



Review of relevant food and feed safety laws governing the use of insects as animal feed in Serbia and Türkiye

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Review of relevant food and feed safety laws governing the use of insects as animal feed or human food in Serbia and Türkiye

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Dit rapport analyseert de wetgeving met betrekking tot voedsel- en voedselveiligheid die het gebruik van insecten als voedsel en veevoer reguleert in Servië en Turkije. Insecten, als een duurzame bron van eiwitten, ondervinden in beide landen aanzienlijke belemmeringen door lacunes in de wet- en regelgeving, hetgeen de integratie van insecten in de voedselsystemen belemmert. In Servië ontbreekt het aan specifieke wetgevende bepalingen voor producten op basis van insecten, wat de ontwikkeling van deze sector remt. Tegelijkertijd is de wetgeving in Turkije onduidelijk met betrekking tot de kweek en verwerking van insecten. Beide landen dienen expliciete richtlijnen te formuleren voor voedselveiligheid en productkwaliteit, en een gedegen regelgevend kader te ontwikkelen ter ondersteuning van de sector. Het wegnemen van deze juridische obstakels kan het potentieel van insecten als voedingsbron ontsluiten en bijdragen aan de versterking van de mondiale voedselzekerheid en duurzaamheid.

This report analyzes food and feed safety laws governing the use of insects as food and animal feed in Serbia and Türkiye. Insects, as a sustainable protein source, face regulatory gaps in both countries, hindering their integration into food systems. Serbia's legislation lacks specific provisions for insect-based products, limiting industry growth, while Türkiye's laws lack clarity on insect farming and processing. Both countries need to define safety and quality guidelines and create comprehensive regulations to support the sector. Addressing these challenges can unlock the potential of insect-based products, contributing to global food security and sustainability.

This report can be downloaded for free at <https://doi.org/10.18174/685855> or at www.wur.nl/livestock-research (under Wageningen Livestock Research publications).



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Table of contents

Foreword	5
Summary	7
1 Introduction	9
2 Methodology	11
3 Case study: Serbia	12
3.1 Legislative review	12
3.1.1 Food legislation	12
3.1.2 Feed legislation	12
3.1.3 Insect-related legislation	13
3.2 Gap analysis	15
3.2.1 Gap analysis on insects as food	15
3.2.2 Gap analysis on insects as feed	15
3.3 Recommendations for policy development	16
3.4 List of regulatory documents	18
4 Case study: Türkiye	19
4.1 Legislative review	19
4.1.1 Food legislation	19
4.1.2 Feed legislation	19
4.1.3 Insect-related legislation	19
4.2 Gap analysis	21
4.3 Recommendations for policy development	22
4.4 List of regulatory documents	22
5 Conclusion	23
6 Future perspectives	25
7 Acknowledgement	26
References	27

Foreword

The global food system faces significant challenges as it strives to meet the demands of a growing population while preserving environmental sustainability. The search for innovative, sustainable, and efficient food production solutions has brought the use of insects for food and animal feed into focus. Insects offer high-quality protein, a minimal environmental footprint, and the potential to transform organic waste into valuable food and feed resources. Despite these benefits, regulatory frameworks remain a critical factor in enabling the safe and widespread adoption of insect-based products.

This report, prepared by Wageningen Livestock Research in collaboration with local experts from Serbia and Türkiye and funded by FAO, explores the legislative landscapes governing the use of insects as food and feed in these countries. The study highlights existing regulations, identifies gaps, and provides targeted recommendations to foster the growth of this emerging sector. With insights drawn from thorough legislative reviews, stakeholder consultations, and comparative analyses, the report aims to support policymakers, industry leaders, and researchers in creating an enabling environment for insect production industries.

We hope this report serves as a valuable resource for advancing the dialogue on sustainable food systems and encouraging regulatory harmonization. By addressing the unique challenges and opportunities presented by insect-based food and feed, Serbia and Türkiye can take significant steps toward achieving their sustainability and food security goals.

On behalf of the research team, we express our gratitude to the local consultants and their connections who contributed their expertise to this report. Their input has been crucial in shaping a comprehensive and actionable analysis.

Somaya Naser El Deen
Wageningen Livestock Research
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Summary

This report provides a comprehensive analysis of food and feed safety laws governing the use of insects as animal feed and human food in Serbia and Türkiye. In the context of the growing global demand for sustainable protein sources, insects offer a high-protein, low-environmental-impact alternative to conventional livestock. However, regulatory gaps hinder their full integration into food and feed systems in these countries.

For Serbia, the report highlights a lack of specific provisions for insect-based products in existing regulations. While harmonized with EU standards in areas like food safety and traceability, Serbian legislation does not explicitly define insects as novel foods or recognize them as feed materials. This regulatory ambiguity restrains industry development and limits market opportunities. Recommendations include aligning local laws with EU directives, defining standards for substrates used in insect farming, and establishing guidelines for insect-based product safety and quality.

In Türkiye, a similar gap exists in the absence of clear regulations for insect farming, processing, and application in feed. The Veterinary Services, Plant Health, Food, and Feed Law provides a foundation for food and feed safety but lacks provisions for processed animal proteins derived from insects. Aligning Türkiye's legislation with EU standards and addressing these gaps will be essential for fostering industry growth and facilitating international trade.

The report concludes with actionable recommendations, including drafting comprehensive legislation tailored to insect farming, harmonizing regulations with international standards, and engaging stakeholders to support innovation and sustainability in the insect-based food and feed sectors. By addressing these challenges, Serbia and Türkiye can unlock the potential of insect-based products (protein, fat, chitin...), contributing to global food security and sustainability goals.

1 Introduction

Our planet faces huge challenges because of the growing population and increasing competition for scarce resources. The global population is expected to reach 9 billion by 2050 and the Food and Agriculture Organization (FAO) estimates that the world needs to increase its food production by 70% by that time to meet food consumption of such a growing population. In 2011, meat consumption and demand were forecasted to increase by 72% between 2000 & 2030, whilst 60 MT proteins are forecasted to be missing by 2030 in order to meet the expected demand (FAO, 2011). However, several conditions have affected these forecasts. In 2024, global meat consumption was anticipated to rise 12% by 2033 relative to the *Outlook 2021-23* base period (OECD/FAO, 2024). This decrease is mainly related to concerns about human health, environmental impacts and animal welfare rather than income level, which used to be the main determinant of changes in meat consumption (OECD/FAO, 2023).

Animal feed production increasingly competes for resources (land, water & fertilisers) with human food and/or fuel production. This competition contributes to increasing the pressure on the environment (e.g. water supply, deforestation or soil decline in producing countries) which will pose a major challenge for primary food production. Environmental sustainability is a key issue as mentioned in The United Nations Sustainable Development Goal #12 of ensuring sustainable consumption and production patterns (UN, 2022). In the context of achieving environmentally sustainable food security worldwide, edible insects as a future food for humans and feed for animals have received increasing attention and interest. Nowadays, more than 2,000 insect species are consumed around the world mainly in tropical countries, including, beetles (Coleoptera); caterpillars, butterflies and moths (Lepidoptera); wasps, bees, and ants (Hymenoptera); crickets, grasshoppers, and locusts (Orthoptera); cicadas, honey ants, aphids, plant hoppers, leafhoppers, scale insects, and true bugs (Hemiptera); and others such as termites and cockroaches (Blattodea) (Jongema, 2017). Insect production for food and feed is rapidly evolving into a significant component of global efforts to create sustainable food systems.

