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Review

Vacuum coating of pelleted feed for broilers: Opportunities and challenges

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ABSTRACT

Post-pellet application of fats and protection of heat sensitive bioactives can be achieved through vacuum coating. This review highlights the use of vacuum coating for delivery of liquid fat or bioactives (i.e., enzymes, vitamins, probiotics, etc.) in pelleted broiler diets. Pre-pellet delivery of fats substantially reduces pellet durability and results in losses in bird performance and customer satisfaction. Vacuum coating can also improve storage life and bioavailability of bioactives sensitive to digestion in upper part of gastrointestinal tract. As for encapsulation, vacuum coating may also offer a means of improving delivery and safe handling of offensive compounds. This technology requires highly durable and porous pellets for effective application. The challenges of this technology are the need to better understand how to improve pellet porosity and increase liquid inclusion while maintaining pellet durability; bearing in mind the increased handling of pellets when they are vacuum coated. The discussion also includes methods for measuring and manipulating the porosity of the pellets to achieve optimum pellet durability and liquid application.

Contents

Abbreviations: a_w, water activity; kPa, kilopascal; MPa, megapascal; NIR, near-infrared reflectance; NSP, non-starch polysaccharides.

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1. Introduction

This paper reviews the potential of using vacuum coating to manufacture nutrient dense durable pellets and protect the feed additives during processing, handling and storage. Vacuum coating has been successfully applied in aquaculture feeds and pet foods where end-product quality and high level of fat inclusion (i.e., up to 300 g/kg) are important. In these instances of high fat inclusion, it is necessary to extrude rather than pellet these diets before vacuum coating. Pellets and extruded products have different functional properties due to application of different processing conditions during production. The term "pellet" is often used synonymously for extruded and pelleted products in the literature, and causes confusion. Extruded feed will be designated as "extrudate"; and the products obtained by the conventional pelleting process will be referred to as "pellet". The review will describe the vacuum coating process and applications and potential opportunities, with a primary focus on pelleted broilers diets.

Vacuum coating of pelleted or extruded feed is based on a simple physical exchange of air inside the pores of the feed with a liquid. Perez (2001) described the principles of vacuum coating for extruded feed and reported that extrudates are first dried to approximately 80 g/kg moisture and maintained at approximately 70 °C until vacuum coated. The product is then placed in the vacuum coater, and the air is removed creating a vacuum in the pores of the extrudates. The designated liquid is then applied (i.e., spray nozzles) and mixed to allow uniform coating. Following mixing, vacuum pressure is quickly released allowing the liquid to be drawn into the pores (Fig. 1). Lastly, the extrudates (~60 °C), now full of liquid, are sent to a cooler prior to packaging. Based upon this principle, extruded aquaculture feeds and pet foods are supplemented with high fat levels that improve performance and palatability while maintaining the feed form. This principle applies for pellets too. However, it is felt that the lower porosity of pellets creates a greater challenge to maintain pellet durability and uptake of high level of liquids.

Vacuum coating enables the inclusion of higher proportion of fat without compromising pellet durability (Borquez and Perez, 2007), and protects heat sensitive liquid ingredients (e.g., vitamins or enzymes) from excessive heat and oxidation by air (Li et al., 2003). Perez (2001) has summarized the advantages of vacuum coating as

- Allowing a variety of liquid to be used;
- Higher levels of liquid can be added after processing with minimal loss of feed structure;
- Liquids (with or without additives) can be blended before addition to the products;
- Intake can be improved by adding flavors or masking the detection of unpalatable additives inside the pellet.

Perez (2001) has reviewed different features of vacuum coaters and the influence on product durability, capacity to facilitate good mixes in a short period and the ease of cleanout to minimize cross contamination. There are not many references on the use of vacuum coating to achieve these targets. The application of vacuum coating of the pellets has certain challenges such as low porosity, which implies limited liquid inclusion, and a significant increase in cost. However, selection of ingredients and optimization of processing variables may improve the porosity and durability of the pellets for vacuum coating.

2. Opportunities

Vacuum coating has been used extensively to add higher levels of fat in extruded diets. The technology can also be used to protect or mask feed additives during the different stages of pre- and post-pellet production. Potential uses of vacuum coating are now described.

2.1. Addition of fats

It is increasingly necessary to maximize the utilization of low energy–high protein co-products of the oilseed or the biofuel industries in broiler diets. Therefore, there is a requirement for use of more fat to balance energy levels in these diets. To form a durable broiler pellet, the limit of pre-pellet fat inclusion is less than 50 g/kg (Thomas et al., 1998). At higher levels of fats added at the mixer, the distribution of water from steam is altered and interferes the solubility of the protein

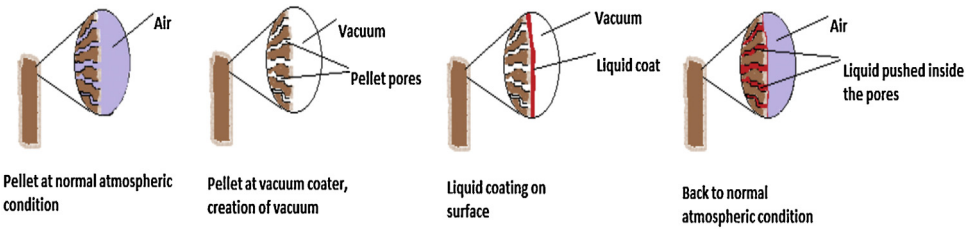

Fig. 1. Principle of vacuum coating.

Adapted from Perez (2001).