Natural pigmentation in poultry production: Why the right product makes all the difference

Poultry producers worldwide use natural carotenoids in feed formulations for laying hens and pigmented broilers. With European Union regulation restricting the use of apoester to 5 ppm in animal feed, it is more relevant than ever for poultry producers that safe, natural alternatives exist. Regulatory limits for natural xanthophylls, in contrast, are set at up to 80 ppm in complete feed.

At EW Nutrition, natural xanthophyll production is a specialized and standardized process that includes quality assurance at all stages, from planting to harvesting, extraction, and saponification. The outcome is uniform and very stable products that deliver consistent, reliable results.

How to choose and handle pigmentation products for maximum performance?

- Choose a trusted pigment brand with verifiable quality controls and carotenoid handling expertise
- Use commercially available products in their original, unopened bags
- Use fresh products that are within their shelf-life period
- Suspend products that do not fulfill pigmentation levels after opening (e.g., a level that is one third or more below the supplier specification indicates a damaged product)
- Store products in closed and dark bags with little exposure to oxygen during storage

EW Nutrition's Colortek Yellow B pigment for poultry contains ≥ 100 g/kg of natural yellow xanthophylls extracted from the marigold flower (*Tagetes erecta* spp.). It achieves consistent, uniform, and high-quality coloration for egg yolk and broiler skin, as attested by independent certifications FAMI QS, ISO 14000, and

ISO 9001.

A trial was designed to compare the stability of natural Colortek Yellow B and a synthetic apoester product (Carophyll Yellow, DSM [Batch L 1954]) in a premix under challenge conditions (high level of choline chloride). As shown in Figure 1, Colortek Yellow B outperformed the apoester, offering superior stability.

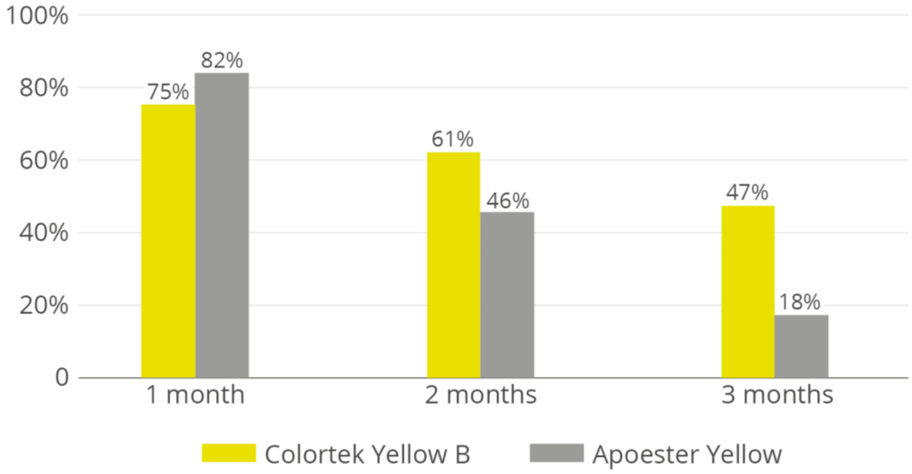

Figure 1. Stability in vitamin mineral premix (12.5% choline chloride, closed bag, 30°C, 75% RH)

These results underscore that Colortek Yellow B offers the stability poultry producers require for a successful pigmentation program. As poultry producers adopt natural carotenoid alternatives, they can be assured that specialized and standardized production processes and strict quality controls guarantee these products' reliable performance.

Appetizing eggs with natural pigmentation: The new-generation solution

*By **Dr.** Inge Heinzl, Editor, EW Nutrition*

Eggs are an unparalleled source of nutrition for humans. Apart from being tasty and easy to cook, they are an essential ingredient for pasta, cakes, ice cream, and more. More importantly, they provide high-value proteins with amino acids we cannot produce, various B-vitamins, fat-soluble vitamins, and trace elements.

