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Effects of different dietary oil sources on immune function in cyclophosphamide immunosuppressed chickens

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Abstract

An experiment with 3 × 2 factorial arrangement was carried out to determine the effects of dietary supplementation with different dietary oil sources on immune function in cyclophosphamide (CY) immunosuppressed chickens. Three hundred and sixty day old male Arbor Acre broiler chickens were randomly allocated into six treatments. The main factors consisted of dietary supplemental oil sources (45 g fish oil, maize oil or poultry oil per kilogram of diet) and immunosuppressive challenge (birds challenged with CY or treated with sterile saline). Growth performance, the relative weights of the spleen, thymus and bursa, antibody production, lysozyme activity and prostaglandin E_2 (PGE_2) synthesis were investigated. The fish oil diets resulted in higher body weight gain, feed efficiency, lysozyme activity, anti-bovine serum albumin (BSA) and anti-NDV titers than the maize oil or poultry oil diets ($P<0.05$) in different growth periods. Chickens treated with CY showed significant decrease ($P<0.05$) in growth performance, the relative lymphoid organs' weight, lysozyme activity, antibody response to BSA and NDV when compared to the saline-treated control chickens. The interaction of oil source with CY on body weight gain, feed intake and anti-NDV titers was observed across different growth periods, *i.e.* fish oil attenuated the growth-suppressive and immunosuppressive effects of CY treatment. The effect of oil source was significant on the production of PGE_2 ($P<0.05$), and the lowest

Abbreviations: BSA, bovine serum albumin; CY, cyclophosphamide; NDV, newcastle disease virus; PGE_2, prostaglandin E_2; PUFAs, polyunsaturated fatty acids; PO, poultry oil; MO, maize oil; FO, fish oil

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level of PGE_2 production was in fish oil (FO) fed chickens and the highest level was in maize oil (MO) fed chickens independent of CY treatment. The negative correlations were found between PGE_2 synthesis and lysozyme activity in serum at the age of 28 d ($R^2 = -0.686$, $P<0.001$), but no correlation was observed between PGE_2 synthesis and antibody titers. The results suggest that dietary $n-3$ polyunsaturated fatty acids (PUFAs) supplementation enhanced the humoral immune response under not only the normal physiological status but also the immunosuppressive status, and the overall effects of fish oil on humoral immunity cannot be accounted for solely on the basis of PGE_2-mediated effects.

Keywords: Oil sources; Broiler chickens; Immunosuppression; Antibody production; Prostaglandin E_2

1. Introduction

Immunosuppression, caused by many factors such as infection and stress, is a common biological phenomenon in poultry. Some immunosuppressive diseases are very broad, which usually can be ignored because of their subclinical signs, such as Marek's disease (MD), infectious bursal disease (IBD), chicken anaemia (CA) and reticuloendotheliosis (RE) (Sharma et al., 2000; Islam et al., 2002; Markowski-Grimsrud and Schat, 2003). Immunosuppressed flocks may have an increased incidence of secondary infections, poor feed conversion, and reduced protection response to commonly used vaccines (Sharma et al., 2000).Thus, immunosuppression resulted in a great deal of economic losses to poultry industry. A possible application of immuno-modulator such as polyunsaturated fatty acids (PUFAs) to animals has been reported (Alexander, 1998).

Numerous experimental observations have revealed modulatory roles of dietary PUFAs on immune function, as summarized in many review articles (Miles and Calder, 1998; Hwang, 2000; Calder et al., 2002). However, the immunomodulatory effects of dietary PUFAs are largely inconsistent. Fritsche et al. (1991) have reported that feeding chickens a diet rich in $n-3$ PUFAs (70 g fish oil/kg of diet) significantly enhanced their primary antibody response and altered lymphocyte proliferation. However dietary supplementation of $n-3$ PUFAs derived from fish oil decreased antibody production in rats (Pricket et al., 1984) and humans (Virella et al., 1991). It has also been reported that $n-3$ PUFAs from linseed oil or fish oil had no effect on antibody production in rabbits (Kelley et al., 1988) and rats (Kim and Lee, 1992). Most studies in animal were carried out in the normal physiological status or inflammatory challenge status. There are few studies on the effect of dietary PUFAs on immune function in animal immunosuppressive status. The immune system of chickens is somewhat different from mammals. The bursa is unique in birds and has been used to study B-lymphocyte development. Humoral immune response is important in protecting chickens from infectious disease and facilitating cell-mediated immune responses to clear pathogens. Cyclophosphamide (CY) is a nonspecific immunosuppressant agent affecting primarily antibody-mediated immunity (Corrier et al., 1991). CY may cause depletion of B-lymphocytes and suppress humoral immunity (Reynolds and Maraqa, 1999). It has been reported that injection of CY to chickens induced selective B-cell damage resulting in humoral immunosuppression (Corrier et al., 1991; Reynolds and Maraqa, 1999).

Different types of fatty acids can play different modulatory roles on immune function of the immunosuppressive chickens. Both fish oil, as a source of $n-3$ PUFAs, and maize oil,