

Enrichment of Poultry Diets with Polyunsaturated Fatty Acids (PUFA) for Human Consumption

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Abbreviations: PUFA: Polyunsaturated Fatty Acids; EPA: Eicosapentaenoic Acid; DHA: Docosahexaenoic Acid; AA: Arachidonic Acid; α -LNA: α -Linolenic Acid

Introduction

In recent years, polyunsaturated fatty acids (PUFA) have received considerable attention in both human and animal nutrition, particularly those of the n-3 family. These are PUFA in which the first double bond is situated on the third carbon atom from the methyl end of the fatty acid molecule. Consumption of n-3 PUFA are low, particularly the long chain (>18 carbon atoms) ones that are most commonly found in fish oils. As a mean of increasing the low consumption of the long chain n-3 PUFA by humans consuming western diets, there has been some interest in the enrichment of poultry meat with these fatty acids for people seeking healthy lifestyles.

Involvement in Health and Clinical Problems

Vitality of living cells depends profoundly on dietary lipids that are incorporated into phospholipid layers of cellular membranes. n-3 PUFA, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are reported to compete with arachidonic acid (AA) for this incorporation. Since AA is responsible for up-regulation of eicosanoids such as leukotrienes, this competitive inhibition down-regulates inflammation responses related to many diseases and disorders such as cardiovascular disease, increased triglycerides, blood pressure, thrombosis, atherosclerosis, stress, mental problems, asthma and rheumatoid arthritis. These benefits of an optimal ratio of n-3/n-6 PUFAs on health are just a few examples of a wide range of clinical problems that are improved by consumption of the very long chain n-3 fatty acids [1-4].

n-3PUFA enrichment of poultry diet

Traditionally, fish and fish oil are the main sources of essential, long chain n-3 PUFA that induce modifications in the lipid composition of poultry products because marine sources in general contain high levels of EPA and DHA PUFA. Of less nutritional importance are plant sources such as linseed that is rich in

α -linolenic acid (α -LNA). α -LNA is an 18 carbon n-3 fatty acid that is the precursor to the long chain n-3 PUFA, but because the efficiency of conversion is so low in humans, the accumulation of α -LNA is of little real nutritional benefit. Chickens fed linseed oil deposit significant amounts of α -LNA in the egg yolk (in laying hens) and meat (in broilers) [5-9]. However, to achieve enrichment of poultry products with long chain n-3 PUFA, marine oils need to be fed. Bou et al. [10] reported that supplementing broiler diets with 25g/kg fish oil produced double the amount of beneficial EPA and DHA than diets supplied with 12.5g/kg fish oil. High concentrations of fish oil supplementation decrease the saturated and mono saturated FA and increase the very long chain PUFA in poultry meat [11]. Lopez-Ferrer et al. [12] substituted 82g/kg fish oil in supplemented broilers diet with the same amount of linseed and rapeseed. They concluded that the total amount of the very long chain PUFA in the chicken meat decreased when fish oil was removed from the diet. On the contrary, the n-6 PUFA and mono saturated FA in form of oleic acid increased. These results support the fact that fish oil is more efficient in elevating levels of long chain n-3 PUFA.

Involvement in Avian Immune Function

The immunomodulatory effect of PUFA in broiler chickens occurs by affecting intercellular communications and signals that change the reactivity of leukocytes upon antigenic stimulation. This effect is highly associated with down-regulation or up-regulation of different cytokines that are believed to affect the avian immune function such as IL-1 β , IFN- γ , MGF, IL-1, IL-4, IL-2 [13,14].

There is some concern that diets enriched with n-3 PUFA have detrimental effects on chicken immunity and impair resistance to infection. However, it is not clear whether this concern is justified, since some studies show no effect [15], some show a detrimental effect [16] while some show an improvement [16,17] in chicken immune response following feeding of n-3 PUFA.



All in all, n-3 PUFA are essential for human health and enrichment of these fatty acids is successful. However, care should be taken because these fatty acids may modulate the immune system.

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