Assessing the value of the egg

The quality characteristics of eggs are usually divided into external features, such as:

- egg weight
- egg shape
- shell structure
- shell crack resistance
- dynamic shell resistance
- shell color

and internal characteristics, including:

- albumen weight
- Haugh unit (a measure of egg protein quality)
- yolk height,
- yolk diameter,
- albumen pH,
- yolk pH
- yolk color

For consumers, **yolk color** is probably the most important criterion for egg quality. Higher color intensity often is taken as indicating the good health of the laying hen.

Depending on the region or on the culture, people prefer more yellow or more orange yolks. In countries with traditional corn feeding, e.g., Mexico, they often like a deep yellow. In Northern Europe, consumers prefer a lighter yellow; in Southern Europe, more gold-orange yolks (see table 1).

Country	**Yolk color fan value***
Belgium	12-13
Denmark	9-10
Finland	9-10
France	11-12
Germany	11-14
Greece	11
Italy	12-13
Netherlands	7-9

Austria	12-14
Portugal	12-14
Spain	11-14
Sweden	9-10
United Kingdom	10-11

Table 1. Egg pigmentation preferences – variation across European countries
** Values range from 1 (very pale yellow) to 16 (intense orange)*

Egg yolk color is achieved via feed

The typical color of the yolk depends on pigments that are ingested with the feed. Corn and alfalfa meal provide the yellow pigments lutein and zeaxanthin, belonging to the xanthophylls, a sub-group of carotenoids. The golden-orange color is provided by red pigments from chili or paprika (Grashorn, 2008). Egg yolks start changing color about 48 h after the application of xanthophylls.

To reach an optimal yolk coloration in egg production, diets should be supplemented with yellow and red xanthophylls. Yellow xanthophylls achieve a correct yellow base coloration. The main yellow pigments used in poultry feeding are apoester, a synthetic carotenoid, and saponified marigold extracts, a natural alternative containing lutein and zeaxanthin. For the redness, paprika or chili offer natural sources; canthaxanthin is a nature-identical red xanthophyll.

For a long time, synthetic colorants were the substances of choice in the poultry industry because they provide consistently predictable results and high product stability. However, consumers' preferences concerning food have shifted; demand favors natural over synthetic food ingredients. Moreover, current EU regulations restrict these synthetic molecules' inclusion level due to their potentially harmful effects on human health if applied in excessive doses.

Carotenoid	Maximum inclusion level
Apoester (ethyl ester of β-apo-8'-carotenoic acid)	5 ppm
Canthaxanthin (β,β-Carotene-4,4′-dione)	8 ppm

Table 2. Maximum concentration allowed in feed for poultry production

Fortunately, there is already a natural, highly efficient option to replace apoester.

Lutein: a natural colorant, antioxidant, and provider of health benefits

One of these natural compounds is lutein, a lipophilic pigment. It is extracted from marigold petals, which contain up to 8.5 mg/g wet weight. Lutein is always accompanied by its isomer zeaxanthin.

Lutein – the yolk colorant

The use of xanthophylls such as lutein and zeaxanthin enables producers to safely control the color of the egg yolk and the broiler skin. In poultry, the carotenoids are deposited in high quantities in the epidermis, the fatty tissue, and the egg yolk. According to Grashorn (2016), between 4.4-23 % of dietary lutein and 23 % of dietary zeaxanthin are deposited in the egg yolk.

Lutein – the antioxidant protects the egg lipids

Another critical characteristic of lutein is its antioxidant effect. Egg yolks contain a high fat content. Therefore, they are very susceptible to lipid oxidation. Lutein, acting as an antioxidant, can prevent or at least limit lipid oxidation during egg processing. Kljak et al. (2021) compared different sources of pigments (basil, calendula, dandelion, marigold, and an industrial product containing canthaxanthin) concerning their antioxidant capacity. In this trial, marigold improved the yolks' oxidative stability by 75 % compared to the control, with canthaxanthin showing no antioxidant effect. Kljak et al. attributed this effect to the carotenoids in the marigold extract.

Lutein – a value-added ingredient

Lutein and its isomer are nutritionally valuable and, therefore, welcome ingredients of the eggs. Once more, due to their antioxidant effects, they play an essential role in preventing and reducing cataracts and age-related eye dysfunctionalities in humans and animals (Landrum & Bone, 2001; Wang et al., 2016).

