The effect of omega-3 in chickens

by José Ignacio Ferrero, Nutega and Andrés Ortiz, Novation, Madrid, Spain.

Polyunsaturated fatty acids (PUFAs) in the w-3 series play an important role in animal and human tissues. Long-chain fatty acids are converted to eicosanoids (prostaglandins, thromboxanes and leukotriens), substances with a great many physiological functions.

Eicosapentanoic acid (EPA, C20:5), and docosahexaenoic acid (DHA, C22:6) play an important role in reducing blood viscosity and pressure, platelet aggregation, cardiac arrhythmia and plasmatic triglyceride level and, therefore, have a beneficial effect on the immune system and cardiovascular disease prevention.

In current production conditions, chickens are prone to infection, mainly in the early days of their life. This situation has worsened after the removal of growth promoting antibiotics.

These infections, in many cases clinically undetectable, activate the immune response and are a waste of energy decreasing productive and economic results.

Given the properties attributed to omega-3 fatty acids, it might be interesting that they be added to the diet to improve the development of chickens.

Sources of omega-3

In plants, omega-3 fatty acids are found in the form of linolenic acid (C18:3), which is precursor to other fatty acids in the series.

This fatty acid is found in almost all plants, at very variable doses, linseed oil standing out because of its richness.

In animals, the sources of long-chain omega-3 fatty acids are fish oils and seaweed. The bioconversion capacity of linolenic acid is highly variable between fish species. It is generally high in freshwater fish and low in saltwater fish, and the omega-3 content therefore varies between fish species (Table 2).

The w-3 content of a certain species of fish oil is also variable, among other reasons because it is heavily influenced by food.

Sardine oil has the highest omega-3 content, followed by anchovy and salmon.

	C18:3	C18:4	C20:5	C22:5	C22:6	Total W-3
Anchovy (%)	0.8	2.4	18.3	1.5	8.5	31.5
Capelin (%)	0.3	1.4	3.7	0.3	2.0	7.7
Cod liver (%)	0.5	0.9	11.0	1.4	10.8	24.6
Herring (%)	0.7	1.4	6.8	0.8	5.8	15.5
Menhaden (%)	0.8	-	12.2	1.7	7.9	22.6
Sardine (%)	0.9	2.0	16.9	2.5	21.9	44.2
Salmon (%)	0.6	2.1	12.0	2.9	13.8	31.4
Golden redfish (%)	0.5	1.1	8.0	0.6	8.9	19.1

Table 2. Omega-3 fatty acid content of several fish oils (Sauvant et al, 2002).

Essence

Long-chain fatty acids, DHA and EPA, may be synthesised by an animal from linolenic acid (C18:3), but this is a limited route. More so taking into account that the enzymes involved in the metabolic route are the same used to synthesise omega-6 long-chain fatty acids (Fig. 1). This competitive effect of the two meta-

Continued on page 27

Fig. 1. Metabolic PUFA desaturation and elongation mechanisms in the w3 and w6 series.

