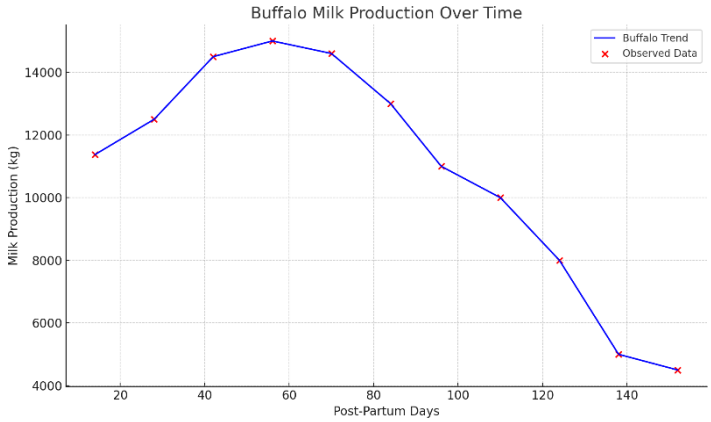


Figure 1: Buffalo milk production vs. post-partum days

Conclusion

The research emphasizes the necessity for strategic enhancements in genetic selection, nutritional approaches, and dairy processing technologies to optimize buffalo milk production. These findings offer essential insights for enhancing dairy farming in Malaysia and promoting the sustainable advancement of the local dairy sector.

Acknowledgement

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Category: Ruminant production
POS_07

Post Acidified Slurry Application on Brachiaria Pasture

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Introduction

Livestock manure management is a critical factor influencing greenhouse gas (GHG) emissions and soil fertility. The application of treated manure, particularly acidified slurry, has been proposed as a strategy to reduce ammonia (NH_3) and methane (CH_4) emissions while enhancing nutrient availability. Acidification of slurry with strong acids such as sulfuric acid (H_2SO_4) and hydrochloric acid (HCl) has been shown to improve nitrogen retention, thereby reducing NH_3 losses. However, the impact of acidified slurry on nitrous oxide (N_2O) emissions and overall pasture productivity remains uncertain.

This study evaluates the effects of acidified slurry application on gas emissions and pasture productivity under field conditions. The research specifically examines how acidification influences nitrogen (N) and phosphorus (P) availability, along with emission dynamics of NH_3, CH_4, and N_2O. Findings from this study will contribute to improving sustainable manure management strategies and optimizing agronomic benefits in tropical pastures.

Materials and methods

The experiment involved the preparation of dairy cattle slurry and its application to pasture. Cattle slurry was acidified and reacidified to pH 5.0 using sulphuric acid (H_2SO_4), lactic acid ($C_3H_6O_3$) and nitric acid (HNO_3) every three weeks for a total of three acidification cycles. The slurry was applied to *Brachiaria ruziziensis* pasture at a rate of 40 m^3/ha. Gas emissions (NH_3, CH_4, and N_2O) were monitored using closed-chamber techniques post-application. Soil nitrogen dynamics, including NH_4^+ and nitrate (NO_3^-) concentrations, were measured after two harvests. Pasture yield (*Brachiaria ruziziensis*) was assessed by dry matter production at multiple growth stages.

Results and discussion

The findings indicate that slurry acidification effectively reduced NH_3 volatilization, particularly in H_2SO_4- and HCl-treated slurries, due to higher NH_4^+ retention (data not shown). CH_4 emissions were significantly lower in acidified treatments (15–41% reduction) compared to the control, with H_2SO_4 demonstrating the highest reduction (15.3%) and HCl at 25.6%. Conversely, HNO_3 treatment resulted in increased CH_4 emissions (16.2%). N_2O emissions varied widely, with increases ranging from 11% to 122% relative to the control, except in lactic acid-treated slurry, which exhibited minimal impact. Soil nitrogen content was higher in acidified treatments, enhancing NH_4^+ retention but with variable effects on NO_3^- accumulation. Despite improved nutrient retention, acidified slurry application did not significantly increase pasture biomass yield. The low organic matter content and diluted nature of the treated slurry may have limited the expected productivity gains. Weather conditions during the study period also influenced nutrient uptake efficiency and plant growth.

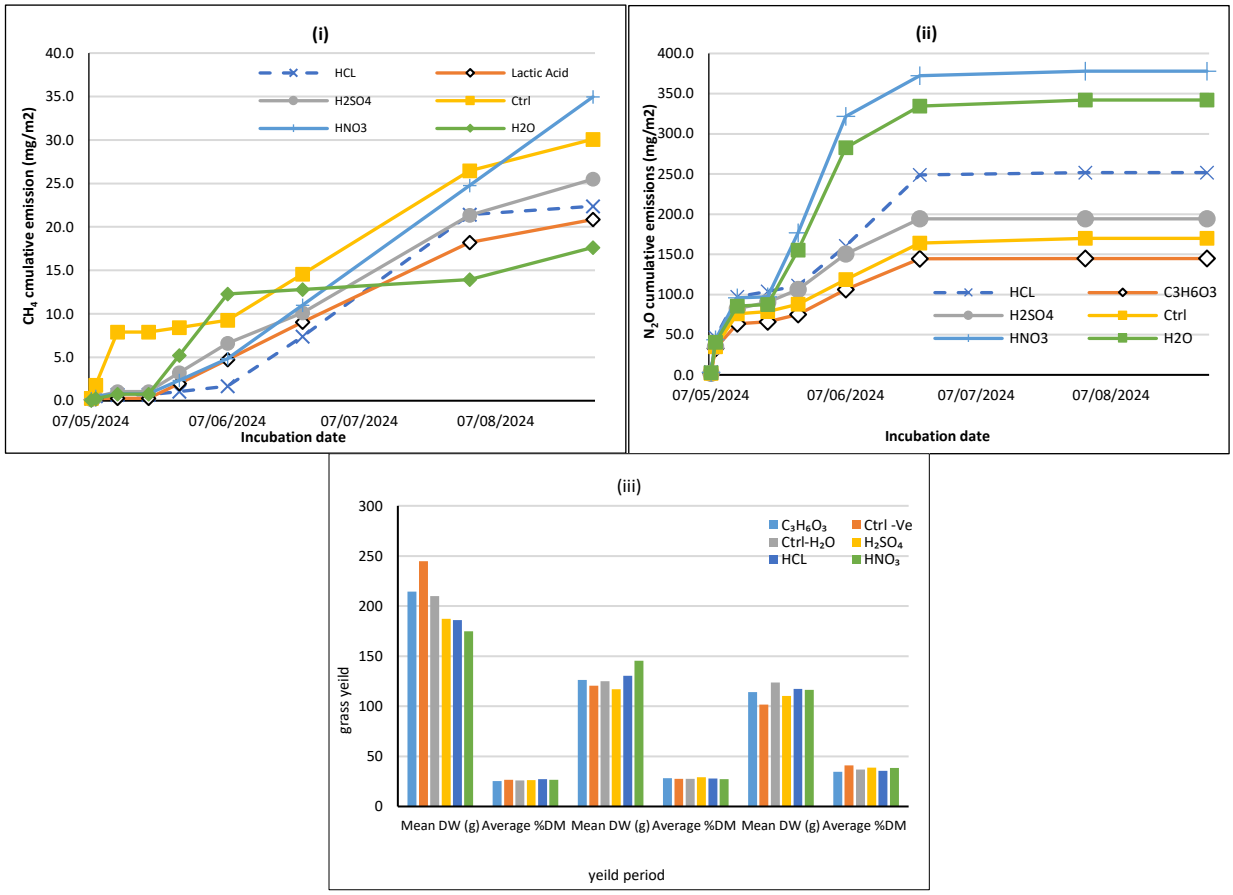


Figure 1. Cumulative emission (i: methane; ii: nitrous oxide) from dairy slurry during storage period and iii: grass pasture yield harvested after slurry application

Slurry pasture application effectively reduces NH_3 and CH_4 emissions, particularly in H_2SO_4- and HCl-treated slurries, due to increased NH_4^+ retention. However, this treatment also led to higher N_2O emissions, ranging from 11% to 122% relative to the control, except

for lactic acid, which exhibited minimal impact. The application of acidified slurry did not significantly enhance pasture yield, likely due to its low organic matter content and diluted nature. Future research should focus on optimizing acidification strategies to balance emission reductions with agronomic benefits, ensuring sustainable and effective manure management practices.

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Category: Sustainable livestock & feed production
POS_08

Optimizing Rural Sustainability: Economic Material Innovations for Rabbit Waste Management in Malaysian Farming Initiatives

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Abstract

This study addresses the critical challenge of selecting the most economical material for rabbit waste management systems within Malaysia's Projek AZAM Tani Mardi Pahang initiative. Using the Analytical Hierarchy Process (AHP), we systematically evaluated five material alternatives—zinc sheets, wooden sheets, stainless steel plates, HDPE sheets, and fibreglass sheets—against five criteria: cost, time, maintenance, lifespan, and DIY capability. The AHP methodology allowed for structured decision-making by decomposing the complex problem into hierarchical levels, conducting pairwise comparisons, synthesising priorities, and assessing consistency. Our findings revealed that zinc sheets emerged as the optimal material choice with an overall priority score of 0.45, outperforming wooden sheets (0.30), stainless steel plates (0.25), HDPE sheets (0.15), and fibreglass sheets (0.10). Zinc sheets demonstrated superior performance in cost-effectiveness, requiring changing only once annually, while significantly reducing pest presence by 60% for flies and 45% for mosquitoes. The economic analysis showed zinc sheets to be 32% more economical than wooden sheets, 48% more economical than stainless steel plates, 25% more economical than HDPE sheets, and 40% more economical than fibreglass sheets over five years. This selection not only addresses the immediate waste management challenges faced by participants but also supports sustainable agricultural practices promoted by the Malaysian Agricultural Research and Development Institute (MARDI). The implementation of zinc sheet waste management systems provides participants with a practical solution that balances economic constraints with environmental benefits, ultimately enhancing the sustainability and productivity of their rabbit breeding operations. Zinc sheets' high recyclability rate (up to 99%) further enhances their environmental credentials, aligning with global sustainability goals and MARDI's commitment to circular economy principles in agricultural development.

Keywords: *material selection, waste management, Analytical Hierarchy Process, rural development, sustainable agriculture.*

Category: Non-ruminant production

POS_09

Saga Chicken: A Promising Hybrid of Village Chicken for Sustainable Poultry Farming

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Introduction

Village chickens have been an integral part of Malaysia's agricultural landscape for generations. Over time, the introduction of foreign breeds by colonizers, traders, and miners led to natural crossbreeding between local and imported chickens, resulting in a genetically diverse village chicken population.

Building on this legacy, the Saga Chicken (Ayam Saga) represents a significant advancement in genetic improvement, spearheaded by the Malaysian Agricultural Research and Development Institute (MARDI) to strengthen the national poultry industry. As a dual-purpose breed, Saga Chicken was developed by crossing two village chicken lines, one from the western and the other from the eastern regions of Peninsular Malaysia (Jamaludin et al., 2022). Combining the traditional characteristics of village chickens with enhanced growth rates and egg-laying performance, Saga Chicken is notable for its uniform body size and feather color. It reaches market weight within 10 to 12 weeks, with males averaging 1.8 kg and females 1.5 kg.