However, the amounts of antioxidant pigments in a standard egg are not very high (approx. 400 µg/egg). Compared to the total amount of antioxidants ingested, their importance for humans is only limited (Grashorn, 2008). The situation is different for functional eggs, which are widely sold in certain English-speaking countries. These eggs are enriched with n-3 fatty acids and with antioxidants such as ß-carotene (approx. 150 IE/egg).

Can natural pigments be as effective as synthetic apoester?

The precondition for the deposition of lutein in the egg or the skin is its absorption in the intestine. This absorption makes the difference between the synthetic apoester and the traditional yellow natural xanthophylls (lutein/zeaxanthin). In the case of traditional yellow xanthophylls, about three parts of the product are necessary to achieve the same effectiveness as one part of apoester.

With special technology owned by EW Nutrition, it is possible to improve the absorption of natural carotenoids and, therefore, the efficacy of lutein products. Only about 1.25 parts are then needed to replace one part of apoester.

Trial 1: A new generation of pigment products as effective as apoester

A trial was conducted in Spain to compare the effectiveness of apoester and a new generation natural pigment in combination with canthaxanthin.

For the trial, 288 layers (Hy-Line Brown, 39 weeks of age) were divided into 12 groups with 8 replications and 3 hens per replication. The trial consisted of a 7-week xanthophyll depletion and a 4-week experimental phase. The products included in the trial were a natural lutein product produced with a unique absorption-improving technology (Colortek Yellow, CTY), the synthetic xanthophyll apoester, and canthaxanthin. Three yolk color fan (YCF) targets were tested (10, 11, and 12).

For canthaxanthin, 1.5, 2.0, and 3.0 ppm were used. Within these groups of three different canthaxanthin concentrations, different concentrations of [Colortek Yellow] and apoester were applied to an otherwise xanthophyll-free diet:

Group	YCF target	Ratio CTY/APO	Yellow pigment source	Dose yellow TX* (ppm)	Dose red CTX** (ppm)
T1	10		**Apoester**	2.50	**1.50**
T2		x 1.00	**CTY**	2.50	
T3		x 1.25	**CTY**	3.13	
T4		x 1.50	**CTY**	3.75	
T5	11		**Apoester**	2.50	**2.00**
T6		x 1.00	**CTY**	2.50	
T7		x 1.25	**CTY**	3.13	
T8		x 1.50	**CTY**	3.75	
T9	12		**Apoester**	2.50	**3.00**
T10		x 1.00	**CTY**	2.50	
T11		x 1.25	**CTY**	3.13	
T12		x 1.50	**CTY**	3.75	

*Table 3. Trial design | *   TX= total xanthophylls | ** CTX = Canthaxanthin*

The colors of the egg yolks were measured with the help of the DSM egg yolk color fan.

Figure 1 shows that Colortek Yellow at a 1.25 fold concentration as apoester (3.13 ppm) provided the same result as apoester regarding YCF target 11 (= canthaxanthin concentration of 2.00 ppm). In the case of YCF target 12 (= canthaxanthin concentration of 3.00 ppm), the same yolk color as apoester could be achieved using Colortek Yellow at a 1.25 or 1.5-fold concentration as apoester. Furthermore, it could be seen that the recommendations for apoester were overestimated and yielded color results 1 point above the target.

