Hindawi
Veterinary Medicine International
Volume 2023, Article ID 3220344, 10 pages
https://doi.org/10.1155/2023/3220344

Review Article

Omega-6: Its Pharmacology, Effect on the Broiler Production, and Health

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Received 10 November 2022; Revised 9 February 2023; Accepted 10 February 2023; Published 1 March 2023

Academic Editor: Alessandro Di Cerbo

Lipids and oils are the primary sources of monounsaturated and polyunsaturated fatty acids (MUFA and PUFA), which are necessary for human and animal health. Omega-3 and omega-6 are essential nutrients for broilers. Omega-6 members, such as linolenic acid, are essential for broilers and must be obtained through feed. Vegetable oils are the primary source of omega-6 added to broiler feeds. Unsaturated fatty acids are better digested and absorbed than saturated fatty acids and generate more energy at a lower cost, boosting productivity. Feeding supplements with omega-6 can increase the fatty acid content in meat and increase weight, carcass, viscera, and FCR. The quality of meat taste and antioxidant content was also improved after giving omega-6 and influencing mineral metabolism. Broiler reproductive performance is also enhanced by reducing late embryonic mortality, hence enhancing fertility, hatchability, sperm quality, and sperm quantity. Meanwhile, for broiler health, omega-6 can lower cholesterol levels, triglycerides, very low-density lipoprotein, and low-density lipoprotein. It also supports support for T-helper cell (TH)-2-like IgG titers, increasing prostaglandins, eicosanoids, and antioxidants. In addition, it also supports anti-inflammation. Other researchers have extensively researched and reviewed studies on the effects of omega-6 on poultry. Meanwhile, in this review, we provide new findings to complement previous studies. However, further studies regarding the effects of omega-6 on other poultry are needed to determine the performance of omega-6 more broadly.

1. Introduction

The proportion of poultry meat in the average global output of 323.25 million tons (mt) over the past five years was 122.82 million tons (mt) or 37.99% [1]. Also, chicken meat output has increased in developed and developing nations over the past six decades [2]. Moreover, due to its high protein, low-fat content, and tasty flavour, chicken is expected to be the most consumed animal protein in the world in 2020. Fat and oil are frequently added to poultry diets to boost their energy density. By selecting minerals and supplements for live birds, it is possible to boost the nutritional value of chicken meat, which is one of its benefits. In recent years, numerous oils have been employed commercially to supply lipids to chickens. Some studies have indicated that supplementing poultry diets with lipids alters feed intake, energy efficiency, the profile of thigh and breast muscles, and broiler meat quality [3–5].

The supplementation of polyunsaturated fatty acids (PUFAs) can raise the concentration of PUFAs in the carcass. Fatty acids, particularly essential fatty acids, are gaining relevance in poultry feeding systems because they improve birds' health and productivity. Our health-conscious culture favours well-balanced diets to reduce the risk of unfavourable health effects [6]. PUFA has also boosted the demand for animal diets containing γ-linolenic acid [7]. γ-linolenic acid (C18 : 3 $n-6$) improves chicken health by acting as an anti-inflammatory, antithrombotic,

Table 1: Various forms of the omega-6 group.

Omega family	Common name	Systematic name	n and Δ abbreviations
$n-6$	Linoleic acid (LA)	*all-cis*-9,12-octadecadienoic acid	$18:2n-6$ or 18: $2^{\Delta 9,12}$
	γ-Linolenic acid (GLA)	*all-cis*-6,9,12-octadecatrienoic acid	$18:3n-6$ or 18: $3^{\Delta 6,9,12}$
	Dihomo-γ-linolenic acid (DGLA)	*all-cis*-8,11,14-eicosatrienoic acid	$20:3n-6$ or 20: $3^{\Delta 8,11,14}$
	Arachidonic acid (AA)	*all-cis*-5,8,11,14-eicosatetraenoic acid	$20:4n-6$ or 20: $4^{\Delta 5,8,11,14}$
	Adrenic acid (DTA)	*all-cis*-7,10,13,16-docosatetraenoic acid	$22:4n-6$ or 22: $4^{\Delta 7,10,13,16}$
	Tetracosatetraenoic acid (TTA_{n-6})	*all-cis*-9,12,15,18-tetracosatetraenoic acid	$24:4n-6$ or 24: $4^{\Delta 9,12,15,18}$
	Tetracosapentaenoic acid (TPA_{n-6})	*all-cis*-6,9,12,15,18-tetracosapentaenoic acid	$24:5n-6$ or 24: $6^{\Delta 6,9,12,15,18}$
	Docosapentaenoic acid (DPA_{n-6})	*all-cis*-4,7,10,13,16-docosapentaenoic acid	$22:5n-6$ or 22: $5^{\Delta 4,7,10,13,16}$