To ensure the distinct identity of Saga Chicken, comprehensive morphometric evaluations and genetic analyses were carried out using simple sequence repeat (SSR) markers. These highly polymorphic and reproducible molecular tools provide valuable insights into genetic diversity, population structure, parentage, evolutionary relationships, and breed identity (Zhang et al., 2020). Building on these findings, the objectives of this study were to evaluate the morphometric traits of Saga Chicken and to analyze its genetic relationship with other

Malaysian Village Chicken (MVC) ecotypes across Peninsular Malaysia. These efforts aim to distinguish the genetic makeup of Saga Chicken from other village chickens and commercial breeds.

Materials and methods

A total of 15 Malaysian MVC ecotypes were sampled across Peninsular Malaysia, including Kelantan (D, n = 30), Kedah (K, n = 128), Pahang (C, n = 53), Perak (A, n = 30), Selangor (Saga, n = 29), Negeri Sembilan (NS, n = 48), Malacca (M, n = 57) and Johore (J, n = 29). Four commercial chicken breeds: broiler Cobb (n = 30) and Ross (n = 30), Sasso (n = 22), and laying hen Hy-Line (n = 30), along with jungle fowls (n=21) were included as reference groups. All animal handling and procedures were approved by MARDI Animal Ethics Committee (Approval Number: 20210827/R/MAEC0097). Chicken ecotypes were selected based on uniform appearance within flocks and sourced primarily from small-scale farms with at least 250 chickens. Birds aged more than 16 weeks were selected for morphometric measurements. Individual morphology was documented through photographs and physical measurements for shank length, sternum height, and overall body length.

Results and discussion

Morphometric data were visualized using the ggplot2 package and analyzed in R software (version 4.4.1) to assess phenotypic variability. Violin plots revealed that Saga Chicken exhibited the most distinct morphology, with greater average lengths for all three measurements and more uniform body size compared to other groups (Figure 1). In contrast, jungle fowls consistently recorded the smallest body measurements, probably influenced by both genetic and environmental factors. Sexual dimorphism in sternum and overall body length was detected in Saga Chicken. ANOVA tests showed significant differences in shank length, sternum length, and total body length among the four chicken breed categories ($p < 0.0001$), rejecting the null hypothesis of no differences. For shank length, Duncan's multiple range test revealed that MVC and Saga were grouped together, both exhibiting longer shanks compared to the other two groups.

For genetic analysis, blood samples were collected from the brachial vein in EDTA tubes and stored at -4 °C prior to DNA extraction using the DNeasy Blood and Tissue Kit (Qiagen, Germany). Seventeen SSR markers were successfully amplified using the PCR protocol described by Schuelke (2000), and fragments were analyzed on an ABI 3130XL Genetic Analyzer (Applied Biosystems, USA). Allele scoring was conducted to assess genetic variability across ecotypes. A Neighbor-Joining (NJ) dendrogram, constructed based on genetic distances, highlighted genetic relationships among the samples. Within the blue clade representing 14 local chicken ecotypes, Saga Chicken clustered closely with chickens from N. Sembilan (NS) and Kedah (Figure 2). While the AK_Johor group formed a distinct branch, it still shared ancestral links with Saga and other related populations within the blue clade. This highlights the genetic and regional ties among native chickens, with Saga standing out for its distinctive size and consistency.

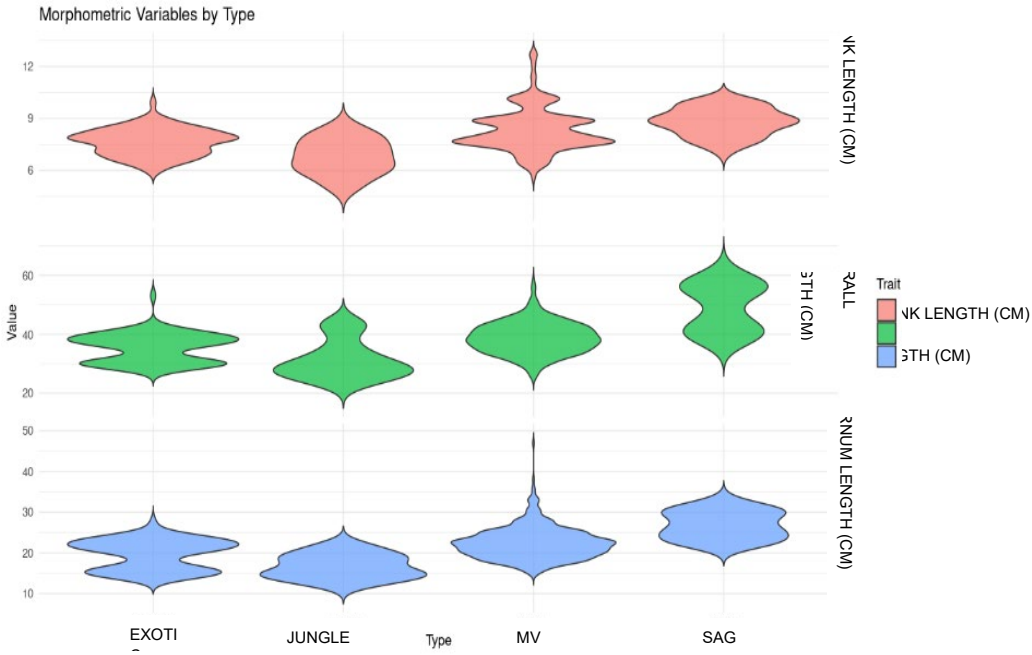


Figure 1. Violin plots were generated based on chicken types. MVC denoted Malaysian Village Chicken, while Exotic comprised all four commercial chicken breeds, and jungle fowl represented the reference group. The p-values for the ANOVA tests were less than 0.0001 for all three measurements. Different letters above the violin plots indicate statistically significant differences among the respective chicken groups, at a significant level of $p < 0.01$ (Duncan's test).

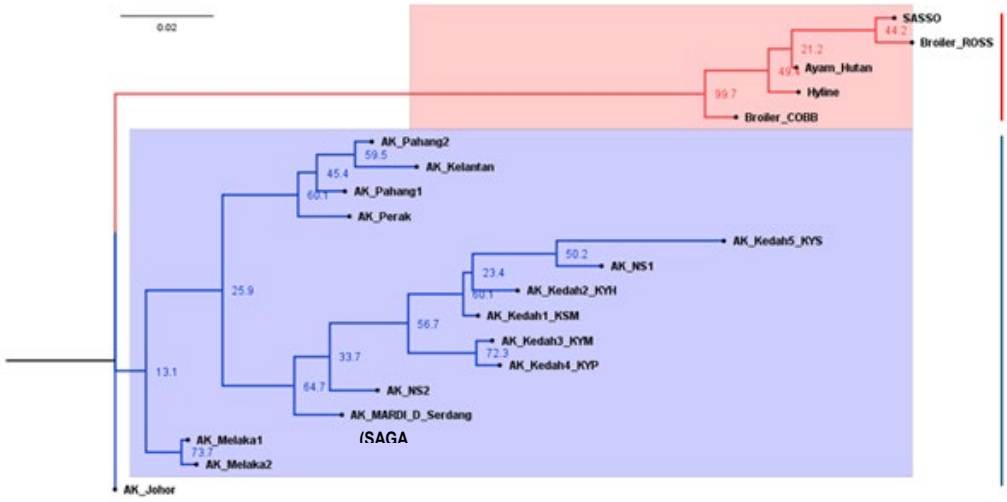


Figure 2. NJ Dendrogram constructed based on 17 SSR markers. The blue clade comprised MVC ecotypes, while the red clade represented commercial breeds and red jungle fowl.

Conclusion

In conclusion, Saga Chicken presents a promising hybrid within the MVC category. Its distinct morphometric traits and genetic profile support its classification as a superior native breed. With strong performance and genetic consistency, Saga Chicken offers a sustainable

alternative to commercial breeds, contributing to a more resilient and secure poultry industry in Malaysia.

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Category: Animal breeding & genetics
POS_10

Effects of Precision Feeding on Breeding and Reproductive Performance of Brakmas Cattle Under Breedlot Production System

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Introduction

Insufficient acreage of land available for livestock activity and animal grazing is one of the issues which hamper the progress of livestock production, particularly for large ruminants. To overcome this issue, a fully intensive production system known as breedlot is suggested which serves as an alternative to the currently practiced production system. Under the breedlot production system, selected female cattle are bred in a confined area throughout the year. The advantages of this system is breeding cycle can be increased up to three (3) breeding cycles every year; increasing the land productivity in terms of number of calves born every year within limited acres of land; and genetic traits within the offsprings can be preserved as only selected female and male cattle are bred in the lot. As feed cost remains the highest production cost for the system, precision feed concept is applied where feed is formulated according to the needs of local breed cattle at identified physiological stages and with inclusion of locally available agricultural by-products. It is hoped that via precision feeding, the feed cost to add 1 kg to animal weight can be reduced compared to the usage of available commercial feed. The objective of the study is to evaluate the effect of precision feeding on female Brakmas cattle breeding and reproductive performance under the breedlot production system.

Keywords: *breedlot, brakmas, precision feed, breeding performance, reproductive performance*

Materials and Methods

A total of 68 heads of Brakmas female cattle at first parity; weighed at 300 to 350 kg were selected and divided into eight pens (53' x 38'). Approximately eight heads of Brakmas female cattle were allocated in each pen. Feed formulation (fattening, breeding, lactation, calf growth) used in the experiment were formulated based on local cattle energy requirement as control, and 20% higher energy than control feed. Four pens received control feed; while another four pens received 20% higher energy feed than control. Prior to breeding, each female cattle received flushing / fattening diet to improve animal weight and body score. Each female cattle were hormonally synchronized two weeks prior to breeding. Breeding commences with the inclusion of Brakmas bull in each Brakmas female group at 1:8 ratio of male: female. Breeding lasts for 60 days and Brakmas bull were removed from the female groups. Pregnancy detection was conducted on Brakmas female subsequently after 60 days. Pregnant female cows were separated while the non-pregnant cows were rebred again for another 60 days. All female cows received formulated feed for breeding until birth. Each female cow that gave birth to a calf received formulated feed for lactation, to provide nutritious milk for the calf until it reached weaning age. Subsequently the cows received fattening diet; while the weaned calves received growth formulated feed until it reach two years old. Breeding efficiency (conception rate) were calculated based on number of conceived Brakmas female cattle from total female cattle under breeding program. Reproductive efficiency (birth rate) were calculated based on number of conceived cattle giving birth to a calf from total conceived cattle. Breeding and reproductive performance of Brakmas cattle were compared between feed. Data was analysed by one-way of analysis of variance (ANOVA) and Duncan's Multiple Range Test was used to compare treatment means using SAS version 9.4 software.