Insects are valued for their high protein content, efficient resource use, and minimal environmental impact. They have high feed conversion efficiency compared to chicken, pork and ruminants, producing high-quality protein using significantly less water, land, and feed compared to traditional livestock (Lange and Nakamura, 2023).

The major advantage of edible insects is the viability of farming them using organic food waste, such as compost, manure or vegetable waste not suitable for human consumption (Naser El Deen *et al.*, 2023; Veldkamp *et al.*, 2021). They convert organic waste into nutrient-rich food and feed, making them an attractive solution for addressing food security and reducing reliance on traditional feed ingredients like soy and fishmeal (van Huis, 2013; 2020). Insects are increasingly used in animal feed, particularly for aquaculture, poultry, and pets (Gasco *et al.*, 2023). For example, black soldier fly larvae are a popular choice for feed due to their ability to grow efficiently during a short life cycle on organic waste and produce biomass with a high-protein content.

The global edible insect market, valued at approximately USD 500 million in 2022, is projected to grow significantly, fuelled by their high protein content, low environmental footprint and successful business case. Edible Insects Market Size was valued at USD 1.49 billion in 2023. The Edible Insects market industry is projected to grow from USD 1.87 billion in 2024 to USD 17.95 billion by 2032, exhibiting a compound annual growth rate (CAGR) of 28.6% during the forecast period 2024 - 2033 (Lawande and Bawkar, 2024).

For each government, the primary aim of regulating insect food and feed production is to guarantee product safety and quality. In the European Union (EU) the most critical change in favour of insect rearing was introduced in 2017 by Regulation (EU) No 2017/893, which amended Regulations (EC) No 999/2001 and (EU) No 142/2011, allowing the use of seven insect species in aquaculture. The Regulation (EU) No 68/2013 on the Catalogue of feed materials and in accordance with Regulation (EC) No 999/2001 and Regulation (EC) No 1069/2009 has authorized the use of insect protein, as a processed animal protein (PAPs), in aquaculture, pig

and poultry feed from 2021 (Commission regulation (EU) 2021/1372) (IPIFF, 2024). Efforts to integrate insect farming into policies such as the EU Green Deal and "Farm to Fork" strategy are helping align the industry with sustainability goals.

The insect farming sector is expanding in Asia, Africa, and Latin America, in regions where entomophagy (insect consumption) is already part of cultural traditions, in addition to the use of insects in animal feed and valorisation of different waste streams. These regions are investing in scaling production to meet local and international demands. However, the regulations between countries within the same region are unharmonized which is hindering the upscaling and the international exchange (Lähteenmäki-Uutela *et al.*, 2021).

The industry of insect-based protein sources presents a unique opportunity for agricultural and food sectors in non-EU countries of Europe. This report seeks to address the challenges and leverage the potential within these regions, where traditional food and feed regulations are yet to fully accommodate the use of insects. The selected countries display a diverse regulatory landscape, each with its distinct guidelines aimed at safeguarding food and feed safety. This variety in regulations not only affects local production but also complicates the cross-border marketing of insect-derived products. The current regulatory frameworks in these regions often do not reflect the latest advancements in food technology, particularly regarding novel food sources like insects. While some countries in the region are progressively amending their regulations, others maintain stringent, outdated policies, leading to a fragmented market.

Thailand, for example, is a major producer of edible insects. It demonstrates thorough national policies that regulate the entire insect value chain—from farming to processing and marketing. These policies include substrate safety and farmer training programs, which ensure the industry's scalability and alignment with international standards. Serbia and Türkiye can enhance their insect-based feed industry by adopting Thailand's approach to training and awareness. Implementing training programs for farmers would promote best practices in rearing, processing, and marketing insect products.

This report aims to explore and navigate these regulatory complexities to foster the growth of the insect protein industry in Serbia and Türkiye. It also aims to recommend actions on regulatory harmonization, food safety, and market development. By examining the specific regulatory environments in Serbia and Türkiye, this report will identify barriers to market entry and propose strategies for harmonizing standards nationally and internationally. It will also address how these countries can balance the need for innovation in food solutions with the imperative of maintaining rigorous food safety standards. The ultimate goal of this report is to establish a more uniform and supportive regulatory framework in these countries, facilitating the growth of the insect-based food and feed industry while ensuring safety and quality.

2 Methodology

The legislation analyses, translation and data collection were conducted by local consultants under the supervision of researchers from Wageningen University and Research/ Wageningen Livestock Research. The local consultant from Serbia was the University of Novi Sad - Faculty of Agriculture represented by assistant professor Saša Krstović from the Department of Animal Science. The local consultant from Türkiye was the University of Erciyes - Faculty of Agriculture represented by Professor Yusuf Konca from the Department of Animal Science.

The local consultants had conducted an extensive desk review including several pertinent references primarily concerning food and feed safety regulations in Serbia and Türkiye. These references played a crucial role in shaping the regulatory framework and identifying the existing gaps regarding the insect production sector. After preparing the literature review and being reviewed by Wageningen Livestock Research, the local consultants engaged relevant stakeholders, including policymakers, policy organizations, ministry representatives, feed producers, and insect producers, to gain deeper insights into the existing gaps and necessary actions and recommendations to regulate and enhance the insect production sector in Serbia and Türkiye.

This report presents the regulatory framework of the two case studies: Serbia and Türkiye, followed by the existing gaps and recommendations per case. Finally, the report includes a general conclusion and future perspectives regarding the insect production sector in Serbia and Türkiye.

3 Case study: Serbia

This report reviews the legislative frameworks relevant to insect-based food and feed in Serbia. The selection process focused on national laws harmonized with EU regulations, particularly directives concerning food safety, animal feed quality, and novel food approvals (reviewed documents are listed at the end of the report). These regulatory documents were analysed to identify existing provisions for insect-based products and pinpoint gaps that could affect the growth of this industry. The limitations of this review stem from the absence of explicit insect-specific legislation, and thus, interpretations are based on general food and feed regulations that may indirectly relate to insect-based products.

3.1 Legislative review

THE LAW ON FOOD SAFETY ("Official Gazette of RS", no. 41/2009 and 17/2019).

This law regulates general conditions for food and animal feed safety, obligations and responsibilities of subjects in the food and animal feed business, rapid notification and warning system, emergency measures and management of crisis situations, hygiene and quality of food and animal feed.

The provisions of this law do not apply to primary food production, preparation, handling, or storage of food for the needs of one's own household, as well as feed for animals that are not used for food production.

3.1.1 Food legislation

DIRECTIVE ON NOVEL FOOD ("Official Gazette of RS", no. 88/2018)

This regulation is harmonized with the Regulation (EU) 2015/2283 of the European Parliament and of the Council of 25 November 2015 on novel foods, amending Regulation (EU) No 1169/2011 of the European Parliament and of the Council and repealing Regulation (EC) No 258/97 of the European Parliament and of the Council and Commission Regulation (EC) No 1852/2001.