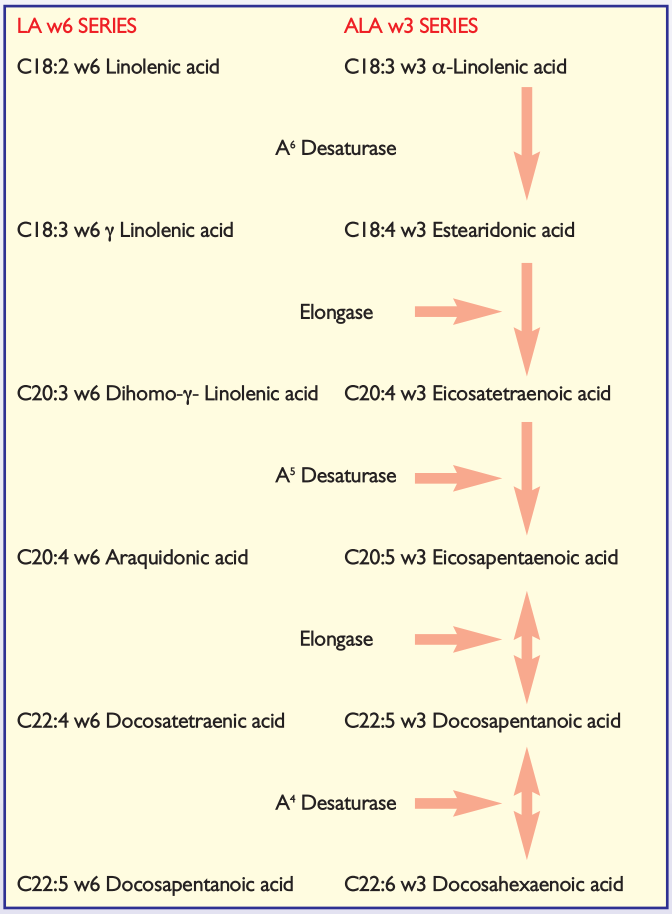


Table 1. Linolenic acid content of different raw materials used for manufacturing animal feed (Sauvant et al, 2002).

	Fatty matter (%)	Linolenic acid (% MG)
Wheat	1.5	5.9
Corn	3.7	1.0
Peas	1.0	10.2
Beetroot pulp	0.6	10.5
Dehydrated alfalfa	2.2	37.0
Soy oil	99.0	7.4
Linseed oil	99.0	54.2
Rapeseed oil	99.0	9.8
Sunflower seed oil	99.0	0.3
Tallow	99.0	0.9

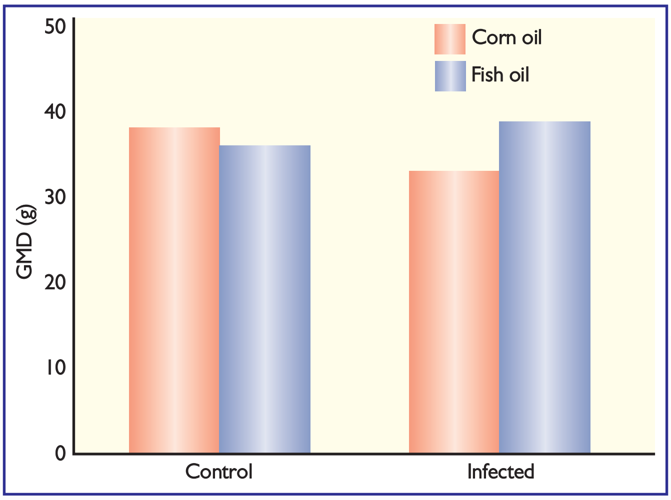


Fig. 2. Effect of E. tenella infection on the growth of chickens fed with corn oil or fish oil (3-27 days) (Korver and Klasing, 1997a).

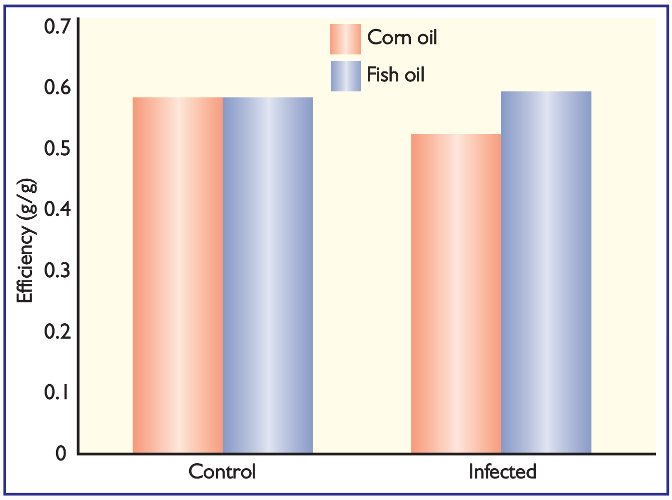


Fig. 3. Effect of E. tenella infection on the efficiency of chickens fed with corn oil or fish oil (3-27 days) (Korver and Klasing, 1997a).

Continued from page 25
bolic routes because of the use of desaturase and elongase enzymes has been observed in practical conditions on several occasions.

Therefore, the best strategy to increase DHA and EPA plasma levels is to add them directly.

Health effects

Allen and Danforth (1998) found improvements in Eimeria tenella induced injuries when chicken diets were supplemented with 5% of fish oil. On the other hand, they saw no improvements against E. acervulina or E. maxima infection.

The protective effect of omega-3 fatty acids on the inflammatory response to E. tenella reduces the impact of the infection on productive results.