antiproliferative, and lipid-lowering agent by conversion to prostaglandin E1 [8].

Enriching broiler chicken muscles with PUFAs, particularly omega-3 and omega-6 fatty acids, can reduce the risk of cardiovascular disease and protect against atherosclerosis and coronary heart disease by lowering cholesterol and low-density lipoprotein (LDL) levels in the blood and reducing platelet aggregation [9]. However, there is limited research on the particular mechanism of omega-6 in broiler performance. The current article includes an update on the therapeutic qualities of omega-6, as well as its origins, chemistry, biosynthesis, absorption, distribution, broiler production, and health.

2. Data Collection

Data gathering a search of electronic databases follow a previous report such as PubMed, Elsevier, ResearchGate, and Google Scholar using the keywords "omega-6," "omega-6 pharmacology," "omega-6 absorptions," "omega-6 for poultry," "omega-6 for broilers," "omega-6 for broiler production performance," and "omega-6 for broiler health." Selected papers from 2006 to 2022 were chosen based on their content. Relevant articles that used the keywords mentioned previously and written in English have been included.

2.1. Sources and Chemistry of Omega-6. Lipids' physical and chemical properties are dictated by their fatty acid content, carbon chain length, and degree of saturation. Unsaturated denotes the presence of one or more double bonds, whereas saturated indicates the lack of double bonds in chemical structure [10]. Increasing the length of the carbonic chain of saturated fatty acids raises the fat's melting point, while the presence of a double bond lowers the fat's melting point [11]. Additionally, the shape of the double bond impacts the melting point. The melting point of trans fatty acids is higher than that of their cis isomers [12].

The acyl chain of polyunsaturated fatty acids has two or more methylene-interrupted double-bond desaturations [13]. PUFAs may also contain a carboxylic acid at one end of the molecule and a methyl group at the other. This structure is named Omega ("☐" or "n") and is subdivided into $n-3$, $n-6$, $n-7$, and $n-9$ fatty acids, which correspond to the double bond if unsaturation is present [14]. (n–) indicates the position of the carbon double bond counting from the methyl end. Omega-3 and Omega-6 family members are the nutritionally essential PUFAs for poultry health [15]. As seen in Table 1, there are numerous Omega-6 variants. Palmitoleic acid and oleic acid could be generated in the body via metabolic pathways. However, linolenic acid and linoleic acid are necessary fatty acids that must be ingested [14]. Additionally, high amounts of polyunsaturated fatty acids undergo autoxidation far more rapidly than saturated PUFAs, particularly when exposed to heat, light, oxygen, and transition metals during manufacture, processing, and storage [15, 16]. However, conjugated linoleic acids are sometimes misclassified as omega-6 (abbreviated −6 or $n-6$) fatty acids. Conjugated linoleic acids are a class of fatty acids including up to 56 isomers with conjugated (juxtaposed or adjacent) double bond pairs along octadecadienoic (18 : 2) [17, 18].

Typical vegetable oils such as sunflower oil, safflower oil, palm oil, *Silybum marianum* oil, sesame oil, pumpkin seed oil, peanut oil, wheat germ oil, rice bran oil, linseed oil, and maize oil are sources of $n-6$ PUFAs [19–23]. Figure 1 shows sources of $n-6$ PUFAs. The majority of PUFAs in plants and marine foods are cis-configured. $n-6$ PUFAs are predominantly composed of linoleic acid (C18 : 2) and arachidonic acid (AA, C20 : 4) [24], whereas linoleic acid might undergo desaturation and elongation to produce arachidonic acid (ARA, 20: $4n-6$) and docosahexaenoic acid (DTA, $22:4n-6$) [25].