The regulation has an appendix that lists novel food that is approved in the EU. However, insects as food are not currently listed as Novel Food under Serbian legislation. While the Serbian directive aligns with EU Regulation 2015/2283 on Novel Foods, it does not explicitly mention insects, leaving their status as a food source undefined.

3.1.2 Feed legislation

DIRECTIVE on the quality of animal feed ("Official Gazette of RS", no. 4/2010, 113/2012, 27/2014, 25/2015, 39/2016, 54/2017).

This directive regulates the quality of animal feed, namely for: categorization, physical, chemical, physico-chemical and nutritional properties; physical, chemical, physico-chemical and nutritional properties of raw materials, as well as the type and amount of raw materials; elements of essential technological procedures applied in production and processing.

However, the regulation does not recognize insects as feed materials of animal origin, as stated in Article 21. Article 21 Feeds of animal origin, in the sense of this directive, are products obtained by processing animal parts and their products, namely: fish meal, whale meal, products from fish processing, by-products during the slaughtering and processing of poultry, meat meal, meat-bone meal and leather - meat meal, blood meal, liver meal, crackers, fat and fish oil, skimmed milk, whey, albumin and casein.

Moreover, the regulation of substrates used for insect rearing is not explicitly addressed in Serbian legislation. This creates uncertainty in ensuring the safety and quality of insect-derived products, as there are no clear guidelines on acceptable substrate sources or their impacts on product quality.

3.1.3 Insect-related legislation

This section provides an overview of the existing legislation that can be applied also to different phases of the insect chain: insect rearing, insect processing, insect application and transportation and storage of insect-based products.

3.1.3.1 Insect rearing

To the best of our knowledge, there is no legal document that specifically regulates insect rearing. However, DIRECTIVE ON VETERINARY-SANITARY CONDITIONS OF FACILITIES FOR GROWING AND KEEPING OF UNGULATES, ARTIODACTYLS, POULTRY AND LAGOMORPHS ("Official Gazette of RS", no. 81/2006) and DIRECTIVE ON VETERINARY-SANITARY CONDITIONS OF FACILITIES FOR TRADE OF ANIMALS ("Official Gazette of RS", no. 105/2013) regulate the facilities for rearing and trade of other animals (ungulates, artiodactyls, poultry and lagomorphs).

Moreover, the DIRECTIVE ON REGISTRATION AND APPROVAL OF FACILITIES FOR ANIMAL BREEDING, KEEPING, AND TRADE (Official Gazette of RS, No. 36/2017) does not specifically regulate farmed insects, however, it regulates and ensure compliance of facilities involved in various aspects of animal breeding, keeping, and trade with veterinary and animal welfare laws. It primarily outlines regulations for facilities involved in animal breeding, keeping, and trade. It defines two categories of facilities (1) Registered Facilities - These are establishments where animals are kept for purposes like reproduction, fattening, or production of animal-based food products for trade. They form distinct production units and must comply with veterinary medicine and animal welfare laws. Examples include farms for ungulates, pigs, poultry, game, fish, snails, as well as kennels, and incubator stations. (2) Approved Facilities - These are facilities where animal transactions occur and meet specific veterinary medicine and animal welfare criteria. Examples include shelters for abandoned animals, pet boarding facilities, and quarantine centres.

The directive categorizes these facilities into registers (1) The Register of Facilities includes farms, kennels, and incubator stations. (2) The Register of Approved Facilities includes shelters, pet boarding facilities, and quarantine centres.

3.1.3.2 Insect processing

Hygienic and veterinary-sanitary conditions for the facilities for the processing of specific insect species as material into PAPs (processed animal protein) are regulated by the DIRECTIVE ON THE METHODS OF CLASSIFICATION AND HANDLING OF BY-PRODUCTS OF ANIMAL ORIGIN, VETERINARY-SANITARY REQUIREMENTS FOR THE CONSTRUCTION OF FACILITIES FOR THE COLLECTION, PROCESSING AND DESTRUCTION OF BY-PRODUCTS OF ANIMAL ORIGIN, THE METHOD OF PERFORMING OFFICIAL CONTROL AND SELF-CONTROL, AS WELL AS CONDITIONS FOR LIVESTOCK CEMETERIES AND GRAVE PITS ("Official Gazette of RS", no. 31/2011, 97/2013, 15/2015, 61/2017 and 118/2023).

This regulation categorizes by-products of animal origin into three categories. Article 8 defines (in point 12) that aquatic and terrestrial invertebrates, except species that are pathogenic for humans or animals are classified as Category 3 material. Moreover, Article 30 states that processed protein of animal origin (PAP) can also be produced from farmed insects intended for the production of animal feed (livestock feed and pet food), and only from insects of the following species: black soldier fly (*Hermetia illucens*) and house fly (*Musca domestica*), yellow mealworm (*Tenebrio molitor*) and lesser mealworm (*Alphitobius diaperinus*), house cricket (*Acheta domesticus*), tropical house cricket (*Gryllodess igillatus*) and field cricket (*Gryllus assimilis*), silkworm (*Bombyx mori*).

Article 14 of this document regulates handling of Category 3 material. Such material can be destroyed, composted, used to produce biogas, fuel, or processed as animal feed or organic fertilizer.

Hygienic conditions for performing activities in intermediate facilities for Category 3 material are listed in Article 17 and Hygienic conditions for performing activities in facilities for the processing of Category 3 materials in Article 19. Specific Hygienic conditions for performing activities in facilities for the production of pet food, technical products and intermediate products are regulated in Article 25.

Veterinary and sanitary conditions for the construction of intermediate facilities for Category 3 material are listed in Article 81, while Veterinary and sanitary conditions for the construction of facilities for Category 3 material are listed in Article 83. Article 88 regulates Veterinary and sanitary conditions for the construction of facilities for the production of pet food, technical products and intermediate products.

Articles 97 to 100 regulates methods of implementing official control and self-control in facilities for the collection, processing and destruction of animal by-products.

DIRECTIVE ON ESTABLISHING MEASURES FOR EARLY DETECTION AND DIAGNOSIS OF THE INFECTIOUS DISEASE OF TRANSMISSIBLE SPONGIFORM ENCEPHALOPATHIES, THE MANNER OF THEIR IMPLEMENTATION, AS WELL AS MEASURES TO PREVENT THE SPREAD, CONTROL AND ERADICATION OF THIS INFECTIOUS DISEASE ("Official Gazette of RS", no. 96/2010, 33/2016, 54/2019 and 46/2023).

Articles 27 and 28a list special measures that apply to the production and use of insect-derived proteins for aquaculture, poultry, and pigs, ensuring physical separation and avoiding cross-contamination. Moreover, detailed provisions for facilities producing insect proteins ensure separation from other animal proteins and regular testing for contamination are listed in Article 28b.