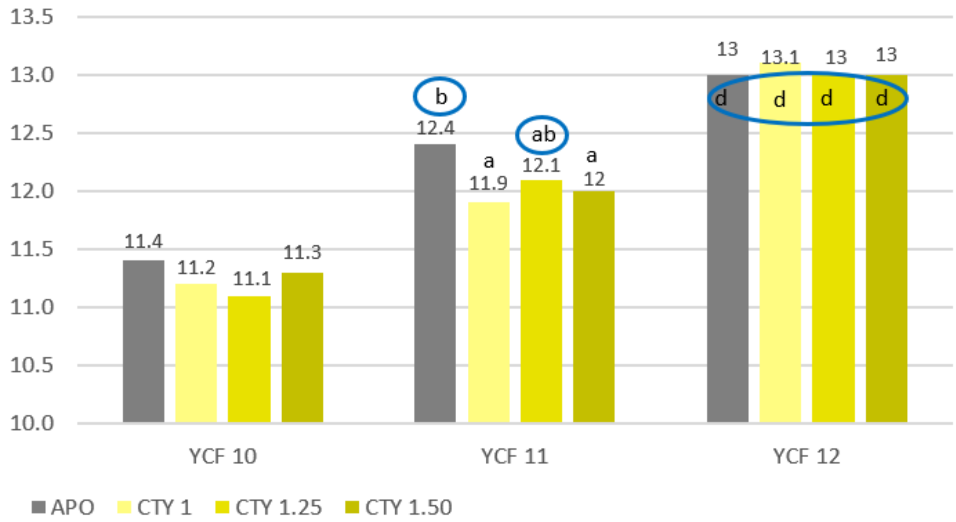

Figure 1. Egg yolk color values achieved by the use of apoester (APO) and different concentrations of Colortek Yellow (CTY)
** a, b, c, d: different superscripts mean statistical difference (P<0.05)*

Can lutein be as stable as synthetic pigments like apoester?

Another potential disadvantage of natural pigments is lower stability. By accelerating saponification in a continuous process, producing a product with low moisture and a high content of xanthophylls is possible. This process leads to higher stability of the product and prolongs the shelf life.

Trial 2: New generation pigment shows better stability than apoester

In this trial, the stability of products containing either a new generation natural colorant (Colortek Yellow) or apoester was tested. A vitamin-mineral premix containing 12.5 % choline chloride and one of the tested products were stored in closed bags at 30 °C and 75 % relative humidity. The recovery of the substances was tested after one, two, and three months.

The trial shows higher recovery rates for Colortek Yellow than for apoester at a longer storage time (Figure 2). This new technology, therefore, provides natural pigments with higher stability than products containing synthetic apoester.

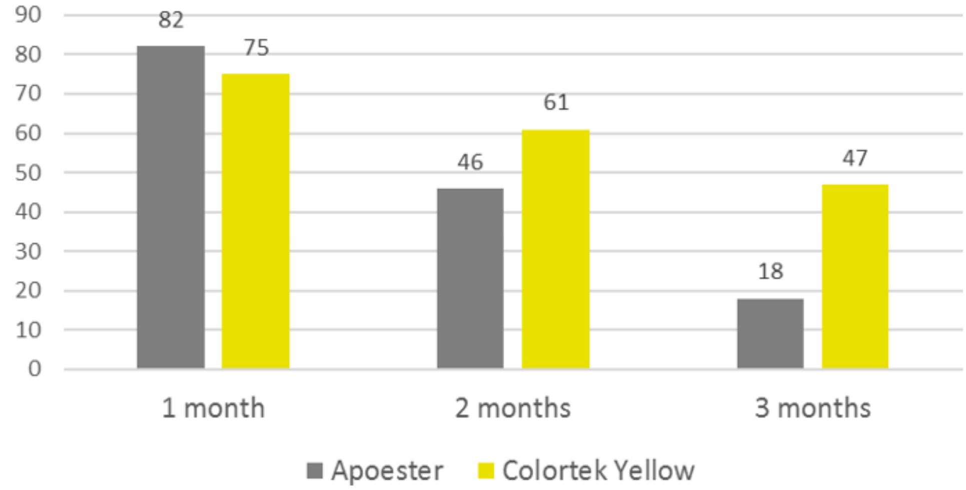

Figure 2. Recovery rates of apoester and Colortek Yellow after different times of storage (%)

New-generation natural pigments beat traditional synthetic options

The trend towards natural food ingredients also affects egg yolk color: consumers want natural alternatives to get their preferred yolk color, and regulators are imposing ever stricter limits on synthetic additives. Natural pigments have historically had two limiting characteristics compared to synthetic ones, their lower absorption and their lower stability. Due to new technologies, natural pigmentation products such as Colortek Yellow can now offer absorption rates comparable to apoester and even higher stability – making them the optimal replacement for synthetic colorants.

