Grand Challenges in Product Quality

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The quality of animal food products comprises a complex set of characteristics and attributes, which is ultimately related to consumer health (nutritional value and bioactive compounds), eating experience (sensory attributes), necessity (reformulation and functional products), safety (pathogenic microorganisms) as well as certified practices during production and processing (welfare and sustainable practices, for instance). Nowadays, ensuring quality is an essential goal for any animal food producer and industry. The diversity of consumers and the constant evolution in consumer expectations about animal food are changing at local and global level, which will require multiple, geographically, and culturally relevant answers from this sector of food market (Santeramo et al., 2018).

The strategic and scientific-based actions to produce high quality animal food products starts at the farm and progress toward the industrial operations that can extend the shelf life and reach the stage of commercialization to consumers (Mouzo et al., 2020). In order to achieve the current level and understanding of quality in animal food industry, major efforts were necessary to evolve from a system characterized by small, less organized and localized producers of short shelf life products. Development of technologies and strategies dedicated to improve shelf life were centered in the scientific advances, particularly in the characterization of factors affecting physic-chemical properties, sensory attributes and nutritional value of animal food products (Kristensen et al., 2014). Moreover, the influence of consumer in the definition of quality became a central pillar to sustain the commercialization of animal products in the current market (Kristensen et al., 2014).

Nowadays, modern trends in consumer life style and product certification have emerged and gained more importance in the strategic planning of food industry during the development of new products. The importance of health, environmental and societal issues, quality grade, indication of geographical origin and convenience are decisive for consumer wanting to buy products that are in accordance with their life style and personal choices (Mikkola and Colantuono, 2017; Teixeira and Rodrigues, 2019).

In terms of safety, animal food products can carry pathogens, environmental contaminants and may contain allergens that can cause severe deleterious effects on human health. In order to reduce the risk of foodborne diseases, the control of microbiological, chemical and physical hazards became a main necessity and obligation for animal food industries (Kristensen et al., 2014; Boor et al., 2017). *Campylobacter* spp., *Salmonella* spp., *Listeria monocytogenes*, *Bacillus cereus*, *Clostridium perfringens*, *Escherichia coli* and *Yersinia enterocolitica* are frequently reported as main causes of foodborne outbreaks in animal food products. According to the European Food Safety Authority, more than 41 thousand people were hospitalized and 500 people died as a consequence of due contamination of animal food products with pathogenic microorganisms in 2018 (Verraes et al., 2015; Omer et al., 2018; European Food Safety Authority, 2019).

Many of the nutritional characteristics of animal food products favors their consumption daily (essential amino acids, fatty acids, vitamins, minerals and bioactive peptides). However, recent evidence indicates a complex scenario about their role in health, particularly in countries where animal food products are over-consumed. Particularly for meat products, the risk of developing cardiovascular diseases and cancer has been the center of discussion among health authorities, researchers and professionals of the meat industry (Bechthold et al., 2019; Zhao et al., 2020).

In order to provide a suitable answer to these threats and changes in consumer behavior, the meat industry must increase the efforts to provide products for consumers who are interested in high-quality products and the provenance of their food. The main current challenges faced by animal products industries are: (1) Food Safety, (2) improving Food Quality in terms of health, nutritional value and sensory quality, (3) Understanding Consumers Trends and Preferences in terms of additional characteristics e.g., food sustainability and provenance, and (4) Meeting Consumer Expectations.

In the face of this complex scenario, the animal food products industry is constantly required to ensure quality as well as pushed to improve the current strategies, technologies and actions toward consumer trends. Product Quality will serve as valuable, cutting-edge and critical source of information for professionals, academics and scientists interested in the advance of knowledge about quality of animal food products. In this sense, science and technology can provide valuable solutions for scientists, academics and professionals in animal food industry to face current challenges: chemometrics and -omics approach, healthier and functional food products, green and innovative technologies, innovative packaging, and sustainable practices.

In order to address the challenges related to Food Safety, green and innovative technologies and approaches includes a set of options to improve the shelf life and safety as well as preserve the quality of animal food products with reduced impact in the environment, especially for fresh products. In this case, high pressure processing has a crucial role by reducing the count of both spoilage and pathogenic microorganisms without affecting the sensory attributes and nutritional value. This technology involves the application of pressure in a sealed vessel with a medium (usually water) which allows the homogeneous distribution of pressure on the whole surface of food. Particularly for liquid products, a moderate temperature during high pressure processing greatly improve the effect of treatment on both enzymes and microorganisms (Hygreeva and Pandey, 2016).

In the same line, the use of ultrasound can increase the limiting stages in animal product processing by increasing mass transfer, improving tenderness and inactivating microorganisms and enzymes in liquid food (milk and dairy products, for instance). The fundament of ultrasound is the application of ultrasonic frequencies in a medium that leads to formation of cavitation bubbles followed by eventual collapse and medium agitation across the medium of liquid food (Paniwnyk, 2017; Kang et al., 2020). Similarly, pulsed electric fields is another emerging and green technology that has been studied in food animal product processing. This technology consists in applying short period pulsating electrical fields on a food. The whole process usually takes few seconds and causes minimal impact on quality of treated products. The main advantages are related to inactivation of pathogenic and spoilage microorganisms and enzymes (Gómez et al., 2019). The inclusion of this technology at industrial level has been growing in the last decade, particularly for fresh milk processing. Recent strategies to optimize the use of pulsed electric fields in the processing of animal food products are mainly related to mild heating. However, the major advances in

the configuration of the equipment are still necessary to achieve sterilization levels (Alirezalu et al., 2020).

