Human Health, Environmental Sustainability and Food Production: Interfaces with Nanomedicine

Editorial

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In recent years, the issues of food and environmental safety have been the target of debate. These issues are particularly important due to FAO's prediction on growth rate of the world population in the coming years, which reached 7 billion people in 2011 and are expected to reach 9 billion until 2045. In addition, changes have occurred in the demographic profile and in the development of the world gross domestic product (GDP), with crescent contribution of Developing Countries to world income. These factors have directly influenced the global demand for food. Other points for concern are the limitation of new areas of arable land to be incorporated into the production systems and the constant reduction in the availability of water for this purpose. As a result, the increase in food production will occur by the verticalization of farming production, with the use of high technology. Thus, ensuring sustainable food security under land and water stresses is one of the biggest challenges for humanity in the forthcoming decades.

In the case of animal production, use of high-density animals in the farm will be accompanied by challenges such as optimizing the use of inputs (e.g. antibiotics, antiparasitics, and nutrients), greater sanitary control, minimizing the risk of transmission of zoonoses, greater control of drug residues in food, and ensuring low environmental impact. These challenges are a window of opportunity for the use of nanotechnology. Coping with the loss of efficiency of pharmaceutical drugs against common pathogens is a great challenge to public health. Resistant pathogens have emerged due to indiscriminate use of drugs, and the massive use of drugs in food animals may be contributing to this situation. Worldwide, most antimicrobials and antiparasitics that are being used in animal production have to be used in a better way. Drug delivery systems may be important tools to optimize veterinary drug use and then mitigate its use. Nanoencapsulation of drugs can lead to therapeutic gains and reduce the amount of drugs used for animal treatment with goal of control and prevention infectious diseases. This can occur because of the changes in the pharmacokinetic profile of the drugs, reduced toxicity and appropriate delivery.

Other approach is the development of nanostructure-based vaccines. By modulating the parameters such as the size and surface of the nanoparticles, an antigen can be selectively presented to specific immune cells. On the other hand, it is known that incorporation in vaccine of inorganic nanoparticles, polymeric nanoparticles, ISCOMs, liposomes and nanoemulsions are strategies used to selectively modulate immune responses (e.g. MHC class I, MHC class II, Th1 or Th2). Thus, use of nanoparticles have shown promise as a strategy for the development of a new generation of vaccines, and it can not only lead to a more specific and long-lasting immune response but also provide single-dose and needle-free vaccines. Detection of pathogens, toxins, and drugs is another relevant area in which nanotechnology can provide strong contribution. Intensive animal production systems provide animal–animal and animal–human interactions, enabling the transmission of pathogens at the inter- and intra-species levels. The recent cases of swine influenza virus infection (subtypes H1N1 and H3N2) and avian influenza virus infection (subtypes H5N1 and H9N2) could be cited as examples of these interactions. Under these conditions, rapid and accurate detection of the etiological agent is a key to preventing pathogens spread, outbreaks and epidemics. With the use of nano biosensors it is possible to rapidly and efficiently detect the interaction between the analyte and the sensor, due to the high contact area and high specificity derived from the use of an organic fraction (e.g. antibody or aptamer).

Finally, considering the environmental impacts, the use of nanomaterials in animal production systems may be viewed in two ways. First, as a new agricultural input that will be present in animal waste. Second, as an emerging technology for environmental remediation of waste arising from the production of food. For example, nanoparticles may be used to deliver drugs in fish farms as well as to catalyze the degradation of pollutants in agricultural waste water treatment. Assuming the guidelines of the World Food Summit of 1996, we could envisage that nanomedicine can contribute to "all people at all times to have access to sufficient, safe, nutritious food to maintain a healthy and active life." In addition, nanomedicine can provide new technologies to prevent emerging and re-emerging zoonotic diseases; to boost food production; and to improve food security.

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