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The 3 critical factors for successful pigmentation

*By **Predrag Persak**, Regional Technical Manager, EW Nutrition*

We eat with our eyes. Depending on our cultural background and our experience, we prefer foods that have a certain appearance. Moreover, we regulate our taste and health

expectations based on this appearance. In that equation, color plays an essential role. Think of healthy-looking salad, fruit, eggs, meat, and more. Certain foods are more appetizing and appear healthier – and, in many cases, are indeed so – when they display a certain color.

For poultry producers, skin color and the yolk color of table eggs are of major concern. This concern is driven by the market (in certain regions, skin and yolk pigmentation heavily affect buying preferences), by regulations, and by an interest in using all options to increase product quality with natural solutions.

Where does poultry pigmentation come from?

Birds cannot synthesize pigments; they must take them up with their feed. Natural pigments have, besides their pigmenting properties, an antioxidant role in the bird's organism. Unfavorable conditions can heavily influence the outcome of pigmentation. For producers looking to achieve reliable and consistent coloration, results are often unpredictable and disappointing.

Knowing the factors that affect pigmentation will help us to better understand how to achieve the desired level of pigmentation – or to identify, in hindsight what went wrong and when. In general, three different factors are decisive for efficient pigmentation:

1. The quality of the product (type, content, and stability of the pigment)
2. The amount of pigment ingested/absorbed/deposited
3. The persistence of the pigment in the final product

1. Product quality is essential

The first point to be considered is the quality of the product you use, including type, content, and stability of the pigment in the product and the feed.

Content and quality of active substances determine efficacy

Concerning type and content, what matters more than the total amount of carotenoids is **the level of active substances**. The trans-isomers have higher efficiency than the cis-isomers and are decisive for pigmentation.

Natural pigments originate from natural sources that often vary due to growth conditions, harvest, and handling. Therefore, producers need to **control incoming materials** and **conduct proper formulation** during the production process. This is crucial in order to obtain an adequate level of pigments for appropriate pigmentation.

Adequate measures ensure the stability of the pigment in the product

Natural pigments are sensitive to light and air; they are easily oxidized. Also in the feed formulation there are many substances (e.g. oxidized forms of trace elements, choline, chloride) enhancing the oxidation of the pigments. Some precautions can be taken to protect natural pigments from oxidation:

- Use of adequate package materials preventing the exposure to light and air
- Use of antioxidants in the product as well as in the feed formulation

With these measures in place, the pigments are given adequate protection to ensure their stability.

2. Pigment intake, absorption, and deposition affect pigmentation

Every factor reducing the amount of pigment reaching its target deteriorates the quality of pigmentation. Below are the crucial factors producers need to take into account.

Feed intake is correlated to pigment intake

Assuming that the pigment is homogeneously distributed in the feed, feed intake directly determines the intake of pigment. Consequently, anything that affects feed intake also affects pigment intake and pigmentation. To that end, what is also decisive is particle size and homogeneous distribution of the pigment in the product.

The energy concentration in the feed is also a critical factor. Antinutrients, unpleasant taste, or inconsistent feed structure negatively influence feed intake.

Feed intake is also influenced by other elements:

- the animal's health status
- environmental conditions
- the availability of water
- the housing system (free-range, farm)
- feeding management factors (length of the feeding lines, separation of the feed in silo bins or through the feeding lines etc.).

Saponification plays a role in pigment absorption

Through saponification, the natural, esterified form of the pigment gets broken down and the pigment is separated from the fatty acid molecule. This step is necessary to enable the pigment to pass the intestinal wall. The higher the saponification, the better the bioavailability of the pigment.

Besides improving bioavailability, saponification also influences the particle size and the homogeneous distribution of the pigment particles in the product.