Improving Food Quality in terms of health, nutritional value and sensory quality is another main challenge. In this sense, the use of chemometrics approach (statistical and mathematical tools to extract information from complex and large datasets and correlate then with quality attributes) is a major advance in quality assessment of nutritional value, physic-chemical characteristics, safety, and sensory attributes. The prediction of quality attributes by the correlation of spectroscopic or chromatography data with well-known and official measurement techniques to select biomarkers has gained attention and importance for application in animal food industry (Zhu et al., 2018; Bergamaschi et al., 2020; Cama-Moncunill et al., 2020; Muhammad et al., 2020). Traceability, carcass characteristics, authentication and detection of fraud were greatly improved from the advances in the chemometrics. In this context, the concomitant advances in each -omics approach (transcriptomics, metabolomics, lipidomics, and proteomics) has strengthen the role of chemometrics in quality assessment and improve the knowledge about the metabolites and relevant molecules that influence the composition, structure, and eating experience of animal food products (Bevilacqua et al., 2017; Muroya et al., 2020).

The nutritional composition and the presence of bioactive components naturally or strategically added to animal feeding and products is another relevant factor that must be considered in the context of quality. Improving animal feeding (Jiang and Xiong, 2016; Delgadillo-Puga et al., 2019) or reformulating meat (Munekata et al., 2020) and dairy (Alenisan et al., 2017) products are the most successful approaches. In this sense, secondary metabolites (especially polyphenols, terpenes, alkaloids, phytosterols, and isothiocyanates) of plant tissues are the most studied and one of the most relevant components to produce healthier animal products due to their antimicrobial and antioxidant activity. The diversity of compounds, sources and the health benefits are favorable aspects for their use, especially considering the growing concern for sustainable practices in food industry (Salami et al., 2019).

Searching and studying the effect of new and alternative feeding components comprise an important strategy to naturally enhance the quality, have additional characteristics and facilitate the progression of animal food production systems toward more sustainable practices. Improving the diet of animals can lead to relevant deposition or transmission of bioactive components to animal food products (Jiang and Xiong, 2016; Delgadillo-Puga et al., 2019). In the same line of thought, the reformulation (reducing and/or replacing certain components) of conventional animal food products is the main approach by taking into account the relation between health concerns and the composition of animal food products. Although reducing components associated with development of diseases (such as salt, fat, and synthetic additives) can be seen as the first answer, this approach can lead to meaningful modifications in the characteristics of animal food and eventually altering the eating experience. Replacing these ingredients by healthier and/or functional options is a suitable approach but the adequate

selection of ingredients and their preparation is decisive to obtain a successful reformulated and high-quality products (Bimbo et al., 2017; Domínguez et al., 2017; Marchetti et al., 2020). Additionally, a stronger relationship among the researchers and professionals working in this category of food products is necessary to improve the multidisciplinary view of the current and future challenges regarding the efficacy, safety and the most suitable technologies for extraction and stabilization of bioactive components (Granato et al., 2020).

Understanding Consumers Trends and Preferences for additional characteristics encompasses aspects such as sustainability and provenance. Sustainability is one of the main trends in the meat industry and encompass the economic, environmental and social aspects (Bansback, 2014). Some sustainable practices have already been implemented in the meat chain such as cleaner production, green technologies, environmentally friendly packages, traceability, and social reputation (Golini et al., 2017). Although important advances have been reported in the meat sector, more effort is necessary to coordinate and integrate suppliers, breeders, slaughterhouses and retailers toward sustainable practices for the whole chain (Bansback, 2014; Golini et al., 2017). Improving the current practices toward organic production and fomenting smaller and niches production (such as small family farms), particularly in developing countries, are also relevant aspects are some of the aspects that can be improved in the current animal food chains (Bansback, 2014; Golini et al., 2017).

In this line of thought, the next logical step is Meeting Consumers Expectations. For instance, innovative packaging with edible, biodegradable and natural compounds are of great importance to meet the expectations of consumers in terms of sustainability. This approach is of great importance due to the additional properties provided by the innovative package: antimicrobial and antioxidant. Since the main causes of loss of quality are the growth of pathogenic and spoilage microorganisms, the occurrence of oxidative reactions, the addition of compounds (especially those from natural sources) is a great alternative to maintain quality. This strategy has been showing successful results in the last decade and the progression toward edible and biodegradable matrix is an important advance (Domínguez et al., 2018).

However, it is important to remember that the relation between animal food industries and consumers in a country developed country may differs in relation to a developing country. The characteristics of population, the level of urbanization, the consumer income and health and dietary awareness, and the potential increase in the consumption per capita are some of the factors that may modify the challenges and the strategies/approaches to face these challenges among different countries (Pacho, inpress; Henchion et al., 2014; Ortega and Tschirley, 2017).

Taking into account the importance of quality in animal food quality, Product Quality (specialty section of Frontiers of Animal Science) will be a meaningful source of information of forefront and innovative research for the continuous development of animal food industry in terms of product quality. The topics considered for publication are: animal performance and their relationship with product quality; all species used to provide meat or dairy products; technologies and systems for quality measurement; healthier and functional products; green and innovative technologies and approaches in animal food processing; sustainability in animal food chain; shelf life; safety; healthier and functional animal food products; products from indigenous breeds, traditional processing and geographical indication; sensory analysis; active and innovative packaging; chemometrics and -omics approaches; and understanding consumer attitudes and preferences.

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The author confirms being the sole contributor of this work and has approved it for publication.

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