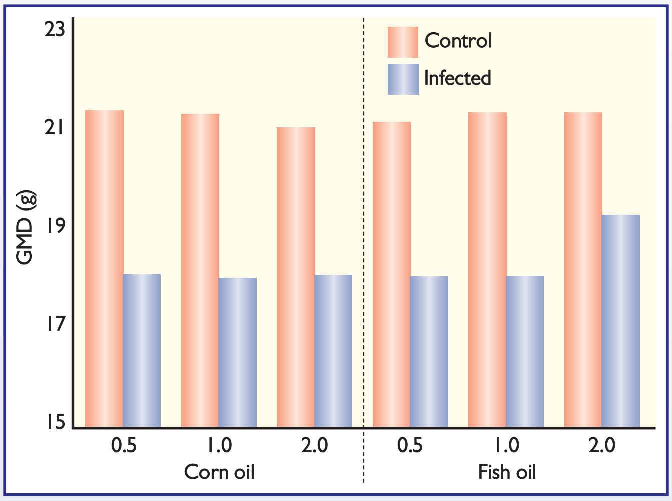
As part of the immune response, the animal synthesises a varied group of proteins.

These proteins are produced in response to broad ranging pathogenic and non-pathogenic inflammatory stimuli.

The immune response can also be triggered by injecting Salmonella typhimurium lipopolysaccharides (LPS), causing a greater development of liver, spleen and intestine with respect to the total weight and, in turn, decreasing the productive results. Korver and Klasing (1997b) observed that the reduction of the performance in LPS injected chickens was less acute in treatments with fish oil (Fig. 4).

Hulan et al (1988) observed a lower incidence of sudden death syndrome the higher the incorporation of fish flour.

Fig. 4. Effect of dietary oil type and doses on the growth of chickens challenged by LPS injection (Korver and Klasing, 1997b).



Nutritional effects

The incorporation of DHA and EPA has not only shown improved productive results in animals submitted to infectious challenges, but can also improve results in healthy animals in normal conditions.

In Fig. 5 we can observe that inclusion of fish oil in chicken diets improved growth, regardless of whether or not the animals were infected with LPS.

The inclusion of 1.5% of fish oil improved growth by 11% and efficiency by 9.5% in non-infected animals, whereas the improvement was 4% in growth and 14% in efficiency in non-infected animals.

The results improved less when omega-3 fatty acids were added through fish flour than through oil. This was probably due to the fact that processing fish flour adversely affected PUFAs or that other fish flour components can have deleteri-
Continued on page 28

Fig. 5. Effect of diet type on the growth efficiency of chickens 10-14 days old (Korver and Klasing, 1998).

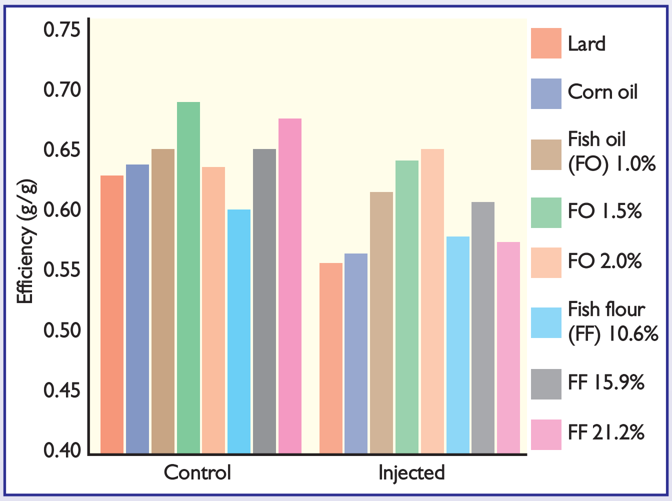
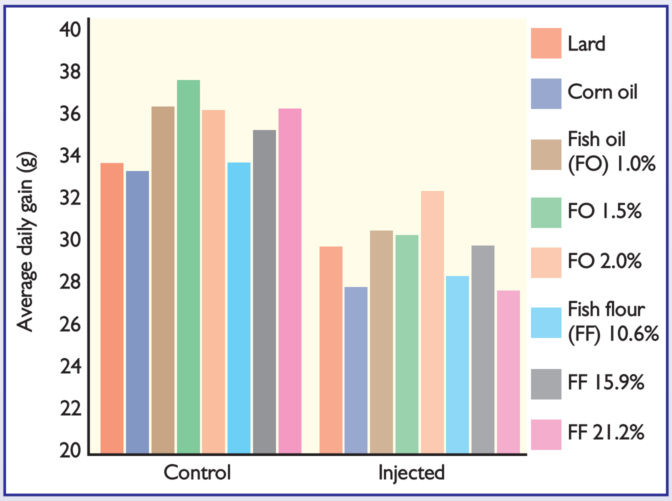


Fig. 6. Effect of diet type on average daily gain of chickens 10-14 days old (Korver and Klasing, 1998).