Some feed materials and nutrients influence pigment absorption

If pigments are used, it is essential to know that some feed materials or nutrients have a beneficial or adverse effect on the absorption or deposition of the pigments. **The inclusion of saturated, low-digestible fats or fat sources decreases pigment absorption and, therefore, the efficacy of pigmentation, whereas unsaturated fats (oils) facilitate it.** The addition of oil up to 5% linearly increases pigment deposition in the egg.

Nutrients such as Calcium or Vitamin A also change pigment absorption. In the case of calcium, the level and the source are decisive. High levels of fast soluble limestone or calcium levels higher than 4 % will decrease the absorption. Also, increased levels of Vitamin A are critical for the effectiveness of deposition, as Vitamin A and the pigment use the same transporters. This fact is very important in broilers if vitamin A addition is applied through the water.

Mycotoxins affect feed intake and absorption

The presence of mycotoxins in feed, especially DON, will reduce feed intake due to the bad taste. The gut health-impacting effect of the mycotoxins will increase the passage rate of the feed and will prevent adequate absorption through the intestinal wall. Additionally, the liver function is negatively impacted by the mycotoxins. This results in an affected serum transport and a lower storage capacity for the pigments, leading to lower deposition in the tissue.

Impacted gut health is bad for pigmentation, too

Good gut health is essential for good pigmentation, including the uptake/absorption of pigments, their deposition, but also already existing pigmentation. All health challenges that negatively affect digestion and absorption, such as dysbiosis, negatively influence pigment availability and pigmentation. In such cases, products or strategies improving digestibility and gut integrity can be a solution.

Specific diseases such as NCD, Coryza, *helminthiasis*, as well as coccidiosis are an important consideration. The first three diseases lower pigment deposition; coccidiosis, however, has multiple impacts. It not only affects digestion and absorption and, therefore, the ongoing pigmentation but also decreases the already existing one.

Coccidia cause damage to the intestinal wall and affect its activity, resulting in a lower absorption. Additionally, the animals lose weight due to an insufficient supply of energy. The consequence is a degradation of fat tissue where the pigments are stored. Furthermore, coccidiosis means oxidative stress for the animal – triggering a reaction of the organism. As pigments also serve as antioxidants, they are removed from the fatty tissues and used as antioxidants.

Within three days post-infection, pigment levels in the subcutaneous tissues, but also in the serum and the liver, drop to 0. Coccidiosis outbreaks occur more frequently in alternative housing systems, affecting broilers, but also laying hens. Paying close attention to coccidiosis and having a proper anticoccidial program in place is obligatory for good pigmentation.

3. Pigmentation ends when the final products are on the shelf

For the end consumer, an attractive color in the final products (such as pasta or the broiler carcass) is essential. Producers of these final products request to put more pigments into the feed, but is this always the solution? As described before, there are a lot of factors possibly impacting the process of pigmentation during animal production on the farm.

However, also in the pasta factory or in the slaughterhouse, pigmentation of the final products can be impacted. In the pasta factory, oxidizing enzymes can destroy the pigments making the pasta pale and unattractive. If they have issues with *Salmonella* in the slaughterhouse, the birds may be scalded in slightly hotter water. The defeathering afterward can cause the loss of the upper layer of the skin with the pigments.

These examples show why pigmentation is not just the responsibility of the animal producer, but rather continues up to the moment when the pasta or meat is ready for the consumer.

