Abstract

The research conducted in avians with emphasis on omega (ω)-3 fatty acid enrichment of edible meat portions and the use of fertilized eggs as a unique model for nutrition research is addressed. In a typical Western diet, over 70% of dietary fat is supplied through animal products. Considering the health benefits of ω-3 fatty acids, feeding strategies have been adopted to meet the recommended increased intake. Addition of flax seeds or fish oil is commonly used to manipulate the ω-3 content of poultry foods. The efficacy of flax in increasing the content of long chain ω-3 is limited after 10% inclusion in the bird’s diet. Incorporating flax results in an increase in α-linolenic acid (18:3) in triglycerides and long chain (>20-carbon) ω-3 in the phospholipids. Generally, dark meat is rich in α-linolenic acid and white meat is rich in long chain ω-3. However, considering the total fat content of dark meat, which is twice that of white meat, dark meat provides more long chain ω-3 on a portion basis. In oviparous species, the developing embryo is dependent on nutrients stored in the egg for sustaining its growth and development. Thus, hen egg and hatched chick is a unique model to study the role of nutrition in the maternal–fetal system because during development the embryo is in an “isolated” environment not under the influence of nutrients from maternal circulation as in the mammalian system. In addition, the short span of time needed to raise multigenerations of progeny, and considering the similarities that exist between mammalian and avian species in the accretion of long chain polyunsaturated fatty acids during embryonic development makes the avian model a unique tool for nutrition research.

Key Words: Avian model; chicken eggs; meat; omega-3 fatty acids; flax; fish oil.

1. INTRODUCTION

The aim of this chapter is to review the research conducted in avians on ω-3 fatty acids. The health effects of omega (ω)-3 fatty acids and the role of diet is well described in the several other chapters of this book. This chapter will cover the role of poultry foods in providing health-enhancing ω-3 fatty acids to humans and the use of ω-3 fatty acid modified fertilized eggs as a unique model for nutrition research. Research in avians on ω-3 nutrition can be broadly classified as:

1. Those conducted in laying hens as a way of enriching eggs with ω-3 fatty acids and thereby producing eggs with a low ω-6:ω-3 ratio;
2. Those conducted in meat-type chickens and turkeys for increasing the ω-3 content and thereby reducing the ω-6:ω-3 ratio in the edible portion;
3. Those conducted on ω-3 fatty acid modified egg as a unique tool for studying polyunsaturated fatty acid (PUFA) metabolism in the maternal–fetal system; and
4. Those conducted on metabolic, bird immune health-related aspects and poultry product lipid stability issues.

The major research emphasis on $\omega$-3 in avian nutrition has focused on enriching eggs with $\omega$-3 compared with other aspects. This is evident by the successful marketing of $\omega$-3 fatty acid modified eggs in several countries.

2. CONSUMPTION OF $\omega$-3 IN THE UNITED STATES DIET

The current consumption of $\omega$-3 fatty acids in the United States is 1.4 g $\alpha$-linolenic acid (LNA, 18:3) and 0.2 g/d of long chain (>20-carbon $\omega$-3) (1). Although no official dietary recommendations have been made in the United States, nutritional scientists suggest including LNA at 2.2 g/d and long chain $\omega$-3 (20:5 + 22:6) at 0.65 g/d (1). Therefore, an additional 0.8 and 0.45 g of LNA and long chain $\omega$-3 is needed in the current United States diet (Fig. 1).

3. $\omega$-3 FATTY ACIDS: WHY POULTRY FOODS?

To accommodate for the 57% (of LNA) and 225% (long chain $\omega$-3) increase in $\omega$-3, alternate dietary sources of $\omega$-3 fatty acids other than marine sources have to be provided. In a typical Western diet, over 53% of dietary fat is supplied through animal products. Therefore, feeding strategies have been adopted to increase the content of $\omega$-3 fatty acids in animal food lipids like meat, eggs, and milk (2–5). However, lipid metabolism in ruminant animals limits the changes in fat composition of milk and ruminant products (e.g., cheese and meat) compared with products from monogastric species (eggs, pork, chicken, and meat). In addition, as consumer preference is to opt for low-fat dairy foods and/or “lean” meat, the availability of $\omega$-3 from ruminant foods will be further limited. Consumer preference, availability, low cost, ease, and versatility in preparation makes skinless poultry meat a major source of animal food protein. Poultry meat accounts for 38% of the consumption of meat and meat products in the United States (calculated from food disappearance data on boneless meat, United States Department of Agriculture (USDA), Economic Research Service, 2004) (6) and the