In addition, Certık et al. [26] identified oleaginous lower filamentous fungi as a rich source of γ-linolenic acid. Utilizing these fungi in a solid-state fermentation method generates a bioproduct enriched with γ-linolenic acid that can be utilized directly as a chicken feed supplement. However, there are limited γ-linolenic acid sources, notably in the plant (e.g., blackcurrant, evening primrose, borage, or hemp seeds). Utilizing solid-state fermentation (SSF) is an alternate method for producing γ-linolenic acid from microorganisms. SSF is a prospective bioprocess that combines fungal consumption (*Thamnidium elegans*, *Cunninghamella species*, or *Mortierella isabellina*) of moist solid materials (agricultural byproducts) with the generation of valuable metabolites in a cost-effective manner [27].

2.2. Omega-6 Biosynthesis, Absorption, and Distribution. Specifically, long-chain $n-6$ and $n-3$ PUFAs are regarded as necessary due to the inability of avian species to insert

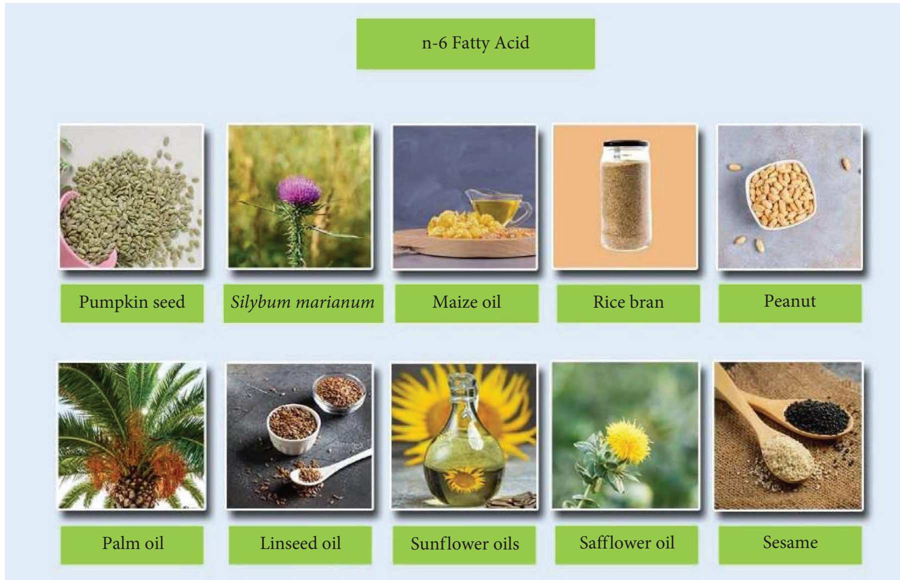

Figure 1: Various plants that contain a high level of omega-6.

a double bond beyond 19 carbons due to a lack of 1–12 and 15 desaturases; they must be supplied from the food [28, 29]. Long-chain PUFAs are mainly generated in the liver [20]. During the conversion of γ-linolenic acid to eicosapentaenoic acid or docosahexaenoic acid and linoleic acid to arachidonic acid, desaturation and elongation of the respective precursors take place in the presence of elongation of very long-chain fatty acids ELOVL2 and ELOVL5, Δ5-desaturase, Δ6-desaturase, and peroxisomal β-oxidation to acquire docosahexaenoic acid (Figure 2.) [12]. However, desaturase enzymes for omega-3 and omega-6 routes are identical [29].

Absorbed γ-linolenic acid fatty acids and linoleic acid are transferred to adipose tissue and other tissues. In contrast, arachidonic acid is retained more in the liver, duodenum, heart, spleen, brain, and other cells (thrombocytes, peripheral blood mononuclear (PBMN)) [30]. Moreover, long-chain unsaturated fatty acids have more potential to form micelles. They could function synergistically in the absorption of saturated fatty acids (SFA) when combined with saturated fatty acids (SFA). Furthermore, micelles have an estimated particle size between 30 and 40 Å, which is sufficiently tiny to pass between the microvilli of mucosal cells [31]. In monogastric animals, fat absorption occurs between the end of the duodenum and the end of the ileum [32].