3.1.3.3 Insect application

The DIRECTIVE ON ESTABLISHING MEASURES FOR EARLY DETECTION AND DIAGNOSIS OF THE INFECTIOUS DISEASE OF TRANSMISSIBLE SPONGIFORM ENCEPHALOPATHIES, THE MANNER OF THEIR IMPLEMENTATION, AS WELL AS MEASURES TO PREVENT THE SPREAD, CONTROL AND ERADICATION OF THIS INFECTIOUS DISEASE ("Official Gazette of RS", no. 96/2010, 33/2016, 54/2019 and 46/2023) includes specific provisions for the use of processed animal proteins from farmed insects in animal nutrition.

Article 4 classifies Farmed insects as farmed animals permitted to produce processed proteins of animal origin under specific regulations.

Regarding animal nutrition, Article 18 states that in aquaculture, poultry, and pig nutrition, processed proteins from farmed insects are permitted alongside other animal proteins like fish meal and proteins from pigs and poultry.

Insects as material for the production of PAPs are regulated by the DIRECTIVE ON THE METHODS OF CLASSIFICATION AND HANDLING OF BY-PRODUCTS OF ANIMAL ORIGIN, VETERINARY-SANITARY REQUIREMENTS FOR THE CONSTRUCTION OF FACILITIES FOR THE COLLECTION, PROCESSING, AND DESTRUCTION OF BY-PRODUCTS OF ANIMAL ORIGIN, THE METHOD OF PERFORMING OFFICIAL CONTROL AND SELF-CONTROL, AS WELL AS CONDITIONS FOR LIVESTOCK CEMETERIES AND GRAVE PITS ("Official Gazette of RS", no. 31/2011, 97/2013, 15/2015, 61/2017 and 118/2023).

Furthermore, Article 30 regulates General hygiene conditions regarding Hygienic conditions for processed protein of animal origin and other obtained products that can be used for animal nutrition. Specific hygiene conditions for processed protein of animal origin are regulated in Article 32. Article 30 also states that in the production of processed protein of animal origin and other products intended for animal nutrition, only Category 3 material from Article 8, point 1) to 13) and point 15) of this directive, are allowed, which was handled, stored and transported in accordance with this directive.

3.1.3.4 Insect-based products transportation and storage

Insect-based products storage facilities are regulated by the DIRECTIVE ON THE METHODS OF CLASSIFICATION AND HANDLING OF BY-PRODUCTS OF ANIMAL ORIGIN, VETERINARY-SANITARY REQUIREMENTS FOR THE CONSTRUCTION OF FACILITIES FOR THE COLLECTION, PROCESSING AND DESTRUCTION OF BY-PRODUCTS OF ANIMAL ORIGIN, THE METHOD OF PERFORMING OFFICIAL CONTROL AND SELF-CONTROL, AS WELL AS CONDITIONS FOR LIVESTOCK CEMETERIES AND GRAVE PITS ("Official Gazette of RS", no. 31/2011, 97/2013, 15/2015, 61/2017 and 118/2023).

The specific hygiene requirements for conducting activities in facilities where insect-based products for pet food production, technical products, and intermediate products are stored are outlined in Article 26.

Article 89 specifies the veterinary and sanitary requirements for constructing facilities used to store insect-based products obtained from facilities producing pet food, technical products, and intermediate products.

DIRECTIVE ON ESTABLISHING MEASURES FOR EARLY DETECTION AND DIAGNOSIS OF THE INFECTIOUS DISEASE OF TRANSMISSIBLE SPONGIFORM ENCEPHALOPATHIES, THE MANNER OF THEIR IMPLEMENTATION, AS WELL AS MEASURES TO PREVENT THE SPREAD, CONTROL AND ERADICATION OF THIS INFECTIOUS DISEASE ("Official Gazette of RS", no. 96/2010, 33/2016, 54/2019 and 46/2023).

To prevent cross-contamination, Article 20 states that animal feed containing processed insect proteins must be transported and stored separately from feed for farmed ruminants. Additionally, Article 21 indicates that facilities producing feed for ruminants cannot produce mixtures containing processed insect proteins intended for non-ruminants.

The directive regulates testing where each shipment of feed materials, including processed proteins from farmed insects, must be tested to ensure the absence of illegal animal-origin ingredients before market placement (Article 22). The storage is regulated in Article 23, indicating that farms must not use, or store feeds intended for different animal species unless strict preventive measures are implemented.

Labelling Requirements are indicated in Appendix 3. Labels on processed animal proteins from insects must indicate the source animals and specify the permitted recipient animal species to prevent misfeeding.

Furthermore, this directive regulates the requirements for the implementation and control across the document indicating that (1) Vehicles, containers, and warehouses must be cleaned and inspected to avoid cross-contamination; (2) Records of transportation, storage, and production must be maintained for at least five years. (3) Regular testing and analysis of animal feed to confirm the absence of unauthorized ingredients using specific analytical methods.

3.2 Gap analysis

Despite existing directives in Serbia that regulate the facilities for rearing and trade of ungulates, artiodactyls, poultry, and lagomorphs, there remains a significant regulatory gap in addressing insect rearing specifically. These directives do not encompass the unique biological, environmental, and operational aspects associated with insect farming. Insects, unlike traditional livestock, have distinct requirements for housing, feeding, and disease management that are not adequately covered by current legislation. Additionally, environmental impacts and waste management practices specific to insect farming are not addressed, leaving uncertainties regarding sustainable practices and ecological considerations.

3.2.1 Gap analysis on insects as food

The Directive on Novel Food ("Official Gazette of RS", no. 88/2018) aligns with Regulation (EU) 2015/2283, which sets out rules for the approval and market placement of Novel Foods within the European Union. Novel Foods are defined as those that were not consumed to a significant degree within the EU before May 1997.

The regulatory gap exists because the current directive and its harmonized EU regulation do not explicitly address edible insects as novel foods in Serbia. Therefore, there are no specific provisions for the approval, safety assessment, and market authorization of edible insects as a food category within the Republic of Serbia. Edible insects have gained global recognition as a sustainable protein source with potential environmental benefits compared to traditional livestock. Despite this, their regulatory status within the Republic of Serbia remains undefined, potentially hindering their development and integration into the food market.

Without specific regulations, there are uncertainties regarding the safety assessments, labelling requirements, and quality standards applicable to edible insects intended for human consumption. This gap may lead to inconsistent practices among producers and insufficient protection for consumers.

The absence of regulatory clarity may affect market access for producers of edible insects in Serbia, as well as trade relationships with other jurisdictions, predominately the EU market, where edible insects are recognized and regulated. Harmonizing local regulations with EU and international standards can facilitate market entry and competitiveness.

3.2.2 Gap analysis on insects as feed

The current Directive on Registration and Approval of Facilities for Animal Breeding, Keeping and Trade ("Official Gazette of RS", No. 36/2017) primarily focuses on traditional livestock such as mammals, birds, and fish. It lacks explicit provisions or definitions for farmed insects, despite their increasing relevance in agriculture and food production both in Serbia and worldwide. This omission means that facilities specifically designed for breeding, rearing, or keeping insects for commercial purposes are not clearly addressed.

Because farmed insects are not mentioned in this directive, it's unclear whether facilities engaging in insect farming should register under existing categories (e.g., "other animals for breeding") or if they require a distinct category altogether. This ambiguity can lead to confusion among facility operators and regulatory authorities regarding compliance and registration processes.