Results and Discussion

The effects of precision feeding on Brakmas female breeding and reproductive performance (Table 1); and Brakmas male calf growth performance (Table 2) under breedlot production system are simplified as follow:

Table 1. The Effects of Precision Feeding on Brakmas Female Cattle Breeding and Reproductive Performance under Breedlot Production System

Brakmas Cattle	Control (100%)		20% higher energy feed		Percentage increment (%)
	n		n		
Pre-Breeding (ADG) (Kg/day)	35	0.530 ± 0.05	33	0.714 ± 0.03*	34.7
Breeding (Pregnancy rate, %)	23	65.75	23	69.69	6.1
Reproduction (Birth rate, %)	19	79.17	21	91.3	15.33

* Values on the same row has a significant difference at confidence level $p<0.05$.

Table 2. The Effects of Precision Feeding on Brakmas Male Calf Growth Performance under Breedlot Production System

Brakmas Cattle	Control (100%)		20% higher energy feed		Percentage increment (%)
	n		n		
Lactation (Calf Wean Weight) (kg)	5	142.38 ± 11.35	7	149.25 ± 7.19	4.83
Pre-weaned calf (ADG) (Kg/day)	5	0.81 ± 0.14	7	0.87 ± 0.02*	7.41
Calf growth (ADG) (Kg/day) #	6	0.887 ±0.118	6	1.083 ± 0.146*	22.1

* Values on same row has significant difference at confidence level $p<0.05$,
# treatment at 10% higher energy (4).

Data of male calves growth were collected as a part of requirement data to monitor their potential as breeder bulls. From Table 1 and Table 2, higher energy diet was found to improve all parameters listed for both Brakmas female cattle; and Brakmas calf performance. This is in-line with the statement of Devendra (3) on the improvement of feed and production system on Kedah-Kelantan bodyweight and daily bodyweight gain. Increasing energy level to fulfill animal energy requirement helps in maintaining the animal physiological needs, growth and subsequent reproduction.

For breedlot and other intensive production system, feed cost is the biggest operational cost to bear by the farmers. Therefore, reducing feed cost may make the business more profitable. Besides using locally agriculture by-product (2), quality animal feed can be achieved by ensuring the quality of feed components, accurate feed formulation, consistent feed mixing and quality control measures (1).

Conclusion

The study demonstrates that Brakmas breeding and reproductive performance can be improved by applying better feed and production system. To further appreciate the findings, the efficacy of feed should also be tested in commercial farms to obtain economic data; and tested up to slaughter stage to see the effects on carcass characteristics and meat quality

Acknowledgement

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Category: Animal breeding & genetics
POS_11

Identification of SNP Markers Associated with Fertility Traits in Goats Utilizing Fluidigm SNP Genotyping Platform

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Introduction

The ability to identify individuals with high conception and twinning rate can help to improve farm productivity in goat breeding programs. Numerous genes have been reported to be associated with fertility traits such as ovulation, oocyte maturation, fertilization, ovarian follicular development, fecundity, and litter size [1]. Single nucleotide polymorphisms (SNPs) associated with these traits have been identified in several goat and sheep breeds [2]. In this study, SNPs associated with conception and twinning rates were identified in two local goat breeds.

Keywords: *Fluidigm, SNP genotyping, twinning rate, conception rate, Boer goats, Katjang-Boer hybrid goats*

Materials and Methods

A total of 70 local goats located in MARDI Kluang Station, which are Katjang-Boer hybrid goats (n:55) and Boer goats (n=15) were used in this study . Genomic DNA was extracted from blood samples using the Wizard® Genomic DNA Purification Kit (Promega) according to the manufacturer's protocol, with modifications. The conception rate was determined by dividing the number of does that conceived by the total number of does exposed to breeding and multiplying by 100, while twinning rate was calculated by dividing the number of twin births by the total number of births and multiplying by 100."

The Fluidigm 96.96 Dynamic Array™ IFC was used to genotype 70 goat samples against 95 SNPs. These SNPs were identified utilizing candidate genes related to reproductive, fertility and litter size traits which were obtained from the bibliomic search and public databases (GWAS Atlas & Animal QTL) and by querying the Goat Ensembl database (http://asia.ensembl.org/Capra_hircus /Info/Index).SNP quality controls were applied to obtain high-quality SNPs using snpReady by following these parameters: (i) only the animals with call rate higher than 95% were included, and (ii) SNPs with a minor allele frequency (MAF) of less than 0.01 were removed.

General Linear Model (GLM) of SAS Breeding data such as conception and twinning rate were recorded. Software 9.4 (SAS Institute Inc. 2023) was utilized to find association between individual SNPs and fertility traits in two goat breeds as below:

$$Y = \mu + F_i + G_j + H_{\underline{k}} + \varepsilon$$

where Y is the observed value of a dependent variable (conception or twinning rate); μ is the overall mean of the population; Fi is the fixed effect of ith breeds (€ = 1, 2); G_j is the fixed effect of jth genotype (j = 1, 2, 3) and H_k is the fixed effect of kth breeding season (k = 1, 2, 3, 4, 5); and ε is the random residual for Y. When there was $p<0.05$, it was examined significant statistically.

Results and discussion

Birth, conception and twinning frequency were recorded for all animals in this study across five (5) breeding seasons from 2021 – 2023. The results showed that both the conception and twinning rates were higher in Boer-Katjang (BK) goats compared to Boer goats. "Analysis of breeding season effects revealed that breed had a statistically significant influence on conception rate, whereas breeding season significantly affected twinning rate ($p < 0.05$)."

Fluidigm assays produced 95 SNPs achieving an overall allele call rate of 97%. A total of 55 SNPs were polymorphic while 40 SNPs were monomorphic. The monomorphic SNPs were excluded from the association study. Association study identified three (3) SNPs to be associated with twinning ability and four (4) SNPs associated with conception ability. This information is depicted in Table 2.

One SNP (rs119103319) located on chromosome 20 was annotated within the coding region of the Prolactin Receptor (*PRLR*) gene and were found to be associated with both twinning and conception ability. [3] showed that prolactin receptor *PRLR* play role in reproductive trait and milk production. Another SNP revealed associated with Semaphorin-3A *(SEMA3A)*. Semaphorins has been associated with in the development, differentiation and plasticity of unique neurons that secrete gonadotropin-releasing hormone (GnRH), which are essential for the acquisition and maintenance of reproductive competence in all vertebrates [4]. This study identified SNP markers with interactions associated with fertility. However, further validation and evaluation of these SNPs are required before these markers can be utilized in goat population selections.

Table 1. Conception and twinning performances (%) based on breed and breeding season

Specification	Category	n	Mean (%)	SE	P-value
Conception					
Breed	BK	55	79.62	3.45	**0.013**
	Boer	15	58.45	7.72	
Breeding Season	1	2	75.00	25.00	0.71
	2	10	80.00	11.06	
	3	10	64.17	10.55	
	4	13	81.92	5.70	
	5	33	73.94	4.48	
Twinning					
Breed	BK	55	32.99	5.02	0.17
	Boer	15	16.44	7.61	
Breeding Season	1	2	0.00	0.00	**0.018**
	2	10	50.00	14.91	
	3	10	0.00	0.00	
	4	13	35.52	10.69	
	5	33	31.31	5.50	

P value < 0.05 is significantly different.

Table 2. Summary of significant SNPs associated with conception and twinning using GLM model in SAS

Traits	**SNP ID**	***P-value***	**Gene name**
Twinning	rs119103319	0.056	*PRLR*
	SNP2	0.054	*SEMA3A*
	SNP27	0.032	*DPYD*
Conception	rs119103319	0.031	*PRLR*
	SNP13	0.0061	*ATE1*
	SNP15	0.036	*GLRB*
	snp39037-scaffold494-654020	0.013	*ADCY*

P value < 0.05 is significantly different.

Conclusion

Genotyping of goat SNPs were successfully performed using the Fluidigm 96.96 Dynamic Array™ IFC. Fifty-five polymorphic SNPs were identified in 70 individuals from Boer and BK goats. Trait association identified seven (7) SNPs markers associated with twinning and conception that can be possibly utilized in future genomic-based breeding schemes. However, further verification studies will be needed to ensure the effectiveness of these SNPs as markers for fertility.

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Category: Animal nutrition & feeding
POS_12

Nutrient Composition of Black Soldier Fly Larvae Rearing on Mixed Feed Substrates

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Introduction

Researchers are currently producing black soldier flies (*Hermetia illucens*) by fortifying dietary components and increasing the substrate's absorption capacity in combination with organic waste [1, 2]. The nutrient composition of black soldier fly larvae (BSFL), particularly the protein content, can be improved by increasing the proportion of high-protein waste in the feed substrate [2]. Mixing nutritionally separated single streams for example, mixing soybean curd residue and kitchen waste into the feed substrate may enhance larvae performance [3]. Larvae consuming more nutrients from mixed feed with improved nutrient composition, develop into more nutritious individuals due to the diet's increased digestibility. Combining two ingredients in a mixed feed substrate may offer an alternative method for managing surplus by-products while compensating for nutrient deficiencies in individual substrates, potentially resulting in a better-tasting or more palatable product [3]. Thus, the objective of this study is to examine the effects of varying the proportion of feed substrates in larvae diets on the nutrient profiles of larval biomass.

Materials and methods

Agro-industrial by-products such as milk-extracted coconut meat (MECM) and an underutilized plant, *Sesbania grandiflora* (SG) were used as feed substrate for rearing BSF larvae. The leaves of SG were ground and mixed with MECM at various proportions (seven treatments, each treatment with triplicates) with different nutrient compositions. The larvae growth trial (n=470 larvae) was carried out for 25 days, where sampling of larvae was carried out every two days starting from days 17 – 25. The larvae were cleaned and dried at

60°C (Binder, Germany) to determine the nutrient composition of larvae on each feed substrate. Data was analyzed using SAS Statistical Software, version 9.4.

Results and discussion

Dry matter (DM) content of BSFL increased with age ($p < 0.05$), except in larvae fed solely on MECM (L1) and SG (L7), which showed no significant change. Adding 20% MECM to SG (L6) significantly raised larval DM content compared to L7 (100% SG) throughout development. The crude protein (CP) content of BSFL varied significantly across different developmental stages ($p < 0.05$) and feed substrates ($p < 0.0001$) due to differences in the nutrient composition of the feed substrates. The results showed that the CP content of larvae reared on L3 to L7 increased from days 17 to 19, peaking on day 19, and then declined by day 25. Whereas, larvae on L1 and L2 showed a delayed CP peak on day 23 (Figure 1 left).

Table 1. Proportion of *Sesbania grandiflora* and milk-extracted coconut meat mixed feed substrate and their nutrient compositions for rearing BSFL.