On the contrary, when γ-linolenic acid-rich oils are consumed orally, γ-linolenic acid is readily absorbed and initially appears in serum phospholipids. The substance is then dispersed across different phospholipid fractions following continued dosing. A portion of the γ-linolenic acid received is oxidized. The remainder is rapidly lengthened to Dihomo-γ-linolenic acid in the plasma, renal artery, liver, and aorta and could also elevate arachidonic acid, although exclusively in the plasma and liver [33]. Dihomo-γ-linolenic acid and γ-linolenic acid levels in the liver were proportional to the amount of γ-linolenic acid present, regardless of the oil source, indicating that oils are efficiently absorbed and that the amount of γ-linolenic acid absorbed is dose-dependent [34].

2.3. Effect of Omega-6 in the Broiler Production. Providing a lipid diet with the required fatty acid profile for the resultant tissue makes it possible to modify the fatty acid profiles of broiler tissues. Velasco et al. [35] showed greater feed efficiency in chicks that received diets rich in unsaturated fat sources than in chicks that were fed diets rich in saturated fat. Moreover, current poultry feed is based on grains with a high ratio of $n-6$ fatty acids to $n-3$ fatty acids. This feed results in high levels of arachidonic acid ($20:4n-6$) in meat and egg products and reduced levels of docosapentaenoic (DPA, $22:5n-3$), eicosapentaenoic (EPA, $20:5n$ 3), and docosahexaenoic (DHA, $22:6n-3$) acids [23]. Furthermore, broilers fed diets with high levels of linoleic acid consumed less feed per day than those who received neither a supplement nor diets with low levels of linoleic acid [36].

Omega-6 supplementation shows positive results on broiler performance. The highest body weight, carcass yield, and FCR were observed when linoleic acid was added to broiler feed [37]. Pirzado et al. [38] also found the same result and observed that broilers' feed conversion ratio (FCR) values were significantly enhanced after receiving omega-6. With the addition of linoleic acid, a more significant concentration of chlorides was also discovered in the chickens' serum, which may be connected with a higher requirement for the concentration of HCl in the stomach in response to a higher lipid intake and enhanced chloride ion management in the body [39].

Broiler offal is also affected by omega-6 supplementation. According to a study by Gaad et al. [36], omega-6 increases the weight of giblets; the liver, heart, and gizzard are much heavier. Moreover, the comparatively high concentrations of $n-6$ PUFAs (up to 45.0% in a corn oil diet)

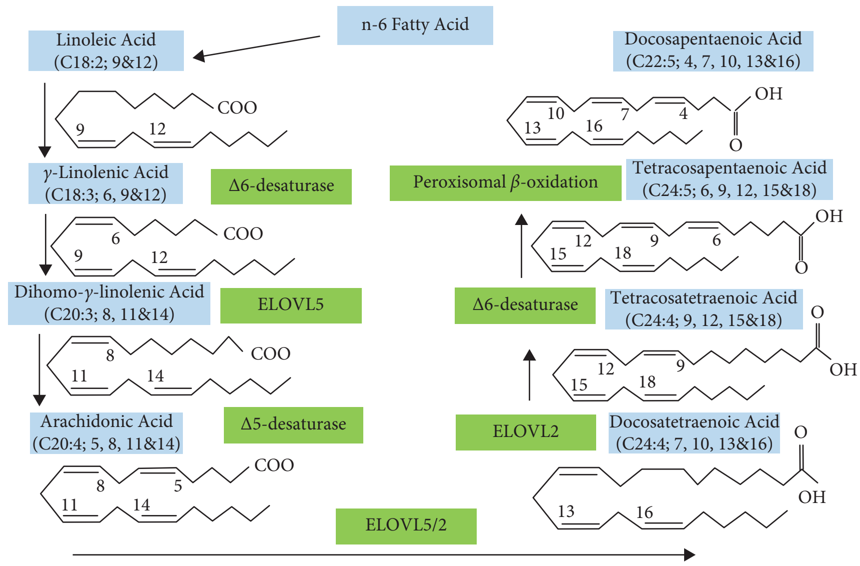

Figure 2: Biosynthesis omega-6.