Without explicit inclusion, there's a risk that farmed insect facilities may fall into regulatory gaps or be subject to inconsistent enforcement. This could impact food safety, animal welfare, and environmental sustainability aspects that are typically addressed through regulatory frameworks.

The gap in the Directive on the Quality of Animal Feed ("Official Gazette of RS", no. 4/2010, 113/2012, 27/2014, 25/2015, 39/2016, 54/2017) revolves around not recognizing insects as feed materials of animal origin, as outlined in Article 21. This article defines "feed materials of animal origin" under the directive, specifying various products derived from traditional animal sources such as fish, poultry, and mammals. However, it excludes insects from this categorization.

In recent years, there has been a significant evolution in the use of insects as a sustainable source of protein in animal feed worldwide. Insect meal and oil are increasingly recognized for their nutritional value and environmental benefits. However, the directive has not adapted to include insects in its definition of "feedstuff (feed materials) of animal origin", thereby overlooking their potential role in animal nutrition.

Furthermore, there are no specific regulations governing the use of live larvae, whole insects, or insect fat as feed. The absence of these provisions presents significant barriers for the insect farming sector, which is rapidly evolving in terms of technological advancements and product applications. While insect fat is recognised as a promising ingredient in animal feed due to its nutritional benefits, the lack of regulations governing its production, safety, and quality standards is a notable omission.

Additionally, the regulation of substrates used for insect rearing is another overlooked area. As substrates directly impact the nutritional profile and safety of insect-derived products, clear guidelines are crucial to ensure consistency and compliance across the sector. The absence of such regulation creates uncertainty for both producers and consumers, raising potential concerns about product quality, food safety, and environmental sustainability.

The absence of specific provisions for insects as feed materials means that there are no established quality standards, safety regulations, or labelling requirements tailored to insect-derived products. This regulatory gap can create uncertainty for producers, consumers, and regulatory authorities alike regarding the safety and legality of using insects in animal feed.

3.3 Recommendations for policy development

To bridge the regulatory gap in Serbia's legal framework for insect rearing, we propose the following recommendations:

- Develop comprehensive regulations specifically tailored to insect rearing. These regulations should encompass detailed guidelines on facility construction and maintenance, sanitation protocols, pest management strategies, and requirements for handling and transporting insects.
- Define rules and/or recommendations for insect feed/substrate composition, including acceptable sources and quality criteria. This should address the nutritional needs of different insect species reared for food, feed, or other purposes. Currently, there is no regulation on the substrates used for insect rearing. As the substrate directly impacts the nutritional profile and safety of insect-derived products, defining acceptable substrate sources and ensuring their quality is vital for standardizing insect farming practices.

Implementing these recommendations for insect rearing will bridge existing regulatory gaps in Serbia, ensuring safe and sustainable practices that support the growth of the insect-based feed industry.

The following recommendations aim to guide the Republic of Serbia in developing policies that support the integration of edible insects into the food market, in alignment with international standards and best practices.

- Amend the Directive on Novel Food to explicitly include edible insects as a category of novel foods requiring safety assessment, authorization, and market approval. Define criteria for assessing their safety, nutritional adequacy, and potential allergenicity.
- Establish specific safety standards, quality controls, and labelling requirements tailored to edible insects. These should align with international best practices and ensure consumer protection while fostering innovation in sustainable food sources.
- Ensure alignment with the EU Regulation (EU) 2015/2283 on novel foods to facilitate trade and harmonization with European standards. This includes adopting relevant updates and amendments to maintain compatibility with EU regulations.
- Provide training and capacity-building initiatives for regulatory authorities, food producers, and stakeholders involved in the production and marketing of edible insects. Foster understanding of regulatory requirements, safety protocols, and market opportunities.

- Engage stakeholders, including insect producers, food manufacturers, consumer groups, and academia, in consultations to develop informed and balanced regulatory frameworks. Incorporate diverse perspectives to address concerns and optimize regulatory outcomes.

By implementing these recommendations, the Republic of Serbia can effectively bridge the regulatory gap concerning edible insects under the Directive on Novel Food.

To address the gap regarding not recognizing insects as feed materials of animal origin in the Directive on Registration, Regarding Approval of Facilities for Animal Breeding, Keeping and Trade ("Official Gazette of RS", No. 36/2017), we can prepare the following recommendation:

- Address the absence of regulations regarding live larvae, whole insects, and insect fat in feed production as a feed component. Currently, there are no specific guidelines for the use of these products in feed, which hinders their potential application in animal nutrition.
- Amend Article 21 of the Directive on the Quality of Animal Feed ("Official Gazette of RS", no. 4/2010, 113/2012, 27/2014, 25/2015, 39/2016, 54/2017) to explicitly include insects as feed materials of animal origin. Define insects and their products (e.g., insect meal, oil) as permissible components of animal feed, subject to regulatory oversight and quality standards.
- Develop specific quality standards and safety regulations for insect-derived feed materials. These should cover aspects such as protein content, amino acid profiles, fat content, microbiological safety, and absence of contaminants.
- Implement clear safety criteria and labelling requirements for insect-based feed products. Ensure that labelling accurately reflects the composition, origin, and nutritional characteristics of insect-derived ingredients, providing transparency to consumers and stakeholders.
- Align regulatory frameworks with EU standards and best practices concerning the use of insects in animal feed. This facilitates trade opportunities and ensures consistency with global norms in agricultural sustainability and food safety.

To address the gap regarding farmed insects not being clearly regulated in the Directive on Registration and Approval of Facilities for Animal Breeding, Keeping and Trade ("Official Gazette of RS", No. 36/2017), we can prepare the following recommendation:

- Recognize farmed insects as a distinct category within the directive, acknowledging their growing importance in agricultural and food production systems.
- Amend Article 2 of the directive to explicitly include facilities for breeding and keeping farmed insects (specify facilities for production, reproduction, breeding, keeping...)
- Define specific conditions and standards for the registration and approval of facilities that rear insects, ensuring compliance with health, safety, and animal welfare regulations. This should align with existing guidelines for animal welfare and veterinary medicine, adapted as necessary to accommodate the unique characteristics of insect farming.
- Establish a clear registration process for facilities involved in insect farming, detailing the documentation required, inspections procedures, and any fees or administrative requirements. This should integrate smoothly with the existing framework for registering other animal-related facilities.

The legislative landscape for edible insects in Serbia reveals significant gaps in regulating edible insects' industry. Existing laws on food and animal feed safety, while comprehensive for traditional food and animal sources, do not sufficiently address the unique aspects of insect rearing. This oversight poses challenges for producers, regulators, and consumers, creating uncertainty and potentially delaying the development of the insect-based food and feed industries.

Amending existing directives to explicitly include edible insects, establishing specific safety standards, and aligning with EU regulations are crucial steps toward bridging these gaps. Additionally, engaging with a broad range of stakeholders will help develop balanced and informed regulatory frameworks that address diverse perspectives and concerns.

By implementing these recommendations, Serbia can create a supportive regulatory environment that promotes the safe and sustainable production and consumption of edible insects.

