Animal Feed Science and Technology 213 (2016) 1–21

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Review article

Fats in poultry nutrition: Digestive physiology and factors influencing their utilisation

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ARTICLE INFO

Article history:
Received 8 October 2015
Received in revised form 13 January 2016
Accepted 14 January 2016

Keywords:
Absorption
Apparent metabolisable energy
Digestion
Emulsification
Supplemental fats
Poultry

ABSTRACT

Fats and oils possess the highest caloric density of all known nutrients. In recent years, because of the ever-increasing energy costs, there is greater interest in maximising the use supplemental fats as nutritionists strive to increase the dietary energy density to meet the requirements of high-performing contemporary birds. To maximise their energy yielding potential, there is a need to better understand the physiological basis and factors affecting fat digestion. Compared to other macronutrients, the digestion and absorption of fats is a complex process and involve sequence of physicochemical events requiring breakdown to fat droplets, emulsification, lipolysis and micelle formation. Current knowledge of the principles of fat digestion and absorption in poultry is reviewed, along with factors influencing available energy content of supplemental fats. The supplemental fats are one of the most difficult ingredients to evaluate in terms of available energy. Important variables influencing the energy content of fats include age of the birds, degree of fat saturation, chain length, free fatty acids and fat inclusion level. Potential strategies to improve fat utilisation in poultry diets are also examined.

Contents

Abbreviations: AME, apparent metabolisable energy; FA, fatty acid; FABP, fatty acid-binding protein; FFA, free fatty acids; HLB, hydrophilic–lipophilic balance; MIU, moisture, insoluble impurities and unsaponifiables; NSP, non-starch polysaccharides; TME, true metabolisable energy; US, unsaturated: saturated.

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http://dx.doi.org/10.1016/j.anifeedsci.2016.01.012
0377-8401/

1. Introduction

The term 'fat' is generally used as a synonym for lipid. Both terms describe a diverse variety of compounds that are insoluble in water, but dissolve in organic solvents such as chloroform, acetone, alcohol and diethylether. Lipids play an important role in the nutrition, biochemistry and physiology of animals (Brindley, 1984). From the nutritional point of view, lipids of importance are triglycerides, phospholipids, sterols and fat-soluble vitamins.

Because of the rising cost, there is an increased interest in recent years in maximising the use of fat supplements in the diet as nutritionists strive to increase the dietary energy density to meet the requirements of fast growing birds. Fats are the preferred ingredients for this purpose as their energy value is at least twice as high as those of carbohydrates and protein (NRC, 1994). The dietary addition of fats also confers other advantages, including reduced dustiness, lower particle separation in mash diets, improved palatability, carriers for fat soluble vitamins, supply of the essential fatty acids (FA) and lubrication of feed milling equipments. Additionally, supplemental fat slows down the rate of feed passage through the digestive tract (Mateos and Sell, 1981b), allowing more time for better digestion and absorption of nutrients.

A diverse array of fats and oils are available for use in feed manufacturing and these include restaurant greases (e.g. recovered frying oils; also known as yellow grease), rendering by-products (e.g. lard, tallow, mutton fat and poultry fat), vegetable oils (e.g. soybean oil, maize oil and palm oil), acidulated soapstocks (by-products of vegetable oil refining, mainly containing free FA), hydrogenated fats (fats or oils which are converted to saturated FA by the addition of hydrogen atom to double bonds of unsaturated FA), and acidulated soapstocks (free FA removed from the refining process by alkali and settled as alkali soaps). These fats and oils vary widely in terms of composition (Table 1). The choice of fat to be used, under a given commercial condition, is largely driven by its cost.

Some FA are termed as essential for poultry because the birds are unable to synthesise or convert one FA to another FA within the same series (Enser, 1984). The essential FA include linoleic acid (C18:2), linolenic acid (C18:3) and arachidonic acid (C20:4) and need to be supplied in the diet. The deficiency of these essential FA may result in impairments in growth and immune system function. Symptoms of linoleic acid deficiency in poultry include retarded growth, increased water consumption and reduced resistance to diseases (Balnave, 1970). In male birds, deficiency symptoms also include lower testes weight and delayed development of secondary sexual characteristics. Decreased egg size is the major outcome of deficiency in laying hens (Watkins, 1991). To ensure adequate supply of these essential FA, a minimum inclusion level of 10 g/kg fat in poultry diets has been suggested by Leeson and Summers (2005). 20 to 50 g/kg fat is usually added in commercial poultry diets depending on the relative prices of fat and cereal grains. The addition of fat above 40 g/kg is generally avoided in pelleted diets because of the negative effects on pellet quality (Abdollahi et al., 2013a). With new technologies, however, it may be possible to add more than 40 g/kg fat in these diets.

The influence of supplemental fats and oils on the carcass characteristics, particularly on fat deposition and carcass FA composition, of broiler chickens is well studied, but it is out of the scope of the current review. For example, Crespo and Esteve-Garcia (2001) reported that broilers fed diets containing tallow had higher contents of saturated FA in the abdominal fat pad, thigh muscle and breast muscle than those fed diets supplemented with olive oil, sunflower oil and linseed oil. The observed changes in FA composition are due the direct incorporation of dietary FA into adipose tissues.