made cardiac and hepatic tissues the wealthiest types of fatty acids [40]. In other poultry species, dietary 6% PUFA originated from corn oil in Japanese quail showed increased productivity, follicular hierarchy in the ovarium, and the heart weight without harming other visceral organs due to its beneficial effects as an energy and essential fatty acid source, antioxidant, antiparasite, and endocrine hormone precursor [41–43]. Furthermore, the antioxidant capacity of broiler breast meat was enhanced by a diet including γ-linolenic acid and linoleic acid, as demonstrated in a prior study [44]. However, Fejerčáková et al. [33] discovered that GPx activity evaluated in the liver is essentially unaffected by agrimony and -linolenic acid-containing diets.

Omega-6 can also impact the fat content of poultry. According to research (El-Katcha), excessive treatment with $n-6$ fatty acids boosts fatty acid oxidation and hence increases the metabolic rate of animals. Qi et al. [45] observed that dietary $n-6/n-3$ PUFA (10 : 1) had a substantial effect on subcutaneous and intramuscular fat content as well as meat quality in chickens (colour and tenderness). Analysis of the chemical composition revealed that hens fed a meal supplemented with linoleic acid had a higher fat content in the breast and thigh [39]. The addition of linoleic acid to compound feed for broilers, according to another study by Haščík et al. [46], enhances the intensity of growth and the proportion of internal, subcutaneous, and intramuscular fat.

Moreover, the chosen cereal product with a greater concentration of γ-linolenic acid (3.676 1.09 kg^{-1} in wheat bran) increased the concentration of γ-linolenic acid in the lipids of chicken breasts produced [47]. On the contrary, Oliveira et al. [48] emphasize the significance of γ-linolenic acid as a representative of $n-6$ PUFAs, which has a synergistic effect with $n-3$ PUFAs such as DHA and EPA, whereas dihomo-γ-linolenic acid and arachidonic acid possibly had a higher concentration due to a higher fraction of γ-linolenic acid. However, Khatibjoo et al. [49] report that a high concentration of linoleic acid in the meat of broilers fed linoleic acid could reduce the proportion of monounsaturated fatty acids and increase the proportion of polyunsaturated fatty acids.

Another study by El-Zenary et al. [50] revealed that the overall $n-6$ PUFA content of boneless, skinless breasts mirrored that of linoleic acid in the diet. Total $n-6$ PUFAs were highest in birds, primarily due to a higher conversion of linoleic acid to arachidonic acid. The $n-6$ PUFAs or their sources, such as fish oil, palm oil, soybean oil, and linseed oil, also promote bone formation, development, and growth by enhancing mineral metabolism, particularly that of calcium, zinc, and magnesium, which renders them inaccessible after age [20].

The data revealed that the arachidonic acid content of *Hinai jidori* flesh can be increased with arachidonic acid dietary supplements and that *Hinai jidori* meat and soup with a higher arachidonic acid content had a significantly better taste perception than those with a low arachidonic acid content [6]. Arachidonic acid stimulates the TRPM5 cation channel, a component of type II receptor cells' sweet, umami, and bitter taste pathways, as suggested by Liu et al. [51]. Takahashi et al. [6] have demonstrated that the concentration of arachidonic acid in chicken flesh may be altered through dietary supplementation with arachidonic acid (AA) and genetic selection utilizing the polymorphism of the FADS1 and FADS2 genes as selection markers. These techniques enhance the flavour of the chicken.

In addition, it was determined that the inclusion of 2% of various sources of omega-6 fatty acids (particularly flax seed oil) in the diets of broiler breeders might reduce late embryonic mortality, hence enhancing fertility, hatchability, sperm quality, and sperm quantity [20, 52]. In addition, $n-6$ FA-rich diets had a beneficial impact on semen volume and total spermatozoa count but a detrimental impact on spermatozoa concentration. Furthermore, avian sperm often contains a high proportion of PUFA, especially $n-6$ PUFA [49]. Table 2 displays the effects of various plant feed resources with the highest omega-6 content on the performance of broilers. Generally, omega-6 supplementation

Table 2: The effects of various plants that contain the main omega-6 content on broiler performance.