Designation	Portion of MECM:SG	Ash	CP	Cfat	CF	Energy
L1	5:0	1.05 ± 0.02^{d}	4.22 ± 0.01^{g}	27.57 ± 0.41^{a}	31.05 ± 0.44^{a}	19.62 ± 0.04^{b}
L2	4:1	1.98 ± 0.06^{c}	7.72 ± 0.06^{f}	23.76 ± 0.17^{b}	21.20 ± 0.40^{b}	20.91 ± 0.07^{ac}
L3	3:2	2.19 ± 0.33^{c}	11.98 ± 0.14^{e}	20.11 ± 0.09^{c}	18.02 ± 0.02^{c}	20.57 ± 0.17^{a}
L4	1:1	2.77 ± 0.06^{c}	14.11 ± 0.04^{d}	17.81 ± 0.27^{d}	16.20 ± 0.19^{d}	19.81 ± 0.07^{b}
L5	2:3	4.02 ± 0.06^{b}	16.24 ± 0.11^{c}	15.84 ± 0.05^{e}	14.05 ± 0.09^{e}	19.57 ± 0.28^{b}
L6	1:4	4.84 ± 0.01^{a}	21.51 ± 0.12^{b}	11.39 ± 0.06^{f}	12.42 ± 0.24^{f}	18.64 ± 0.04^{c}
L7	0:5	5.64 ± 0.16^{a}	27.94 ± 0.12^{a}	4.43 ± 0.02^{g}	8.63 ± 0.12^{g}	17.76 ± 0.06^{d}
p-value		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

^{abcdefg}Means ± standard error of the mean in g/100g DM, for ash, CP=crude protein, Cfat=crude fat, CF=crude fibre. GE is expressed in MJ/kg DM. The mean ± standard error of the mean within the same column with different superscripts are significantly different at $p < 0.0001$.

Adding SG increased the level of nutrients particularly CP in the mixed substrates due to a lower protein content of the MECM (Table 1). Overall, higher SG proportions in the substrate led to increased larval CP content, although CP levels decreased with larval age. The crude fat (Cfat, Figure 1 right) content in the substrates decreased as the proportion of SG increased. Conversely, larvae reared on substrates with higher MECM content had significantly higher Cfat levels, ranging from 15.52 to 33.52 g/100g DM on day 17. The CP and Cfat contents in feed substrates have been shown to influence the levels of these macronutrients in the larvae [4]. A study by [5] found that a protein-to-fat ratio greater than 2.4 was ideal for larval growth, particularly due to the importance of protein.

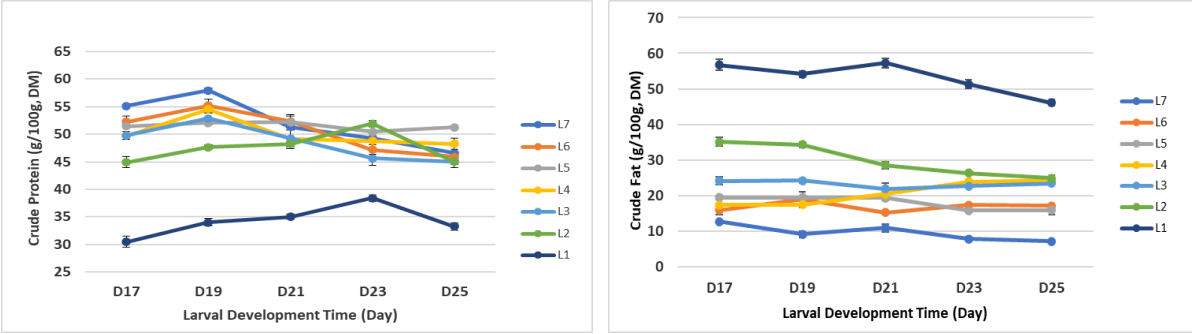


Figure 1: Crude protein (left) and crude fat (right) content of BSFL reared on mixed feed substrate over development time. Error bars represent the standard errors of the mean larval CP and Cfat of triplicate trays. D17-D25=Sampling of larvae between days 17 and 25.

Conclusion

The findings demonstrated that mixing the low-nutrient substrate, milk-extracted coconut meat (MECM), with the underutilized plant species rich in protein, *Sesbania grandiflora* (SG), improved the nutritional values and enhanced its suitability as a feed substrate for BSFL production, compared to using either MECM or SG alone.

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Category: Animal nutrition & feeding
POS_13

Effect of Feeding Different Types of Feed on Progesterone Level in Cattle

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Introduction

Malaysian meat production in 2023 amounted to 38,667 metric tons, which was only able to meet 15.9% of the country's demand. In order to meet the demand, Malaysia imports frozen meat from other countries such as India, Australia, and New Zealand. Malaysia imported 205,246.9 metric tons of fresh, frozen, and processed meat in 2023 [1]. One of the main issues and challenges in developing the ruminant livestock sub-sector are the insufficient quantity and quality of cattle breeds for breeding, with fertility issues are a major concern in the industry, affecting both beef and dairy sectors [2]. Therefore, MARDI has developed cattle breed named Brakmas, with 70% of the population showing successful reproductive performance. This fertility rate limits the efficiency of herd expansion and genetic improvement progress. One key factor influencing fertility is the animal's body condition, which is closely linked to nutritional status. Flushing diets—nutritional strategies that increase energy intake before breeding—have been shown to enhance body condition scores, thereby improving the chances of conception. Additionally, the inclusion of specific nutrients, such as β-carotene, has been reported to play a positive role in reproductive health. This paper aims to study the effects of a flushing diet supplemented with and without β-carotene on the progesterone level of Brakmas cattle.

Keywords: *Brakmas cattle, progesterone level, cattle feed*

Materials and methods

A total of 15 Brakmas cows were randomly assigned into three dietary treatment groups: a commercial diet, an experimental flushing diet, and an experimental diet supplemented with β-carotene (500mg/day), with each group consisting of five animals (n = 5). Cows were fed at 3% of their body weight on a dry matter (DM) basis for 28 days. Subsequently, the cows were randomly assigned into groups of five, with one bull introduced to each group. On day

29, prostaglandin was administered via intramuscular injection. Blood samples were collected on days 5 and 15 post-prostaglandin injection to analyse serum progesterone concentrations and evaluate the effects of the respective diets on hormonal profiles. All data were subjected to statistical analysis using one way analysis of variance. Then, Duncan's Multiple Range Test (DMRT) was used to compare the significant differences between treatments using SAS version 9.4. Significance was set at $P < 0.05$.

Results and discussion

Results have shown that at Week 5, no significant differences were observed among the three treatment groups ($p = 0.1883$). Similar to Week 6, no significant difference in progesterone concentrations was observed among the dietary treatments ($p = 0.9701$). The flushing diet group without β-carotene showed the highest progesterone level (0.45 ± 0.43 ng/mL), which was greater than both the commercial diet group (0.44 ± 0.29 ng/mL) and the experimental diet + β-carotene group (0.41 ± 0.34 ng/mL).

Table 1. Progestrone level of Brakmas cattle on days 5 and 15 post-prostaglandin injection

Treatment	n	Day 5	Day 15
Commercial diet	5	1.07 ± 1.00	0.44 ± 0.41
Experimental diet	5	1.36 ± 0.19	0.45 ± 0.09
Experimental diet + β-carotene	5	1.29 ± 0.97	0.41 ± 0.13
P-value		0.8458	0.9701

These findings suggest that the experimental diet alone may enhance progesterone production without supplemented with β-carotene, although the differences were no significant. Study by Wang et al. [3] also found no significant impact of β-carotene supplementation on plasma progesterone concentrations in cattle. Similar to NASEM [4] as well, the effects of β-carotene supplementation on reproduction in dairy cows are highly inconsistent. Study on the effect of the supplementation in beef cattle is less extensive. In our study, the addition of β-carotene did not show any effect, which could be due to duration of the feeding, as well as breed. Most studies investigating the effect of β-carotene in cattle have been conducted on dairy cattle [5, 6].

Conclusion

This study highlights the importance of dietary formulation in modulating reproductive hormones in Brakmas cattle, which may have practical implications for improving fertility management in tropical beef production systems.

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Category: Sustainable livestock & feed production
POS_14

Enteric Methane Emission Factor for Dairy Cattle Breed in the State of Pahang, Malaysia

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Introduction

Pahang, the largest state in Peninsular Malaysia, comprising 11 districts, plays a significant role in local dairy production. Located within the East Coast Economic Region (ECER), the state alone contributed approximately 15% of Malaysia's domestic milk production, amounting to around 5.84 million liters in 2018 [1]. By 2021, the figure had increased to nearly 7 million litres [2]. This growth reflects the region's ongoing development and its substantial contribution to the national dairy industry, in line with the National Agrofood Policy 2.0, which targets a self-sufficiency level of dairy to up to 100% by 2030 [3].

Ruminant livestock, including dairy cattle, contribute to agricultural greenhouse gas (GHG) emissions, with methane (CH_4) from enteric fermentation having 27 times the global warming potential of CO_2 which may exacerbate climate change [4]. Developing area-specific emission factors (EFs), especially for dairy cattle, is essential for accurate emission estimates, improving national GHG inventories, and supporting Malaysia's reporting obligations to the United Nations Framework Convention on Climate Change (UNFCCC). These efforts also enable the country to set realistic and effective mitigation targets in line with its national policies. Thus, the objective of this research is to conduct a country-wide dairy cattle farm surveys and gather information regarding the dairy cattle production scenario in Malaysia and subsequently develop a country-specific EF for the sector.

Materials & Method

The surveys were conducted in all states within Peninsular Malaysia and Sabah. Data collected included key dairy production parameters such as body weight, average daily gain (ADG), and milk yield. Additionally, information on cattle breed, type and number of animals were also collected to provide a comprehensive overview of the local dairy production scenario. The enteric methane emission factor was then developed based on the collected parameters using the Inter-governmental Panel on Climate Change (IPCC) tier-2 methodology. The enteric CH_4 EF of Pahang is presented as the highest contributor to dairy farming and production in Peninsular Malaysia. The EF was generated based on data from 4200 dairy cattle across 8 major farms in the state. Jersey-Friesien crosses were identified as the main breed across all surveyed farms.

Result and Discussion

Based on Table 1, breeding cows exhibited the highest enteric CH_4 EF consistent with their elevated milk production. The results are also consistent with findings at similar ecological zones with breeding or lactating cow has the highest EF comparing to other types of cattle [5]. This difference is highly significant compared to the IPCC default EF. In the previous GHG inventory reports, the IPCC default EF has been utilized for emission estimates. Utilising this new EF in the current or future emission estimates for GHG inventory reporting would increase the estimates by up to two-fold.

Table 1. Dairy cattle physical parameters and generated enteric CH_4 EF based on different type/stages of animal for the state of Pahang, Malaysia

Type	Mean weight (kg)	Mean ADG (kg/day)	Mean Milk yield (L/day)	EF (kg CH_4/head/year)
Calf	89.17	0.163	-	0.9
Heifer	230.00	0.386	-	23.5
Breeding cow	409.38	0.00	13.98	102.9
Breeding bull	508.33	0.00	-	70.6
IPCC default	-	-	-	47.0

Conclusion

Developing an area-specific EF for dairy cattle allows for more accurate, localized GHG estimates, reducing reliance on lower, default EFs that may not reflect actual conditions. While higher estimates may seem unfavourable, imposing a negative perception towards local dairy production in terms of its GHG emission, the information is crucial towards improving national GHG inventories and guiding effective, targeted mitigation strategies. Thus, this newly developed EF is suggested to be utilized in the future emission estimates for the country-specific GHG inventory report.