3.4 List of regulatory documents

- a. THE LAW ON FOOD SAFETY ("Official Gazette of RS", no. 41/2009 and 17/2019)
- b. DIRECTIVE ON NOVEL FOOD ("Official Gazette of RS", no. 88/2018)
- c. DIRECTIVE on the quality of animal feed ("Official Gazette of RS", no. 4/2010, 113/2012, 27/2014, 25/2015, 39/2016, 54/2017)
- d. DIRECTIVE ON VETERINARY-SANITARY CONDITIONS OF FACILITIES FOR GROWING AND KEEPING OF UNGULATES, ARTIODACTYLS, POULTRY AND LAGOMORPHS ("Official Gazette of RS", no. 81/2006) and DIRECTIVE ON VETERINARY-SANITARY CONDITIONS OF FACILITIES FOR TRADE OF ANIMALS ("Official Gazette of RS", no. 105/2013)
- e. DIRECTIVE ON REGISTRATION AND APPROVAL OF FACILITIES FOR ANIMAL BREEDING, KEEPING, AND TRADE (Official Gazette of RS, No. 36/2017)
- f. DIRECTIVE ON THE METHODS OF CLASSIFICATION AND HANDLING OF BY-PRODUCTS OF ANIMAL ORIGIN, VETERINARY-SANITARY REQUIREMENTS FOR THE CONSTRUCTION OF FACILITIES FOR THE COLLECTION, PROCESSING AND DESTRUCTION OF BY-PRODUCTS OF ANIMAL ORIGIN, THE METHOD OF PERFORMING OFFICIAL CONTROL AND SELF-CONTROL, AS WELL AS CONDITIONS FOR LIVESTOCK CEMETERIES AND GRAVE PITS ("Official Gazette of RS", no. 31/2011, 97/2013, 15/2015, 61/2017 and 118/2023)
- g. DIRECTIVE ON ESTABLISHING MEASURES FOR EARLY DETECTION AND DIAGNOSIS OF THE INFECTIOUS DISEASE OF TRANSMISSIBLE SPONGIFORM ENCEPHALOPATHIES, THE MANNER OF THEIR IMPLEMENTATION, AS WELL AS MEASURES TO PREVENT THE SPREAD, CONTROL AND ERADICATION OF THIS INFECTIOUS DISEASE ("Official Gazette of RS", no. 96/2010, 33/2016, 54/2019 and 46/2023)

4 Case study: Türkiye

4.1 Legislative review

The Turkish food safety framework is regulated by the Veterinary Services, Plant Health, Food, and Feed Law (Law No. 5996), published in the Official Gazette on 13/6/2010 (No. 27610). This law establishes general conditions for ensuring the safety of food and animal feed, detailing the obligations and responsibilities of entities engaged in food and feed businesses. It also includes provisions for a rapid alert and notification system, emergency measures, and crisis management related to food safety. Additionally, the law outlines standards for hygiene and quality across the food and feed sectors. Similar to international frameworks, the provisions of this law exclude certain activities, such as primary food production, food preparation, handling, or storage for personal household use, as well as feed intended for animals not used in food production.

4.1.1 Food legislation

With respect to the protection of food safety and quality, Regulations (Official Gazette dated 26/9/2008 and numbered 27009, 5996: 13/6/2010 Official Gazette, 17 December 2011, Official Gazette, Issue: 28145, 19.02.2020 Official Gazette Number: 31044, 29 December 2011 Official Gazette Number: 28157, 30 June 2013 Official Gazette Number: 28693) were published. These regulations include the production stages of food and the protection of their quality. These Regulations cover, ensuring food safety and quality, by observing the minimum technical and hygienic conditions in the production, processing, and distribution stages of food and substances and materials in contact with food, including the primary production stage, food inspection and control services and procedures regarding traceability, workplace responsibility and the right to object.

With respect to novel foods the Turkish Food Codex Regulation on Novel Foods 2020 lays down the procedures and principles regarding the placing of novel foods on the market, the lists and conditions of use for novel foods. The food business operators in-service must comply with the provisions of this Regulation until 31/12/2024. Foods labelled or placed on the market before 31/12/2024 can be sold in the market until the end of their shelf life. Regarding the issues and cases falling under the scope of this Regulation, the food business operators in-service are obliged to comply with the provisions of the current legislation in force until they comply with the provisions of this Regulation after its publication. Currently, this is still a draft legislation, Turkish Food Codex Legislation for New Foods Regulation, and has been opened for comments but has not been finalized (published) yet.

4.1.2 Feed legislation

Feed regulations are arranged based on 5996 numbered law, published 13.06.2010 date and 27610 numbered Official Gazette, in the fifth part, Food and Feed SECTION ONE Food and Feed Safety, Responsibilities, Food Codex, Labelling and Traceability, Presentation and Advertising, Protection of Consumer Rights are based on the law.

It consists of regulations consisting of sub-sections such as the production of feed, storage, marketing, protection of quality, conditions restricting using as feed and inspection of feed. However, this regulation didn't mention the processed animal proteins (PAPs) that can be used in animal feed.

Since no regulation is considered regarding the use of insects as a whole in feed, also, there is no regulation regarding the use of insect proteins and oils.

4.1.3 Insect-related legislation

The relevant documents (laws and regulations) regarding the use of insects and insect products (protein, fat, chitin) in animal feed and human food were examined and described in the paragraphs below.

In addition to this review, consultations with the relevant authorities at the Ministry of Agriculture and Forestry indicated that, as of now, there is no existing legislation regarding the use of insects or insect-derived products in animal feed.

4.1.3.1 Insect rearing

Upon reviewing the existing legislation and consulting with the relevant units of the Ministry of Agriculture and Forestry, it has been concluded that there is currently no specific regulation on insect farming".

In the REGULATION ON ANIMAL BY-PRODUCTS NOT USED FOR HUMAN CONSUMPTION in Türkiye (Official Gazette dated 24/12/2011 and numbered 28152), it is stated that animal by-products can be used for the production of insects, but in the EU insect production regulation it is stated that "insects may only be fed with materials of vegetal origin". This situation is incompatible with the EU insect regulation.

Insects are not grown on a large commercial scale in Türkiye yet but only in a small hobby setting and products are only sold for hobby fishing. Insect products are currently not exported from or imported to Türkiye.

4.1.3.2 Insect processing regulations

There is no legal document that specifically includes regulations on insect processing in Türkiye.

4.1.3.3 Insect use in animal feed

The use of farmed animal by-products, including protein and fat, in the nutrition of ruminant animals is prohibited according to the situation specified in sub-article b) of Article 8 of the prohibited products section under the "REGULATION ON ANIMAL BY-PRODUCTS NOT USED FOR HUMAN CONSUMPTION" published in the Official Gazette No. 28152 on 24 December 2014. In this case, insects cannot be used to feed ruminant animals.

However, in insect feeding;

ARTICLE 13 - (1) Provided that risks to public and animal health are controlled, except for those specified in the second and third paragraphs of Article 9 and provided that they are not obtained from dead or killed animals due to the presence or suspicion of a disease that can be transmitted to humans and animals; The resulting products are stated in the article (g) that "worms and maggots that will be fish feed" can be used" (Amended:OG-9/8/2022-31918).