Dose rate	Major findings	References
Broilers supplemented with 1.5% different sources of omega-3 and omega-6 (fish oil, coconut oil, canola oil, or a mixture of the three oils)	Enhanced growth performance and immune status, improved blood lipid profile and antioxidants status, and the effect of the oil sources depends on the criteria of response	Attia et al. [3]
Dietary base supplemented with 6% of the following oils: palm oil (PO), soybean oil (SO), and linseed oil (LO)	Had higher oxidative stability and cholesterol	Abdulla et al. [5]
The broilers are fed 2% of various types of omega-3 and omega-6 fatty acids (2% flax seed oil in particular)	Reduce late embryonic mortality	Saber and Kutlu [52]
Sunflower meal is added to broilers' food at a rate of 4%–12%	It did not affect carcass percentage and cut the yield of broilers	Sangsoponjit et al. [53]
Broilers supplemented with sunflower oil at a rate of 2–6%	Had greater duodenum and ilium length as well as higher fat digestibility	Khatun et al. [22]
Broilers supplemented with sunflower oil at a rate of 25–100%	LDL, HDL, and weight of the thigh, breast, heart, and pancreas and abdominal fat were not affected by the type of oil fed	Karimi et al. [54]
Broilers supplemented with sunflower oil at a rate of 2.5%–3.5%	No significant differences were obtained for different parameters of growth performance, carcass parts, and traits of groups	Gaafar et al. [55]
Basal diet supplemented with safflower oil at a rate of 5–20%	Improve weight gain, feed intake, and feed conversion ratio	Malakian et al. [56]
Canola oil was added to the diets at 0–5% concentrations	Decreases the concentrations of saturated fatty acids and blood glucose in broilers	Al-Tawash et al. [57]
Basal diet supplemented with safflower oil and inositol up to 1%	Produces relatively similar intestinal weight and length, crypt depth, and the length and width of intestinal villi	Albasheer et al. [58]
Basal diet supplemented with safflower meal at a rate of 60%	Not significantly increase the performance of chicks to increase economic efficiency	Abrham et al. [59]
Basal diet supplemented with safflower oil 5–10 g/kg	Increased the goblet cell count, mucosal thickness, intraepithelium lymphocytic lick cell infiltrations, villous height, width, and crypt depth	Amer et al. [60]
Basal diet supplemented with flaxseed oil 2.5–10 g/kg	Decreased feed intake and body weight gain but increased the feed conversion ratio and also decreased total cholesterol, triglyceride, very low-density, LDL levels in serum and increased HDL. Dietary flaxseed oil treatment significantly reduced weight gain	Al-Hilali [61]
Basal diet supplemented with flaxseed oil at rate 4% and 8%	Did not show any improvement in chicken breast meat sensory quality	Stanaćev et al. [62]
Basal diet supplemented with high-oleic peanuts at a rate of 10–12%	Increase the meat produced with unsaturated fatty acids without adversely changing the protein or amino acid content of the meat generated	Toomer et al. [63]
Basal diet supplemented with 0.1–2.0 mg/kg at the rate of *Silybum marianum*	Greater anabolic activities in their bodies and increased use of albumin fraction proteins as the principal material for organogenesis	Bagno et al. [64]
Basal diet supplemented with *Silybum marianum* at a rate of 12%	Improve broiler performance	Shahsavan et al. [65]
Basal diet supplemented with fermented rice bran and unfermented rice bran at 500 and 250 g/kg	Beneficial effect on weight gain and feed intake	Nalle and Yowi [66]
Basal diet supplemented with pumpkin seed meal at a rate of 10%	Not changing the productive performance and the sensorial quality of the meat	Martínez et al. [67]
Basal diet supplemented with extruded rice bran at a rate of 30%	Improved the broiler performance	Zare-Sheibani et al. [68]
Basal diet supplemented with *Silybum marianum* at rate 2%–3%	Achieve the maximum body weight at the lowest feed conversion per unit of body weight gain without affecting muscularity or fattening grade	Janocha et al. [69]
Basal diet supplemented with 33–100 g/kg squash seed meal	Enhanced performance and boosted edible carcass sections while decreasing belly fat in the carcass	Aguilar et al. [70]

improves broiler performance by increasing body weight and internal organs, increasing the number of fatty acids in meat, influencing mineral metabolism, and enhancing reproductive performance.