Acknowledgements

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Category: Animal health
POS_15

Correlation Between Lactose and Somatic Cell Counts of Milk in Dairy Cattle

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Introduction

Lactose, the primary carbohydrate in cow's milk, plays a significant role in both bovine physiology. Cow milk typically contains approximately 4.9% lactose by weight. Other components in cow's milk include water (87%) [1], protein (3.3%), fat (3.4%), and minerals (0.7%) [2]. Lactose is positively associated with protein and fat while negatively associated with somatic cell count (SCC) and total bacteria count (TBC) [3]. High in milk SCC is associated with inflammation of udder health, where the white blood cells increase during infection [4]. Cows with higher milk lactose concentrations demonstrated low risks of mastitis, which also means low in SCC. This inverse relationship highlights the potential of lactose concentrations as an indicator for detecting intramammary inflammation. The objective of the study is to determine the correlation between the percentage of lactose and SCC in Mafriwal dairy cattle.

Materials and Methods

The study was conducted in Air Hitam Livestock Centre, Kluang, Johor. During the experiment, 60 heads of Mafriwal dairy cattle (n=60) were milked. The milk collected was analysed using a MilkoScan FT1 to determine the milk composition. Chemometex NucleoCounter® SP- 100TM was used to determine the SCC of each milk sample.

Results

Lactose percentage is significantly low with the increase of SCC ($p<0.05$) (Table 1). Both SCC and lactose correlate negatively with each other (Figure 1). The data indicated that lactose reduction indicates that there is an increase in the SCC of milk. In the study, a lactose reading of 4.65 $\pm$ 0.23% and above would indicate a normal SCC, which is below 200,000 cell/ml in

milk. Any lactose reading below 4.55% or more than 200,000 cell/ml SCC in milk would indicate either a subclinical or clinical mastitis is occurring.

Table 1. Somatic cell count and lactose in Mafriwal milk

Somatic cell count (cells/ml)	Lactose (%)
10,000 - 200,000	4.65 ± 0.23[a]
201,000 - 500,000	4.55 ± 0.26[a]
501,000 - 1,000,000	4.28 ± 0.39[b]
1,001,000 - 1,500,000	3.80 ± 0.66[c]
1,501,000 - 2,000.000	3.40 ± 1.03[d]
> 2,000,000	3.49 ± 0.46[d]

[a,b,c,d] Means in the same column with different superscript differ significantly at $p<0.05$

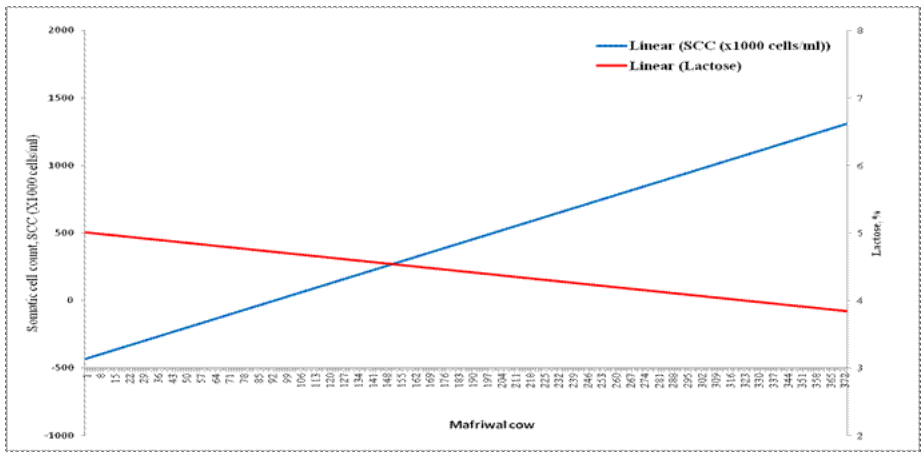


Figure 1: Correlation between Somatic cell count (SCC) and percentage of lactose of milk in Mafriwal dairy cattle.

Discussion

From the data obtained for the analyses of milk collected from Mafriwal dairy cattle, lower readings of lactose percentage indicated higher SCC in Mafriwal milk. Some studies suggested that lactose are indicative of dairy cows' health especially in predicting mastitis in cows. A lactose percentage of 4.70% and lower could indicate there is an occurrence of subclinical mastitis in the herd [5]. [5] suggested the use of lactose as a biomarker on the health status and reproductive success in dairy herds while [6] suggests the usage of lactose as a laboratory method for the detection of subclinical mastitis in dairy herds. Besides, milk composition tests have been conducted daily in some of the dairy farms, therefore the lactose in milk composition data can be used as an inexpensive method to predict the possible mastitis infection.

Conclusion

There is a negative correlation between SCC and the lactose content of Mafriwal milk. The percentage of lactose is potentially an indicator for subclinical mastitis in the Mafriwal dairy herd.

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Category: Sustainable livestock & feed production
POS_16

Optimizing *Eudrilus eugeniae* Vermicomposting of Cow and Goat Manure Ratio and Stocking Density Utilizing Response Surface Methodology

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Introduction

Vermicomposting using *Eudrilus eugeniae* offers an effective and sustainable method for managing livestock manure while producing nutrient-rich organic fertilizers. The efficiency of vermicomposting is influenced by factors such as the type and ratio of manure used, as well as the stocking density of earthworms [1]. This study aims to optimize the vermicomposting process by evaluating different ratios of cow and goat manure and varying stocking densities. Response Surface Methodology (RSM) is employed to systematically analyze and model the effects of these factors [2], with the goal of identifying the optimal conditions for maximizing vermicompost quality and productivity.

Materials and methods

Cow and goat manure were collected, sun-dried, and mixed at designated ratios. *Eudrilus eugeniae* adult worms were introduced into 5L polybag reactors containing 2 kg of manure mixtures. A Central Composite Design (CCD) with 20 runs was used to optimize manure composition and stocking density, analyzed via Response Surface Methodology (RSM) in Design Expert Software 13. Vermicompost quality was evaluated based on worm biomass after 60 days.

Results and discussion

Table 1 shown the independent factors and their levels. Table 2 shown the analysis of variance (ANOVA) indicated that the overall model was significant ($p<0.05$), demonstrating a meaningful relationship between the tested factors and worm biomass. Stocking density had a significant effect ($p<0.05$) on *Eudrilus eugeniae* biomass, whereas manure composition (CM:GM ratio) was not significant ($p>0.05$). The 3D surface plot shows that lower stocking density resulted in higher worm biomass across different manure combinations, suggesting space availability as a crucial factor in optimizing vermicomposting performance.

The ratio of manure composition did not significantly affect worm biomass, as *Eudrilus eugeniae* can reproduce effectively under varying nutrient compositions [3]. However, lower stocking density had a significant positive effect on worm biomass, likely due to sufficient space allowing for comfortable growth and reproduction. In contrast, higher stocking densities resulted in reduced worm biomass, attributed to overcrowding, which limited worm growth despite nutrient availability [4]. This study demonstrated that stocking density significantly influenced the biomass production of *Eudrilus eugeniae*, with lower densities promoting higher biomass yields. In contrast, the ratio of cow to goat manure composition had no significant effect on worm biomass, suggesting that *Eudrilus eugeniae* can adapt to varying nutrient sources.

Table 1. Independent factors and their levels

Independents Factors	Coded	Levels				
		-α	- 1	0	1	α
Manure Combination (CM:GM)	A	0:100	25:75	50:50	75:25	100:0
Stocking Density	B	3.18207	10	20	30	36.8179

Table 2. The effects of manure composition (CM:GM) and stocking density on the reproduction of *E. eugenia*.

Source	Sum of squares	df	Mean square	F- value	p- value
Block	5.89	2	2.95		
Model	14.42	2	7.21	3.94	0.0422
A-Manure Composition (CM:GM)	0.0649	1	0.0649	0.0354	0.8532
B-Stocking Density	14.36	1	14.36	7.84	0.0134
Residual	27.46	15	1.83		
Lack of Fit	18.65	10	1.86	1.06	0.5069
Pure Error	8.81	5	1.76		
Cor Total	47.78	19			

CM – Cow manure; GM - Goat Manure

Conclusion

Overall, optimizing stocking density is a critical factor for enhancing vermicomposting efficiency in mixed livestock manure systems.

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Category: Sustainable livestock & feed production
POS_17

Anaerobic Co-Digestion of Food Waste and Cattle Manure for Biogas Optimization with Supplement of Biochar Using Response Surface Methodology

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Abstract

Food Waste (FW) comprises 45% of municipal solid waste that generates the most greenhouse emissions in Malaysia where most FW sourced from the consumption stage of the supply chain (Jaglo et al., 2021, Noor et al., 2013 and Yong et al., 2019). This study aims to optimise biogas production using Aanaerobic co-Digestion (AcD) with Cattle Manure (CM) as a waste treatment method with a supplement of biochar material as an enhancement for biogas production. Response Surface Methodology (RSM) was used to analyse the optimal amount of FW to CM ratio (100:0, 75:25, 50:50, 25:75, and 0:100) and the optimal amount of Biochar by weight percentage of the total working mass of feedstock (0%, 3%, 6%, 9%, and 12%) at optimal days of Hydraulic Retention Time (20 days, 25 days, 30 days, 35 days, and 40 days) at 5 different levels of the Central Composite Design (CCD) Model against eight responses of Biogas Yield, pH Change, Moisture Content, Total Solid, Volatile Solid, Total Kjeldahl Nitrogen, Carbon/Nitrogen ratio, Orthophosphate Concentration. FW:CM has a significant effect on all eight responses, while biochar is not significant across all eight responses. Co-digestion has an optimal Biogas Yield of 7.247 mg/g VS at a combination of 20.27% of FW with 79.928% of CM in 24 Hydraulic Retention Days. The study concluded that Co-digestion of FW with CM is better than mono-digestion of only FW.

Category: Animal breeding & genetics
POS_18

Genomic Characterization of Kedah-Kelantan Cattle Reveals Selection Signatures in the Selected Population and Implications for Breed Management

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Abstract

Kedah-Kelantan (KK) cattle, a tropically adapted indigenous breed in Malaysia, represent a valuable genetic resource. However, historical crossbreeding practices have posed challenges to maintaining the breed's genetic diversity, potentially leading to the loss of unique adaptive alleles. The development of the MARDI selected "KK Elite" line, while achieving remarkable improvements in growth performance, raises concerns about the unintended consequences of intensive selection on the breed's overall genetic diversity and structure. A thorough understanding of the genomic architecture of KK cattle, including the impact of selection within the KK Elite lineage and its relationship to the broader KK population, is therefore critical for developing sustainable breeding strategies and effective conservation efforts. To address this, we conducted a comprehensive genomic analysis of KK cattle populations across Malaysia. This study employs high-throughput SNP genotyping, utilizing the Illumina BovineHD BeadChip, on an expanded panel of KK cattle (n ≥ 140) representing diverse management systems: KK Elite from MARDI, nucleus herds managed by the Department of Veterinary Services (DVS), and individuals from private breeders across Peninsular Malaysia. Rigorous quality control and filtering of SNP data were implemented to ensure data integrity. Previous analysis of 60 DVS managed KK cattle using similar SNP data revealed moderate genetic diversity, with crossbred individuals exhibiting significantly higher heterozygosity (e.g., observed heterozygosity, H_o =0.35±0.02) compared to purebred (e.g., H_o =0.31±0.01). PCA effectively differentiated purebred and crossbred groups (explaining approximately 15% of the variance across the first two principal components), and specific haplotypes on chromosome 14 were associated with variations in Body Condition Score. Preliminary analysis of the expanded dataset suggests a potential reduction in heterozygosity (e.g., observed heterozygosity, Ho =0.41±0.16) within the KK Elite line compared to the

broader DVS population. Initial Fixation Index (FST) comparisons indicate several genomic regions exhibiting elevated differentiation between KK Elite and DVS cattle, warranting further investigation for candidate genes related to growth and other traits of economic importance. This comprehensive genomic characterization will provide crucial insights into the consequences of selection, inform evidence-based breeding strategies to balance productivity with genetic conservation, and optimize the management of KK genetic resources.