However, the use of animal by-products in the nutrition of poultry is allowed (REGULATION ON ANIMAL BY-PRODUCTS NOT USED FOR HUMAN CONSUMPTION (24 December 2011 Official Gazette Number: 28152), Article 8, sub-article (e)). Therefore, although there is no direct regulation on the use of insects in poultry nutrition, there is also no regulation prohibiting their use.

In Türkiye, regulations on feeds are generally handled within the scope of "Animal Feeds Regulation" and the "Food and Feed Hygiene Regulation". These regulations determine hygienic production conditions, safety standards and permitted additives in the use of insects as feed. In addition, in order to comply with European Union legislation, feed raw materials included in the EU's Commission Regulation No. 2017/893 are accepted as feed. Although Türkiye does not directly follow the European Union's Commission Regulation 2017/893, it is working to align its food and feed legislation with EU standards. With the regulations published by the Ministry of Agriculture and Forestry, regulations are made regarding the raw materials used in animal feed, processing, and storage conditions. In this context, hygiene and safety standards have been determined for the use of insects as feed additives. Work to comply with EU legislation continues. Türkiye laws have accepted EU-2013 feed material lists. It can be found under the legislation of "Categories of Feed Materials For Non-Food Animal Feed" (27 December 2011, No:28155).

According to the Ministry of Agriculture's report vision of 2020 to 2024 years, estimates for the period 2019, imports of animal protein are 222,360 tons/year, oilseeds 2665,025 tons/year (partly used for feed), different plant origin meals 2238,710 tons/year and total raw feed material imports are expected to be 12,435,962 ton/year. At the same time, the annual total animal by-product production amount in Türkiye is around 381,000 tons. Therefore, a significant amount of feed resources is needed in Türkiye.

Türkiye is also a country that exports food and feed, therefore, to increase this capacity, alternative feed sources can reduce the cost of feed and increase export opportunities and income abroad. Türkiye's feed raw material exports in 2019 were 370,830 tons and compound feed 274,324 tons/year¹.

¹ [https://www.tarimorman.gov.tr/TAGEM/Belgeler/yavin/yemsekt%C3%99rp%C3%99l%C3%99tikabelgesi%20\(1\).pdf#page=125.09](https://www.tarimorman.gov.tr/TAGEM/Belgeler/yavin/yemsekt%C3%99rp%C3%99l%C3%99tikabelgesi%20(1).pdf#page=125.09)

Türkiye is strongly advised to produce insects and their products in order to sell them to the European Union and the other 3 countries (Iceland, Liechtenstein and Norway). Therefore, in this way, it can both reduce the budget for imports by producing its own protein source and earn income by exporting to other countries.

4.2 Gap analysis

In the meetings with the Ministry of Agriculture, it is understood that no serious legal study has been conducted regarding the use of insects in feed or food. The Turkish Ministry of Agriculture officials are aware of the developments in the EU regarding insects and are aware that there is a topic on the agenda. Apart from a few studies conducted by some Research Institutes in the Ministry of Agriculture regarding the use of insects in fish and chicken feed, there is no other study. However, studies using insects as feed have been published in various universities in Türkiye and there are ongoing projects. One of the issues that the Ministry of Agriculture officials emphasize is that it is not known whether the insects to be used in feed are vectors and they argue that this should be revealed through experimental studies. However, it is understood that there is no study regarding the vector potential of insects used in industrial insect production.

There are some major initiatives aimed at providing insect production and use in feeds and export. However, currently, there are a few small businesses producing insects in different provinces of Türkiye. In interviews conducted with these insect producers, they reported that they did not receive any permits for insect production, but some Ministry of Agriculture officials visited their production areas. They reported that they generally sold the insects they produced to hobby fish producers, universities and research centres. One of the important points here is that insect producers were determined to be willing to produce more insects if an order was placed. However, when compared to sales made from internet sources, it is seen that insect sales prices are higher. In addition, insect producers reported that they wanted to sell live insects instead of dried ones and that the buyer could dry these insects.

In this context, the reference to the substances to be used in feeds is already directed to the European Union feed list². However, Türkiye has not yet made these arrangements although the necessary arrangements have been listed on the European Union feed list. It can be possible by making Türkiye's domestic arrangements in accordance with these arrangements and making them compatible with the European Union legislations.

With respect to animal health insects are not defined as farm animals in the REGULATION ON GENERAL PROVISIONS CONCERNING THE WELFARE OF FARM ANIMALS (Official Gazette Date: 22.11.2014 Official Gazette Number: 29183)

Insects are not mentioned as feed materials of animal origin in the REGULATION ON ANIMAL BY-PRODUCTS NOT USED FOR HUMAN CONSUMPTION (24 December 2011 Official Gazette Number: 28152), Article 7). Insects are not included in the classification section of animal by-products and their derivative products (REGULATION ON ANIMAL BY-PRODUCTS NOT USED FOR HUMAN CONSUMPTION (24 December 2011 Official Gazette Number: 28152), Article 7).

In the REGULATION ON THE PLACEMENT AND USE OF FEEDS ON THE MARKET (Official Gazette, 27 December 2011, Issue: 28155) in Annex 9, "CATEGORIES OF FEEDS FOR NON-FOOD ANIMAL FEEDS", in article 18, the category "Insects" is described as "All types of insects and their developmental stages". However, this section in the annex of this regulation is not linked to any other issue. In addition, the word "insects" is used here to cover all insects.

According to this expression, every stage of all kinds of insects is included in the category. Since this expression is not limited to insects whose production for feed is permitted in EU regulations, it is not compatible with EU regulations.

A list of insect species allowed to produce insects as feed should be composed according to European legislation. The list currently includes black soldier fly (*Hermetia illucens*), common housefly (*Musca domestica*), yellow mealworm (*Tenebrio molitor*), lesser mealworm (*Alphitobius diaperinus*), house cricket (*Acheta domesticus*),

² <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02013R0068-20220724&qid=1659429580377>

banded cricket (*Gryllobates sigillatus*) and field cricket (*Gryllus assimilis*), and silkworm (*Bombyx mori*) processed animal proteins (PAPs) (ipiff.org³).

4.3 Recommendations for policy development

The following recommendations aim to guide the Republic of Türkiye in developing policies that support the integration of edible insects into the food and feed markets, in alignment with international standards and best practices.

- Türkiye produces many feed and food products following EU laws. If Türkiye also wants to do so for insects, it is necessary to make legal regulations as soon as possible in accordance with European Union laws. Therefore, legislations must be prepared about 1) insect farming, 2) insect processing and 3) insect application in food and feed.
- Large-scale insect production facilities will not be established without legal regulations and as such insects will not be produced as a feed source on short term. Regulations to cover environmental concerns need to be established.

Regulations regarding insect production areas, insect processing facilities and insect protein are required. The institution that will make these regulations is the Ministry of Agriculture in Türkiye. The General Directorate of Food Control, which is under the Ministry of Agriculture, should make those preparations and submit them to the Turkish National Assembly and they should become law. Otherwise, it is not possible to open and process any facility in a short time since there is no regulation regarding insect production and products and use in animal diets and foods.