2.4. Effect of Omega-6 on the Broiler Health. There are limited studies on the immunomodulatory effect of PUFAs on the phagocytosis mechanism. [2]. It is known that the critical omega-6 series (particularly linoleic acid and arachidonic acid) are required for development and growth and have an essential role in the prevention and control of hypertension, arthritis, cancer, cardiovascular disease, diabetes, and autoimmune diseases [30]. In animal lipids, arachidonic acid is a polyunsaturated fatty acid (PUFA). Arachidonic acid is at the head of the "arachidonic acid cascade," which consists of about 20 distinct eicosanoid-mediated signalling pathways that regulate a vast array of cellular processes, including those governing inflammation, immunology, and the central nervous system [71].

Plasma levels of cholesterol, low-density lipoprotein, very low-density lipoprotein, and triglycerides in broilers fed sunflower oil (containing 62.2% $n-6$ PUFAs) were dramatically reduced. This conclusion was consistent with the findings of Shearer et al. [72] and Sidik et al. [73] who showed that the introduction of PUFAs-rich oil in broiler diets lowered serum levels of total cholesterol, very low-density lipoprotein (VLDL), and triglycerides (TG). Moreover, Bartkovský et al. [74] reported that oil containing γ-linolenic acid considerably decreased the serum content of triacylglycerols, cholesterol, and phospholipids compared to palm or safflower oils. In addition, the other $n-6$ polyunsaturated fatty acids diminish the cholesterol level in plasma, with γ-linolenic acid being 170 times more efficient than linoleic acid. Furthermore, dietary PUFAs diminish intestinal cell chylomicron secretion and suppress hepatic fatty acid synthesis and TG production [22]. In addition, the associations between omega-6 and hypocholesterolemic index were relatively positive but moderately negative with total cholesterol and atherogenic index [3]. However, excessive omega-6 fatty acids are associated with an increased risk of severe disorders such as depression and cardiovascular disease [20].

Omega-3 and omega-6 fatty acids are essential for immunity in chicks throughout the early stages of life because of their function in cellular immunity, humoral immunity, and inflammatory regulation [75]. A high concentration of $n-6$ PUFA may promote the helper cell (TH)-2-like response at the expense of the helper cell (TH)-1-like response [49]. Moreover, an increase in $n-6$ PUFA inhibits the immune response to a TH-1 antigen. Also, hatching eggs from hens fed diets with sunflower oil (linoleic, $n-6$) or linseed oil (Arachidic acid) at various ratios found that hens fed diets with a linoleic: arachidic ratio of 0.8 : 1 increased bovine serum albumin-specific IgG titer [21]. Immunoglobulin G (IgG) is the primary antibody detected in the blood of chicks and the predominant antibody generated during humoral responses [76].

Long-chain PUFAs such as eicosapentaenoic acid and arachidonic acid are precursors for eicosanoids such as prostaglandins (PGs) and thromboxanes. In line with this, Bartkovský et al. [74] reported that linoleic acid could increase tissue levels of prostaglandin E1 (PGEI) and reduce chronic inflammation. As a result, it can inhibit the release of LBT4 from polymorphonuclear neutrophils. Moreover, linoleic acid and subsequent γ-linolenic acid, dihomoc-linolenic acid, and arachidonic acid are essential for synthesizing the physiologically active metabolites prostaglandins [77]. Prostaglandins have a crucial role in animal autocrine and paracrine cellular interactions. Pigs are implicated in the activation and regulation of immunological responses, as indicated [78]. Furthermore, the $n-6$ arachidonic acid metabolite prostaglandin E2 (PGE2) enhances the humoral component of the immune response and, similar to other $n-6$ fatty acids, may reduce the cellular responses [49].