Keywords: *Kedah-Kelantan cattle, genomic selection, genetic diversity, population structure, conservation genetics*

Category: Animal nutrition & feeding
POS_19

Biochemical evaluation of nanoemulsified supercritical CO_2-extracted black soldier fly larvae oil as a poultry feed supplementation

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Introduction

Among the key priorities highlighted in the National Agrofood Policy 2.0 is enhancing the growth and sustainability of the poultry industry. This urges the need to explore alternative feed ingredients that are crucial in maintaining the resilience of the local poultry sub-sector amid global economic uncertainties. The source and quality of dietary oils play a critical role as they influence the energy density of diet and the lipid profile of poultry products.

There has been extensive research into the use of insects as animal feed, which underscores their importance. Black soldier fly larvae (BSFL) is one of the most studied insect species, particularly its potential as alternative protein and energy sources. While containing high protein (27% to 61%), BSFL is also high in fat (7% to 42%), which can complicate the feed formulation, especially when balancing the energy and protein contents of the formulated feed. The advantages of using BSFL - whether as whole full-fat larvae, defatted meal and oil extract, such as improved energy efficiency and other prophylactic benefits are well-documented. Reports on the benefits of these BSFL fractions have been inconsistent, mainly due to variations in the larvae quality.

In this study, we explore the potential of BSFL oil as an essential oil preparation through the use of supercritical CO_2-extraction and nanoemulsion technology. Compared to other oil extraction methods, supercritical CO_2-extraction has been shown to be an effective method for producing essential oil with high extraction efficiency and preserving most of the beneficial compounds in the oil [1]. In this method, CO_2 is brought to a supercritical state (at a temperature and pressure above its critical point) where it behaves as both a gas and a liquid. At this state, CO_2 can penetrate the larvae mass and dissolve the oil. Nanoemulsion forms nano-sized oil-water droplets that can improve the delivery of bioactive lipophilic compounds. The application of nanoemulsion formulations in animal nutrition is largely underexplored. To the best of our knowledge, the effects of dietary inclusion of insect oil nanoemulsions on the performance of broiler chickens have never been documented.

The aim of this study was to assess the physicochemical characteristics and non-enzymatic antioxidant compounds in BSFL oil extracted using supercritical CO_2-extraction method and subjected to an optimized nanoemulsion formulation.

Materials and Methods

Whole full-fat dried BSFL was obtained from Bioloop Sdn. Bhd, Teluk Intan Perak, and ground into powder. The oil extraction was performed using the supercritical carbon dioxide (SCO_2) method at the Supercritical Fluid Centre, Faculty of Food and Technology, Universiti Putra Malaysia (UPM). Prior to extraction, 30 kg of dried BSFL was ground using an IKA Multidrive grinder at 10 rpm for 10 s. The sample contained less than 10% moisture and particle size of less than 0.5 mm. The defatting was performed at a pressure of 100 to 400 bar and temperature of 35°C to 80°C.

The nanoemulsion formulation was optimized based on pseudoternary phase diagrams. BSFL oil and non-ionic polysorbate surfactant (Tween 80) were mixed in various ratios (w/w). The prepared composition was left for 1 min until equilibrium. The 5% of water (w/w) was added by titrating the mixtures of BSFL oil and surfactant until an emulsion state had achieved [2]. All components were weighed, sealed and thoroughly homogenized, before being centrifuged at 3500 rpm at 25°C for 30 min. The formulation was selected from the phase diagram plots with the priority of being optically isotropic, clear, one-phase, and physically stable at ambient temperature (25°C).

The nanoemulsion formulation was characterized by stability and thermostability test; particle-size distribution and zeta potential analysis; viscosity and pH; and phenolic and flavonoid contents. Data were analyzed using one-way analysis of variance in R 4.4.3.

Results and Discussion

The solution achieved a nano-emulsified state with a surfactant/oil ratio of 9 to 1. Other ratios did not result in a nano-emulsified state which can be attributed to the insufficient energy input from the used surfactant (food-grade Tween 80) that lead to instability and the formation of larger droplets (cream formation). The raw BSFL oil was in a solid state at room temperature, which made it difficult to determine the particle size, zeta potential and viscosity of the oil in suspension. The nano-emulsified BSFL oil showed a mean particle size of 137.7 ± 49.8 nm, mean zeta potential of -25.4 ± 3.1 mV, and mean viscosity of 0.883 ± 0.010 centipoise (cP).

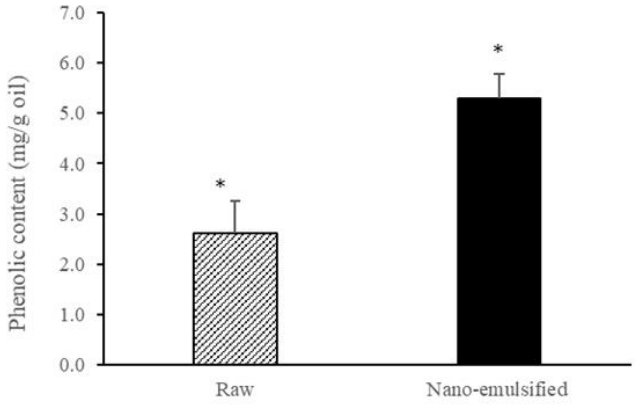


Figure 1. The phenolic content of raw and nano-emulsified oil. Error bars indicate standard deviation, and asterisks (*) indicate significant difference ($p < 0.05$).

There was a significant difference between the raw and nano-emulsified oils in their phenolic contents. Nano-emulsified oil showed one-fold higher phenolic content as compared to the raw BSFL oil. The effects of nano-emulsion on pH and flavonoid content, however, were not significant. The increase in phenolic may be explained by enhanced solubilisation and dispersion of phenolic compounds in the nano-sized droplets. These circumstances improve their extractability and stability by protecting the phenolic compounds from environmental degradation factors such as heat, oxygen, and light [3]. The greater surface area to volume ratio in nanoemulsions may also enhance the interaction between the phenols and oil. The buffering effect of the oil does not impact the acid-base balance of theformulation, maintaining the pH of the solution. No difference in the flavonoid content was observed, which can be attributed to its hydrophilic nature, making it incompatible with the oil phase that primarily encapsulates lipophilic substances of nanoemulsion and poses a potential stability challenge [4].

Conclusion

In conclusion, nanoemulsion can increase the phenolic content of BSFL oil, suggesting a potential improvement in the functional properties of the oil.

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Category: Animal nutrition & feeding
POS_20

Assessing the production traits of broiler IKTA quails fed diets supplemented with supercritical CO_2-extracted black soldier fly larvae oil.

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Introduction

Quail production is a significant and growing segment of the poultry industry in Malaysia with a population of more than 2.7 million in 2022. Quail shows a faster growth rate that demands a lower investment cost which evokes interest among producers [1]. Nevertheless, compared to the chicken industry, the quail industry has a smaller market and cheaper product prices, which lowers the demand and makes businesses unsustainable. Quail producers are facing various issues and challenges due to a lack of knowledge in proper husbandry practices [2].

In recent years, there has been extensive research on insects as alternative feed ingredients that illustrates its importance in future-proofing the industry. Black soldier fly larvae (BSFL), in particular, is one of the most promising insect species as alternative protein and energy sources. Nevertheless, besides containing high protein (27% to 61%), BSFL is also high in fat (7% to 42%) which makes them unfavorable from the animal nutritionist point of view since this will complicate the feed formulation [3]. There have been mixed reports on the efficacy of feeding various fractions of this larvae - as whole full-fat larvae, defatted larval meal or extracted oil. Research also showed that the quality of these larval fractions is largely dependent on the environmental condition and growth substrate used in the larval growing period. To ensure the feed safety, palm kernel meal was used in the larvae production.

In this study, we explore the potential of oil extracted from BSFL as an essential oil and its benefit on the performance of broiler quail. To achieve this, supercritical CO_2-extraction was selected as the oil extraction method. Research indicates that supercritical CO_2-extraction is the most effective approach for producing essential oils [4]. The milder conditions of this method help to preserve heat-sensitive beneficial compounds such as antioxidants, sterols, and fatty acids that may be damaged by the higher temperatures of traditional methods.

The aim of this study was to assess the feed conversion ratio, meat quality traits and fatty acids composition of breast tissue in broiler IKTA quails fed diets supplemented with supercritical CO_2-extracted BSFL oil.

Materials and Methods

The BSFL was sourced from a local supplier that used palm kernel expeller as the growth substrate. The whole full-fat larvae were defatted using a supercritical fluid extractor at the Supercritical Fluid Centre, Universiti Putra Malaysia (UPM). Prior to extraction, 30 kg of dried BSFL was ground using an IKA Multidrive grinder at 10 rpm for 10 s. The sample contained less than 10% moisture and particle size of less than 0.5 mm. The defatting was performed at a pressure of 100 to 400 bar and temperature of 35°C to 80°C. The experimental protocol was approved by the Institutional Animal Care and Use Committee (IACUC) (UPM/IACUC/AUP-R050/2024). The study was conducted at the Animal Research Centre, ITAFoS, UPM. Basal diet was formulated according to the recommended nutrient requirements of quail. A total of 400 unsexed day-old quails (DOQs) were purchased from UPM quail hatchery (Ladang 14). On day 14, quail were sexed based on feather markings. A total of 180 male quails were subjected to 5 treatment groups with different levels of BSFL oil supplementation: 0%, 0.05%, 0.1%, 0.2%, and 0.4%. The daily feed intake and body weight were recorded throughout the trial.

On day 28, all quails were slaughtered according to halal procedures. The breast meat samples were randomly divided into 3 parts and were vacuum-packed and conditioned for 0 and 7 at 4 °C, respectively. All samples were stored at -80 °C for meat quality analyses (drip loss, cooking loss, color and shear force value). Data were analyzed using one-way analysis of variance in R 4.4.3.

Results & Discussion

There were no significant differences ($p < 0.05$) in the fatty acid profiles of breast meat among different treatments. High percentages of SCFA, MCFA, SFA and lowest UFA were observed for the CON groups. T1 showed the highest value for both UFA and PUFA. Meat with high content of unsaturated fat is considered nutritionally superior than the meat with high saturated fat content. Unsaturated fats include the essential fatty acids such as omega-3 and omega-6, which are important for cardiovascular health, brain function, and inflammation regulation [6]. The inverse relationship between unsaturated fat deposition and cholesterol content makes such meat a healthier choice for consumers concerned about cholesterol intake.

Conclusion

In conclusion, supplementation of supercritical CO_2 BSFL oil does not affect the growth performance and meat quality traits, but it can influence the fatty acid deposition in the breast meat of broiler quails.