- A law should be prepared that allows the use of PAP in animals other than ruminants.
- Scientific studies should be initiated and concluded as soon as possible to determine the vector characteristics of insects. For this, the Turkish Ministry of Agriculture, universities and the General Directorate of Agricultural Research and Policies should call and obtain the project results.

There are a significant number of scientific publications in Türkiye that have been published in high-impact scientific journals by adding insects to feed, and the number of these publications is increasing. A significant portion of the insects used in these studies are obtained from small producers in Türkiye. However, it is estimated that these insect farms are not subject to legal control since there is no regulation as mentioned above. Currently, some of these insect farms produce hobby insects and sell to people who keep other pet animals.

4.4 List of regulatory documents

- a. The Law of Veterinary Services, Plant Health, Food, and Feed (Law No. 5996), published in the Official Gazette on 13/6/2010 (No. 27610)
- b. REGULATION ON ANIMAL BY-PRODUCTS NOT USED FOR HUMAN CONSUMPTION in Türkiye (Official Gazette dated 24/12/2011 and numbered 28152)
- c. REGULATION ON ANIMAL BY-PRODUCTS NOT USED FOR HUMAN CONSUMPTION" published in the Official Gazette No. 28152 on 24 December 2014
- d. REGULATION ON THE PLACEMENT AND USE OF FEEDS ON THE MARKET (Official Gazette, 27 December 2011, Issue: 28155)

³ <https://ipiff.org/insects-eu-legislation-general/#:~:text=Insects%20and%20their%20derived%20products,human%20consumption%20%E2%80%93%20under%20EU%20Law>

5 Conclusion

The legislative frameworks in Türkiye and Serbia reveal a significant potential to develop robust policies for integrating novel and sustainable food and feed sources like insects into food systems. Both countries have existing food and feed regulations that prioritize safety, traceability, and quality, yet they fall short in addressing the unique aspects of insect farming, processing, and application.

Serbia's regulatory framework, while harmonized with EU standards in several areas, lacks explicit provisions for insect-based products. The absence of clear guidelines on the rearing and processing of insects, as well as their use in food and feed, creates uncertainty for stakeholders and limits market opportunities. Specific gaps include undefined legal status for insects as novel foods, the exclusion of insect-based products from the quality and safety standards for animal feed, and insufficient regulatory oversight for substrates used in insect farming. These issues highlight the need for Serbia to adopt comprehensive policies that align with EU regulations, fostering innovation while ensuring food and feed safety.

In Türkiye, the Veterinary Services, Plant Health, Food, and Feed Law (Law No. 5996) provides a foundation for food and feed safety but does not explicitly include provisions for insect-based products. The Turkish Food Codex Regulation on Novel Foods (2020) and associated draft legislation indicate a growing awareness and intent to regulate novel foods, though these efforts remain incomplete. Similarly, the absence of specific regulations for insect rearing, processing, and application in feed hinders the development of a competitive insect-based industry. Gaps such as the lack of alignment with EU standards on insect production and processing, and the unregulated use of insect proteins and oils, present challenges that must be addressed to ensure compliance with international trade and safety norms.

The potential of insect-based food and feed lies not only in their environmental and economic benefits but also in their alignment with global sustainability goals. Insects offer a high-protein, low-impact alternative to traditional livestock, addressing the growing demand for sustainable protein sources. Their ability to convert organic waste into valuable food and feed products further enhances their appeal as a solution to resource scarcity and environmental degradation. However, realizing this potential requires a supportive regulatory environment that promotes safe and standardized practices.

To bridge the regulatory gaps identified in Türkiye and Serbia, several recommendations can be made:

- **Develop Comprehensive Legislation:** Both countries should draft and implement regulations specifically tailored to insect farming, processing, and application in food and feed. This includes defining acceptable substrates, establishing safety and quality standards, and providing clear guidelines for facility registration and operation.
- **Harmonize with EU Standards:** Aligning local regulations with EU frameworks, such as Regulation (EU) 2015/2283 on novel foods and Regulation (EU) 2017/893 on processed animal proteins, will facilitate international trade and ensure compatibility with global best practices.
- **Engage Stakeholders:** Policymakers, industry, researchers, non-governmental organisations and consumers must be involved in the regulatory development process to address diverse perspectives and ensure practical, balanced outcomes. Public awareness campaigns can also help build consumer trust and acceptance of insect-based products.
- **Support Research and Innovation:** Investment in research to assess the safety, nutritional value, and environmental impacts of insect-based products will provide a scientific basis for regulation and foster technological advancements in the sector.
- **Encourage Industry Growth:** Incentives such as grants, tax benefits, and technical support can stimulate the development of insect farming and processing industries. Training programs for producers and processors will further enhance capacity and compliance with regulatory requirements.
- **Monitor and Evaluate Implementation:** Establishing robust monitoring and evaluation mechanisms will ensure that regulations are effectively enforced and adapted to emerging trends and challenges in the insect-based food and feed industry.

By addressing these recommendations, Türkiye and Serbia can unlock the full potential of insect-based products, contributing to global efforts to achieve sustainable food systems. The adoption of clear and harmonized regulations will not only support local industry growth but also position these countries as significant contributors in the emerging market for sustainable protein sources. Ultimately, integrating insects into food and feed systems represents a transformative opportunity to enhance food security, reduce environmental impacts, and meet the nutritional needs of a growing global population.

6 Future perspectives

Looking ahead, the integration of insect-based products into food and feed systems represents a critical pathway toward achieving sustainable agricultural practices and addressing global food security challenges. Both Türkiye and Serbia stand at crossroads where proactive policy changes and industry engagement can position them as leaders in this innovative sector.

The global demand for alternative protein sources is expected to rise exponentially, driven by increasing population pressures, environmental concerns, and shifts in consumer preferences toward sustainable products. Insects, as a versatile and eco-friendly protein source, offer a viable solution to meet these demands. By fostering research, aligning with international standards, and creating an enabling environment for the insect industry, Türkiye and Serbia can capitalize on this growing market.

Future initiatives should prioritize the development of public-private partnerships to accelerate advancements in insect farming technologies, processing methods, and market access. Collaboration between academic institutions, governmental agencies, and industry stakeholders will be essential to address knowledge gaps, enhance production efficiency, and ensure compliance with safety and quality standards.

Furthermore, educational campaigns aimed at increasing public awareness and acceptance of insect-based products will be crucial. Highlighting the environmental, nutritional, and economic benefits of insects as food and feed can drive consumer interest and support for this emerging industry.

On a global scale, Türkiye and Serbia can leverage their strategic geographic positions to become important players in the international trade of insect-based products. Establishing export-oriented policies, aligning local regulations with global standards, and investing in infrastructure for large-scale production will enable these countries to access lucrative markets in the European Union, Asia, and beyond.

In conclusion, the future of insect-based food and feed in Türkiye and Serbia is promising, provided that the necessary regulatory, institutional, and societal frameworks are established. By embracing innovation and sustainability, these countries can play a pivotal role in shaping a resilient and sustainable global food system.

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