The synthesis of PGs was initiated by arachidonic acid through the conversion of COX (1-2) to PGH2, followed by the response of several PG synthases, and the transformation of PGH2 into prostanoid end products [75]. On the contrary, the immunomodulatory action of PUFAs in birds results from intercellular communications and signals that influence the responsiveness of leukocytes due to antigenic motivation [24]. This effect is strongly related to the downregulation or upregulation of many cytokines that affect the avian immune system, including IL-1, IL-2, IL-4, IL-1, IFN, and MGF-22.

Eicosanoids are lipid mediators of inflammation that are generated via the cyclooxygenase (COX) and lipoxygenase (LOX) pathways, which use arachidonic acid and eicosapentaenoic acid as substrates [79]. Meanwhile, reducing the ratio of $n-6$ to $n-3$ PUFAs decreases proinflammatory $n-6$ PUFA-derived cytokines such as IL-6 [80]. Also, gamma fatty acids are recently developing biomaterials produced from lipids that can aid in preventing metabolic illness and inflammation and enhancing lipid metabolism [81, 82]. However, according to Schmitz and Ecker [83], omega-3 fatty acids inhibit the production of inflammatory genes, whereas omega-6 fatty acids have the reverse effect. Moreover, the feeding combinations, including microbially produced γ-linolenic acid and plant extracts, are recognized for their antioxidant and anti-inflammatory activities, such as *Agrimonia eupatoria* L. [82]. Concomitant administration of γ-linolenic acid could have also increased dihomo-γ-linolenic acid, which would compete with arachidonic acid and favour the release of less proinflammatory eicosanoids [74].

Meanwhile, linoleic acid has an anti-inflammatory impact by lowering the release of interleukin (IL)-6 and -1 and tumour necrosis factor, as demonstrated by Jung et al. [44]. Furthermore, the products of γ-linolenic acid metabolism influence the expression of several genes via gene product regulation. These gene products are essential for apoptosis [74].

Omega-6 could also decrease lipogenesis and increase fatty acid oxidation in the liver [84]. As a PUFA with three double bonds, γ-linolenic acid is vulnerable to oxidation and peroxide production. In liver cells, γ-linolenic acid supplementation can result in oxidative alteration and aggregation of apo B, which is then lysed [33]. Linoleic acid, another Omega-6, is a PUFA that can create multiple types of free radicals and can accelerate lipid oxidation [44]. The amount of γ-linolenic acid paired with agrimony extract supplementation during the 42 weeks did not affect mitochondrial SOD, GPx, GR, or GSH levels [33]. In addition, increased omega-6 consumption under stressful conditions might raise oxidative stress and a proinflammatory state, increasing the risk of atherosclerotic cardiovascular disease [85].

On the contrary, $N-6$ fatty acids depress the immunological system [53]. In addition, the connection between $n-6$ PUFAs and cytotoxic cell activity was found to be positive in the study [45]. Moreover, omega-6 also boosts IgG titers, prostaglandins, and eicosanoids and decreases cholesterol, triglycerides, VLDL-C, and LDL. Omega-6 supplementation had a favourable effect on the health of broilers; however, it has a pro-anti-inflammatory impact.

3. Conclusion

An omega-6-rich diet can improve broiler performance, including body weight, FCR, ADG, carcass, and meat quality by optimizing antioxidant activity to maintain normal metabolism. Broiler reproductive performance is also enhanced by reducing late embryonic mortality, hence enhancing fertility, hatchability, sperm quality, and sperm quantity. Meanwhile, for broiler health, omega-6 can lower cholesterol levels, triglycerides, very low-density lipoprotein, and low-density lipoprotein. It also supports support for T-helper cell (TH)-2-like IgG titers, increasing prostaglandins, eicosanoids, and antioxidants. In addition, it also supports anti-inflammation.

Data Availability

The data presented in this study are available in this article and can be accessed online or by contacting the corresponding author.

Conflicts of Interest

The authors declare that there are no conflicts of interest in this study.

Acknowledgments

This study was supported by Airlangga University, Surabaya Indonesia. This study was supported by the Faculty of Vocational Studies Airlangga University.

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