Table 1. Least significant means of feed conversion ratio (FCR), meat quality parameters and fatty acids composition of breast tissue in broilers receiving diets with varying supplementation levels of black soldier fly larvae (BSFL) oil.

Parameters	Treatment					p-values
	CON	T1	T2	T3	`T4	
Feed conversion ratio (FCR)	2.89	3.05	2.90	3.15	2.69	0.809
Meat quality parameters						
pH	5.98 ^{ab}	5.98 ^{ab}	6.05 ^{a}	5.92 ^{bc}	5.85 ^{c}	<0.001
Shear force, N	297.21	487.31	416.10	466.71	272.86	0.407
Cooking loss, %	22.25	24.40	24.81	24.35	24.40	0.891
Fatty acids composition (breast tissue), %						
SCFA	1.52	1.40	1.05	1.28	1.35	0.197
MCFA	65.50	56.31	64.68	63.19	61.95	0.165
LCFA	32.90	42.25	34.20	35.50	36.67	0.191
SFA	98.35	83.36	93.21	92.87	92.49	0.257
UFA	1.65	16.64	6.79	7.13	7.51	0.257
PUFA	0.20	0.44	0.15	0.09	0.17	0.638

Values with different superscripts within a row are significant ($p < 0.05$).
CON: Control, T1: 0.05%, T2: 0.10%, T3: 0.20%, T4: 0.40%, T1: 0.05%, SCFA: short chain fatty acid, MCFA: medium chain fatty acid, LCFA: long chain fatty acid, SFA: saturated fatty acid, UFA: unsaturated fatty acid, PUFA: polyunsaturated fatty acid.

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Category: Animal nutrition & feeding
POS_21

Productive Responses of Broiler Chickens to Dietary Supplementation of Supercritical CO_2-extracted Black Soldier Fly Larvae Oil

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Introduction

Exploring alternative feed ingredients is crucial in sustaining the local livestock industry amidst the global economic uncertainty. There are growing interests in the potential of insect meals in improving the energetic efficiency of diet, while exerting prophylactic effects in poultry. High protein and fat contents in insects such as black soldier fly larvae (BSFL) can complicate the diet formulation, especially when attempting to replace a substantial amount of soybean meal and vegetable oil in the diet.

BSFL has been fed as whole full-fat meal, defatted protein meal and oil extract. Many studies have reported the benefits of feeding insect meals to poultry and even ruminants. The crude protein (CP) content of BSFL ranged from 35% to 61% and the fat content ranged from 7% to 42%. The BSFL also contains high concentrations of lauric and palmitic acids. Other reported nutrient contents include methionine (0.08% to 0.90%), threonine (0.22% to 2.26%), calcium (1.21% to 4.39%) and phosphorus (0.74% to 0.95%) [1]. The nutritional profiles of various BSFL fractions offer great potential in animal nutrition, whether as main feed ingredients, feed additives or feed supplements. Nevertheless, reports on the benefits of different BSFL fractions have been inconsistent, mainly due to variations in the larvae quality.

In this study, we investigate the potential of BSFL oil which was subjected to a supercritical CO_2 -extraction method, on improving the productive responses of broiler chickens. Among various extraction techniques, supercritical CO_2 extraction is an efficient method for obtaining high extraction yields while preserving the beneficial compounds. Research has shown the benefit of BSFL oil supplementation which improved the feed conversion ratio in broilers.

The aim of the present study was to assess the effects of dietary supplementation of supercritical CO_2-extracted BSFL oil on growth performance, carcass characteristics and meat quality traits in broiler chickens.

Materials and Methods

The BSFL was obtained from a local supplier. The dried whole full-fat larvae was defatted using a supercritical fluid extractor at the Supercritical Fluid Centre, Universiti Putra Malaysia (UPM). The experimental protocol was approved by the Institutional Animal Care and Use Committee (IACUC) (UPM/IACUC/AUP-R051/2024). A total of 300 day-old male Cobb 500 broiler chicks were placed inside a closed house system. The birds were weighed and randomly assigned to 5 dietary treatments with 6 replicates (10 birds per replicate). A two-phase feeding system was used: starter diets from 0 to 14 days, grower-finisher diets from 15 to 35 days. The dietary treatments were CON (basal diet); T1 (basal diet + 0.05% BSFL oil); T2 (basal diet + 0.1% BSFL larvae oil); T3 (basal diet + 0.2% BSFL larvae oil); and T4 (basal diet + 0.4% BSFL oil). Throughout the experiment, the weekly feed intake and body weight were measured to calculate the feed conversion ratio (FCR).

On day 35, four random birds from each replicate were exsanguinated. The eviscerated carcasses were weighed. The gastrointestinal tract (gizzard, proventriculus, duodenum, jejunum, ileum and ceca) and internal organs (liver and abdominal fats) were excised and weighed. The breast muscles were collected for meat quality analyses (drip loss, cooking loss, shear force, color and pH). Data were analyzed using one-way analysis of variance in R 4.4.3.

Results and Discussion

There was a significant difference in FCR between broilers fed with low oil level (T1) and high oil level (T3 and T4). In comparison with the control group, broilers fed with BSFL oil showed better FCR. This improvement in growth performance indicated that BSFL oil could improve nutrient digestion and absorption of broilers [2].

There was no significant difference in meat quality parameters. However, in terms of carcass characteristics, abdominal fat percentage showed significant difference in which T2 had the highest percentage of abdominal fat. Whereas the abdominal fat percentage of CON and T4 had almost the same value. The result illustrates that broilers in T4 dietary treatment have better energetic efficiency. BSFL oil, which is rich in medium-chain fatty acids primarily lauric acid has the potential to enhance growth performance [2] and reduce abdominal fat, due to their efficiency of energy utilization, as compared to long-chain saturated or unsaturated fatty acids [3].

Conclusion

In conclusion, dietary supplementation of BSFL oil has significantly improved the growth performance of broilers.

Table 1. Effects of feeding BSFL diets with different oil levels on feed conversion ratio (FCR), meat quality parameters and carcass characteristics.

Parameters	Treatment					p values
	CON	T1	T2	T3	T4	
Feed Conversion Ratio (FCR)	1.50 ^{ab}	1.55 ^{a}	1.45 ^{ab}	1.44 ^{b}	1.43 ^{b}	0.011
Meat quality parameters						
pH	5.90	6.02	6.11	6.03	6.16	0.332
Shear force, N	389.55	277.66	309.09	393.89	303.11	0.300
Cooking loss, %	24.19	22.97	21.86	22.02	21.99	0.653
Carcass characteristics						
Hot carcass weight (HCW), kg	2.35	2.24	2.36	2.66	2.24	0.157
Digestive organs, % HCW	8.66 ^{a}	0.77 ^{b}	8.93 ^{a}	9.23 ^{a}	7.88 ^{a}	<0.001
Liver, % HCW	2.33	2.17	2.27	2.26	1.79	0.546
Abdominal fat, % HCW	0.79 ^{b}	0.71 ^{b}	1.93 ^{a}	1.19 ^{ab}	0.79 ^{b}	0.010

Values with different superscripts within a row are significant ($p < 0.05$)
Dietary treatments: CON (basal diet); T1 (basal diet + 0.05% BSFL oil); T2 (basal diet + 0.1% BSFL larvae oil); T3 (basal diet + 0.2% BSFL larvae oil); T4 (basal diet + 0.4% BSFL oil).

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Category: Animal breeding & genetics
POS_22

Exploring Genomic Variants from Selected Malaysian Cattle Breeds Using Whole Genome Resequencing Data

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Introduction

Whole genome resequencing of *Bos taurus* and *Bos indicus* cattle breeds has been extensively used to identify genomic variants and understand their genetic basis for improving desirable traits. Despite these advancements, the genomic basis of Malaysian cattle breeds remains inadequate, and no genome data has been generated for these populations to date. Comprehensive genomic information on cattle can facilitate the development of a high-density SNP array, aid in conservation efforts and support cattle breeding programmes. To address this gap, we performed genome resequencing on selected Malaysian cattle breeds, namely Kedah-Kelantan, Kedah-Kelantan Elit and Brakmas, using next-generation sequencing and bioinformatics approaches. Then, single nucleotide polymorphisms (SNPs) were identified and annotated to uncover their biological insights, revealing several candidate genes linked to economically important traits. SNP data was utilized to gain insights into the genomic landscape of selected Malaysian cattle breeds. This study provides valuable genomic resources on potential markers and the genes that serve as a foundation for future research on trait improvement, breeding strategies, and preserving indigenous cattle genetic resources.

Keywords: *genome, next generation sequencing, single nucleotide polymorphism (SNP), zebu*

Materials and Methods

The KK-Elite samples (N=3) were obtained from MARDI Kemamam while Brakmas samples (N=3) were obtained from MARDI Kluang. All the samples resequencing in this study were male individuals. Genomic DNA was extracted from a blood sample using the blood genomic DNA extraction kit. Qualified DNA was sequenced using the Illumina NovaSeq platform, with a read length of 150 bp and achieving 30x coverage. Whole genome sequence data for KK was obtained from a study by Islam et al. 2022.

Quality controls of short reads were performed using FASTP and Trimmomatic. The clean reads were mapped onto the Nellore reference genome retrieved from the NCBI genome (https://www.ncbi.nlm.nih.gov/datasets/genome/GCF_000247795.1/). Burrows-Wheeler Aligner (BWA) was used to map the clean reads onto the Nellore reference genome. Post-processing mapped reads were performed using Picard and GATK. The variant discovery was carried out using GATK version 4.6 and Freebayes version 1.3.2. Variant concordance and filtering were performed using GATK version 4.6. Variant annotation was performed using Variant Effect Predictor (VEP). SIFT4G was used to identify deleterious effects in SNP. Gene ontology enrichment analysis was performed using ClueGO version 2.5.10.

Results and Discussion

A total of 639.66 Gb high-quality paired-end reads from three local breeds were generated with Q > 30 achieved more than 90% (Table 1). The mapping rate of all local cattle breeds to the Nellore exceeded more than 95%, showing their close relatedness to Nellore (Table 1).

Table 1. Summary of genome sequencing results for Brakmas, KK elite (KKE) and KK

Cattle breeds	Total reads	Q>30 (%)	Total base (Gb)	Total clean reads	Total Mapped reads	Coverage (%)
Brakmas	1925076876	92.99	282.70	1908801808	1893152069	97.69
KKE	1644975302	92.38	242.04	1631798850	1617591857	97.63
KK	391390242	91.11	53.49	387976686	377944898	96.21

In this study, a total of 23,773,409 high-quality single nucleotide polymorphisms (SNPs) were identified. Among these, 11,929,504 SNPs are unique to the three targeted breeds. Additionally, there are 5,144,888 SNPs that are found in all breeds. Chromosome 1 exhibits the highest frequency with 1,460,391 SNPs, followed by Chromosome 2 with 1,327,725 SNPs, and Chromosome 4 with 1,303,515 SNPs (see Figure 1).