Continued from page 27
ous effects. It would seem that small fish oil doses are more efficient than large doses. Increasing doses from 1.5 to 2% of fish oil did not yield additional benefits.

Indeed, in another experiment of the same work, diets with 6.57% of fish oil produced the same results as diets with soy oil, sunflower seed oil or tallow.

Hulan et al (1988) reported that increasing fish oil from 2.1 to 4.1% had a negative effect on consumption and growth.

Vitamin E

The negative effect of high fish oil doses may be due to the fact that PUFAs in the omega-3 series are very sensitive to peroxidation. An increased susceptibility to lipid peroxidation has been reported when fish oils were added to the diet.

This peroxidation probably reflects a decrease in vitamin E concentration, for w-3 PUFAs, particularly DHA, can reduce vitamin E levels in animal plasma and tissues.

Therefore, contributing additional vitamin E doses when w-3 PUFAS are added to the diet is a good strategy for reducing peroxidation susceptibility in both meat and eggs.

In addition, vitamin E also increases the immune protection to

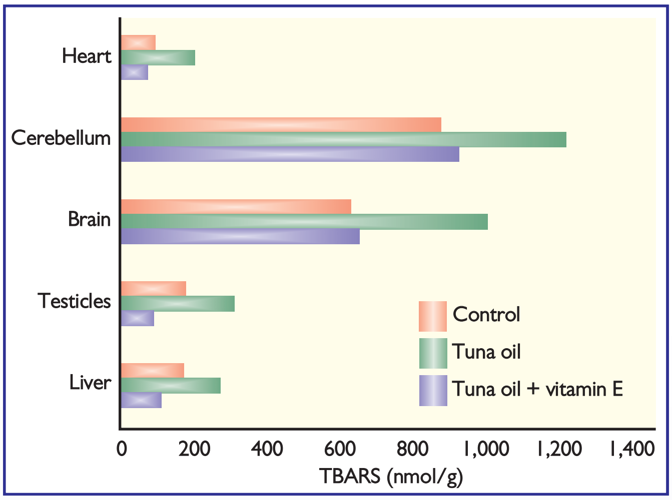


Fig. 7. Effects of tuna-fish oil and vitamin E on the formation of thiobarbituric acid reactive substances (TBARS) stimulated with FE2+ in chicken tissues (Surai and Sparks, 2000).

Escherichia coli, Brucella abortus, Pasteurella anatipestifer, Eimeria tenella and Newcastle disease infections.

Vitamin E supplementation has an immunomodulator effect to bronchitis virus antigens at doses of 25 UI/kg diet, but higher doses were not more effective. Against SRBC antigens the most effective dose was 50 UI/kg diet.

Vitamin E is contributed synthetically in normal conditions – all-rac-α-tocopherol. In this way, eight stereoisomers (RRR, RRS, RSR, RSS, SRR, SSR, SRS and SSS) coexist, whereas the natural form of vitamin E is RRR-α-tocopherol.

The official bioequivalence between both forms is 1.36:1 RRR to all-rac-α-tocopherol. However, in humans 2S stereoisomers disappear quickly from plasma.

Therefore, when the same vitamin E dose is contributed naturally (RRR) or synthetically (all-rac), α-tocopherol concentration in plasma and in tissues is double if it is contributed naturally, for the 2R stereoisomers are the only ones retained.

In pigs, as in humans, natural (RRR) versus synthetic (all-rac) vitamin E deposition has proved to be twice as effective.

In sows, it displayed an average relative deposition efficiency of 2:1 and in suckling piglets of 2.44:1.

Conclusions

Chicken diet EPA and HDA supplementation has an immunomodulator effect which helps the animal face up to certain infections which frequently appear in practical conditions.

As a result of this immunomodulator effect animals show better productive results.

In order to protect these fatty acids from peroxidation, an additional vitamin E dose should conveniently be contributed, which moreover also has an immunomodulator effect.

Such contribution should desirably be in the form of natural vitamin E given its greater biological effectiveness. ■

References are available from the author on request