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SPECIAL ISSUE: *Advancement of insects as food and feed in a circular economy*

Introducing the special issue 'Advancement of insects as food and feed in a circular economy'

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EDITORIAL

In 2017, a book was published entitled 'Insects as food and feed: from production to consumption' (Van Huis and Tomberlin, 2017). However, the sector of insects as food and feed is developing so quickly that an update seems appropriate. There has been an exponential increase in publications dealing with the topic. For example, using the words 'edible insect' as key words in 'Web of Science' scored 421 hits during the last two years (2019 & 2020), an amount which equals the number recorded for the previous 20 years (1999-2018). We did consider publishing a new edition of the book, but concluded that the disadvantages outweighed the short-term results. We identified the following limitations: (1) it must be bought which limits its distribution; (2) the review process is less transparent and rigorous; and (3) the turnaround time for a book is much longer than for research articles. Thus, we felt that given the rate at which the industry is growing and diversifying, a second edition would possibly not be as up to date. In addition to the benefit of publishing up-to-date information quickly, we also concluded that the peer-review system would enhance its quality. Furthermore, publishing open access provides immediate engagement by parties globally in learning more about the industry or by enhancing their current facility. Fortunately, the authors and sponsors of such work were able to cover the open access costs.

As a means of transparency, it should be noted that the strategy adopted for assembling the topics and affiliated authors was done *a priori*. Authors with strong backgrounds on select topics were asked to contribute. Manuscripts were assigned to different Journal of Insects as Food and Feed editors, depending on their expertise. They were also charged with identifying reviewers as well as managing the review process. In some instances, editors were also authors or co-authors. However, they did not manage their own manuscripts in order to protect the integrity of the process.

All chapters dealt with relevant topics related to insects as food and feed, and most of the content of the articles is different from the 2017 book, reflecting developments in the field. In the description below, you will find the names of the authors who wrote the articles between parentheses.

So, the special issue starts with entotechnics, but instead of one chapter as in the 2017 book, four articles by the same author (Kok, 2021a,b,c,d), deal with the following topics: (1) overall mass and energy/heat balances; (2) organism kinetics, system dynamics and the role of modelling & simulation; (3) sub-process types and reactors; and (4) facility consideration. Facility designs and processes to rear insects are covered from artisanal operations to world-scale plants. We hope this will help potential 'entopreneurs' to plan their process and their enterprise before making a major commitment and investment. Then the environmental impact of insect as food and feed is dealt with, in which life-cycle analysis studies were compared (Smetana *et al.*, 2021). Increasingly the question is asked whether the industry can produce insects without compromising their welfare (Van Huis, 2021). When considering the environmental impact of insect mass production, the advantage of using insects as feed is the possibility to rear them on organic side streams. The question is what side streams can be used (Pinotti and Ottoboni, 2021). A topic that receives increasing attention is the role of microbes in transforming substrates into more acceptable materials for mass producing insects (Zhang *et al.*, 2021). Manure is a major waste stream of particular concern in many of the countries which advocate a circular economy. What are the prospects of upcycling

the manure using insects (Cammack *et al.*, 2021)? A core issue with insect rearing and a major concern is colony health (Maciel-Vergara *et al.*, 2021). While insects can be mass produced, manipulating their nutritional value is a key question (Oonincx and Finke, 2021). Furthermore, what is the role of genetics in improving the performance of mass produced insects (Eriksson and Picard, 2021)? What about left-over substrates? Can they be used as fertiliser and are there plant protecting effects (Chavez and Uchanski, 2021)? One of the major advantages of using edible insects is the possible health effects for humans (Stull, 2021) and animals (Gasco *et al.*, 2021). Then, what is the effect of using insects as feed on the target animals: fish (Liland *et al.*, 2021), poultry (Dörper *et al.*, 2021), pigs (Veldkamp and Vernooij, 2021) and pets (Bosch and Swanson, 2021). Food safety deals with biological (Vandeweyer *et al.*, 2021) and chemical (Meyer *et al.*, 2021) contaminants. There is also the issue about allergies brought about by insect consumption (Ribeiro *et al.*, 2021). These food and feed safety issues will have a direct effect on legislative issues and regulatory frameworks (Lähteenmäki-Uutela *et al.*, 2021). The technique of processing is reviewed (Sinderman *et al.*, 2021) as are processing pathways and the extraction and utilisation of insect proteins, lipids and chitins (Ojha *et al.*, 2021). The final part of the special issue deals with consumer issues: how to design quality insect products (Reverberi, 2021) and how to convince consumers to buy insect products (Wassmann *et al.*, 2021). The final question is whether the insect industry is profitable. There are not many publications on this issue but in one article the question is addressed (Niyonsaba *et al.*, 2021). In the final chapter (Van Huis *et al.*, 2021) we try to give some perspective of the future for the industry. While this view is clearly limited due to the industry still being in its infancy when compared to other food and feed sectors, the chapter potentially provides some guidance as to hurdles to be addressed, opportunities to be seized, and new questions to be formulated.

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