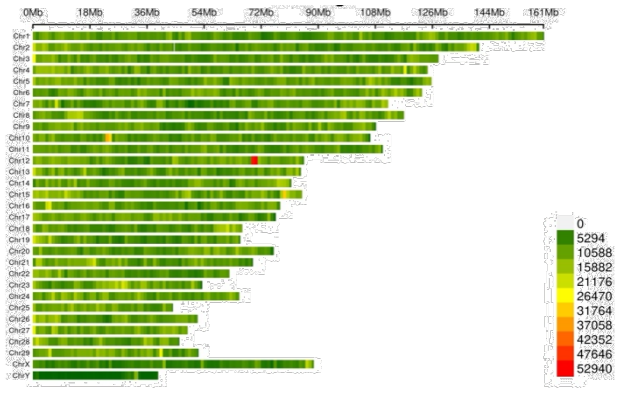


Figure 1. Distribution of SNPs in 30 chromosomes of three local breeds

The analysis of SNPs identified in four local breeds revealed that Brakmas has the highest number of unique SNPs, indicating significant variation compared to both KK and KK Elite (see Table 2). Among these breeds, KKE exhibited the highest frequency of SNPs, followed by Brakmas and KK (Table 2). The Ts/Tv ratio for Brakmas, KKE, and KK was 2.2, which is close to the empirical human Ts/Tv ratio of over 2.1 (Table 2). This suggests that the quality of the identified SNPs is very high [2]. Additionally, the heterozygous/homozygous ratios for Brakmas, KKE, and KK were 1.59, 1.52, and 2.5, respectively. The lower heterozygous/homozygous ratio in KKE shows reduced genetic diversity due to selective breeding objective (artificial selection) [3]. Further studies using large number of populations could provide detailed insights into the causes of reduced diversity in KKE.

Table 2. Summary of identified SNPs in Brakmas, KK Elite and KK

Descriptions	Brakmas	KK Elite	KK2
Total SNPs	14,795,632	15,167,294	10,900,372
Het/Homo	1.59	1.52	2.5
Ts/Tv	2.20	2.20	2.20

SNP annotation identified a total of 7,750,772 genic SNPs. Among these, there were 7,424,496 intron variants, 1,544,570 UTR variants, 77,650 missense variants, and 94,056 synonymous variants. The high density of intron SNPs indicates that most SNPs are found in non-coding regions, which is common since these regions make up a substantial part of the genome (Figure 2a) [4]. SNPs located within introns usually do not alter protein sequences but may influence gene splicing or regulation [5].

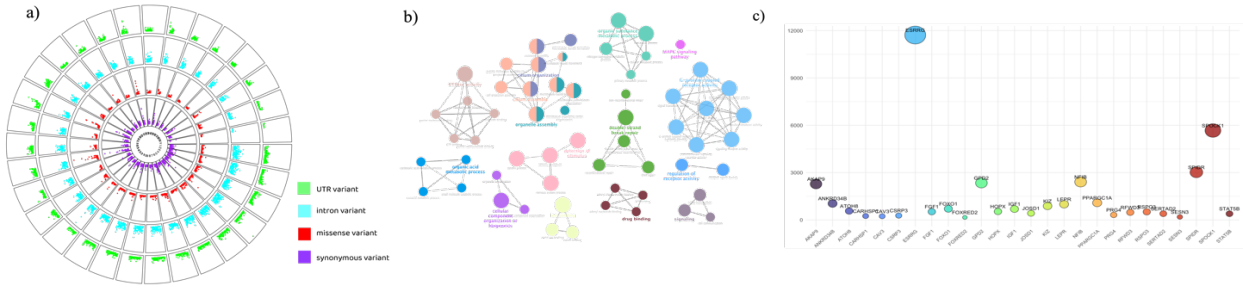


Figure 2. a) Circos plot shows density of SNPs effect in 30 chromosomes. b) Gene ontology (GO) enrichment analysis of 7,536 genes associated with 26,629 deleterious SNPs identified 14 significant biological terms. c) Distributions of SNPs in genes encoding economical traits.

Missense single nucleotide polymorphisms (SNPs) are mutations that result in changes to nucleotides, leading to amino acid substitutions. These substitutions can potentially alter the function of proteins [5]. As a result, we classified these missense variants based on their deleterious effects and identified a total of 26,629 SNPs with harmful consequences. Each of these mutations was annotated accordingly. A GO enrichment analysis revealed 14 significant terms, which predominantly included categories such as signaling pathways, metabolic processes, detection of stimuli, drug binding, and regulation of receptor activity (Figure 2b). We identified single nucleotide polymorphisms (SNPs) in seven economic traits: reproduction, fertility, sexual precocity, carcass quality, meat quality, and growth production. In total, we discovered 26,932 SNPs within genes associated with these economic traits. The SNPs in the *ESRGG* gene had the highest frequency, followed by those in the *SPOCK1* and *SPIDR* genes (see Figure 2c).

Conclusion

This study performed whole genome re-sequencing of Malaysian cattle breeds, which yielded an abundance of SNPs. These potential SNPs serve as powerful tools for enhancing cattle breeding and management, offering valuable insights for breeding decision-making.

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Malaysian Dairy Goat Farming: What Are the Key Trends and Future Pathways?

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Introduction

Dairy goat farming in Malaysia typically operates as a small-scale, cottage industry [1], [2]. The emphasis on milk volume as the main performance indicator of the dairy industry may not fully capture the potential opportunities of dairy goat farming. There is currently no official recorded data on goat milk production and consumption in Malaysia, as statistics are often categorised together with cow and buffalo milk production [3]. Therefore, this paper is crafted to synthesis the available evidence on dairy goat performances in Malaysia, with particular attention to breed-specific performances, economic indicators, consumption patterns, and sustainability challenges, while highlighting potential pathways toward enhanced sustainability of the sector.

Materials and Methods

This review implements a narrative approach to systematically map the available literature extracted from electronic and manual databases, limited to Malaysian studies. The review identifies key themes related to: (i) breed-specific performance parameters; (ii) economic indicators, price structures, and market dynamics; (iii) socio-cultural determinants of consumption patterns; (iv) sustainability challenges across biological, environmental, economic, and institutional domains; and (v) strategic interventions for sustainable sector development. The synthesis of findings provides a comprehensive overview of the current state and future prospects of the dairy goat industry in Malaysia.

Findings and Discussion

Market Dynamics and Economic Indicators:

The Malaysian goat milk market is valued to grow at a compound annual growth rate (CAGR) of 4% from 2025 to 2031 [4]. Although not explicitly reported, the same source defined a three to six times higher price of the goat milk than the cow milk. This substantial price premium

creates significant economic incentives for dairy goat farming despite the challenges of lower production volumes compared to dairy cattle.

Consumer Preferences and Socio-Cultural Factors:

The growth trajectory of the Malaysian goat milk market is driven by multiple factors including increased consumer awareness of nutritional benefits, rising prevalence of lactose intolerance and cow milk allergies [5]. For the Muslim majority population, goat milk holds particular significance as a "sunnah food" - creating a distinct market segment driven by religious and cultural values [6], [7]. Consumption patterns also decrease as children grow older, primarily due to the availability of alternative beverages and aversion to their taste. Gender differences are also noted, with female respondents demonstrating higher consumption rates, potentially related to perceived health benefits for themselves and their families[5]. Negative preferences exist including food neophobia (fear of trying new foods), the distinctive "goaty" odor, [8] and food safety concerns [9].

Nutritional and Health Aspects:

From a compositional standpoint, goat milk possesses several nutritional advantages that contribute to its market appeal. It has a higher buffering capacity and higher alkalinity than cow milk, making it appropriate for people with gastric acidity issues [10]. The smaller fat globules in goat milk result in a softer texture and enhanced digestibility compared to cow milk. This characteristic makes goat milk particularly suitable for individuals with digestive sensitivities or those seeking alternatives to bovine dairy products [5].

Value Addition and Market Development:

Beyond liquid milk, processing can involve developing value-added products to overcome market barriers and enhance economic returns. Innovative approaches include creating goat milk tablets using direct compression methods, which have demonstrated successful improvement of powder properties and the production of tablets with good hardness, weight uniformity, and low friability [11]. Other value-added products include goat milk soap, made using palm-based materials and goat's milk, which has been successfully formulated and accepted by consumers [12].

Breed Performance and Adaptation:

Currently, there is no specific local breed exclusively bred for dairy production in Malaysia [2]. Instead, the industry relies on a combination of imported breeds and their crosses, with Saanen being a prominent choice, alongside other breeds like Anglo Nubian, British Alpine, and Jamnapari [13], [14]. The Saanen breed was among the first imported breeds used in dairy goat farming in Malaysia, starting in the 1950s [15], and has remained a common choice due to its high milk production potential [14].

Research comparing breeds in Malaysia has shown that breed type can have a significant effect on milk yield and composition [16], [17], [18]. Lactation profiles follow expected patterns with peak production during mid-lactation, with a report produced a higher yield for Saanen-Jamnapari crossbreeds during mid-lactation (833.10 g/day) than the early lactation (226.20 g/day) and lowest during the late lactation (142.50 g/day) [17]. Based on milk composition, Jamnapari crossbreeds exhibited superior compositional metrics compared to Saanen varieties, with elevated total solids, fat, and protein concentrations [19].

Production Challenges and Management Practices:

Imported temperate goats often demonstrate disappointing and commercially unviable low milk yields in Malaysia's hot and humid tropical environment due to biological constraints like heat stress, poor feed intake, poorly ventilated barns, and a wide range of tropical parasites and diseases[14], [20].

Disease transmission risks are also significant, with documented outbreaks of brucellosis linked to consumption of unpasteurized goat milk. One study reported a total of 79 people who drank milk from a single farm were diagnosed with brucellosis in a single year, indicating a serious bacterial infection. The outbreak also affected farm workers and laboratory staff handling samples. The disease caused prolonged illness, with some patients experiencing relapses and long-term health effects [21]

Milk quality and safety concerns are substantial, with studies finding significant levels of microbial contaminants in milk of locally produced raw milk [22]. Studies of goat milk from small-scale dairy farms in Penang, Malaysia, found significant levels of microbial contaminants, including total bacteria, yeast, mould, *Staphylococcus aureu*s, E. coli, coliforms, *Klebsiella pneumoniae*, and Salmonella sp. The presence of these microorganisms indicates poor milk quality and poses a serious health risk to consumers, especially if the milk is consumed raw or improperly handled [23].

Sustainable Production Strategies:

Several strategies and initiatives are being pursued to enhance the sustainability of the dairy goat industry in Malaysia. Utilizing improved housing systems like raised slatted floors has become a common practice to prevent intestinal parasites and improve animal welfare. Enclosed housing systems with evaporative cooling have been shown to allow higher productivity of imported purebred goats under the hot and humid climate [24].

The integration of dairy goats with other farming systems, particularly oil palm plantations, presents a promising sustainable approach that addresses land constraints while utilizing available resources. Crop-livestock integration systems developed by the Malaysian Palm Oil Board have demonstrated successful models of dairy goat integration with mature oil palm plantations, offering potential for reduced operational costs and enhanced resource utilization. [25].

Conclusion

The way forward for the Malaysian dairy goat industry lies in addressing key challenges while capitalizing on unique opportunities presented by growing consumer interest, price premiums, and the potential for value-added product development. By embracing sustainable practices, improving breed adaptability, and developing targeted market strategies, the sector can establish a stronger foundation for future growth and contribute meaningfully to Malaysia's agricultural economy.

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