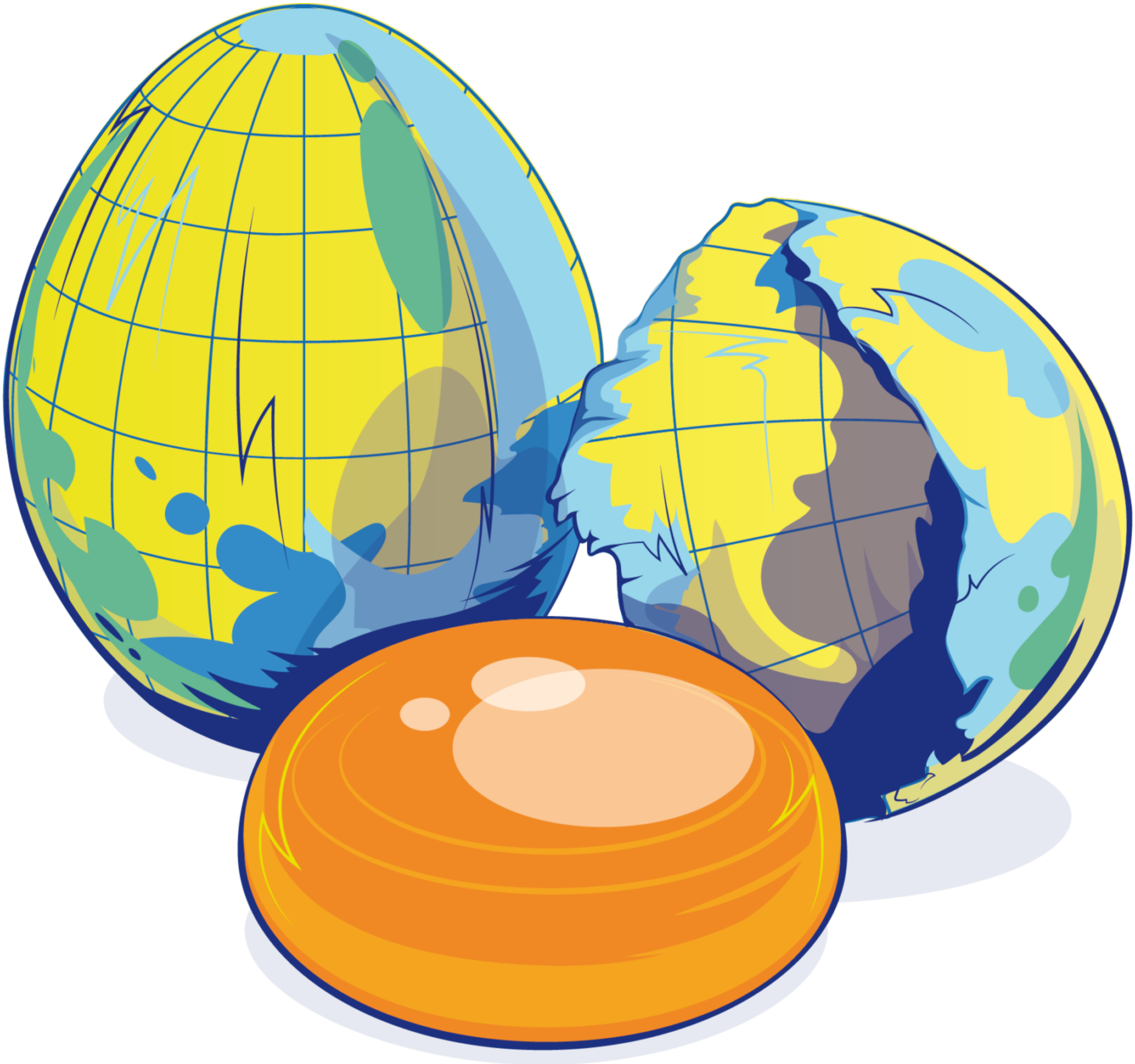
Control these 3 factors for best pigmentation results

Pigmentation is a dynamic process that requires knowledge and attention. The better we control the influences, the more consistent and predictable the outcome. To that end, it is essential to use the product with the best quality, the best amount of pigment that can be not just ingested, but also absorbed and deposited, and with the best persistence in the final product and along its shelf life.

Keeping everything under control is not always possible or is extremely difficult. That is why choosing the right product is a vital link that will allow us to pay more attention to those things that we can find difficult to manage.

To meet all these demands, Colortek Yellow B is the best natural yellow pigment on the market. This highly concentrated natural yellow evidences optimal flowability, homogeneous mixing in feed and high stabilit, for reliable and consistent results. In addition, it boasts high bioavailability and is produced in the EU in a state-of-the art facility, with FAMI-QS certification and strict control of undesirable substances.

Reducing apo-esters: What are the alternatives?



By Technical Team, EW Nutrition

A year ago, the European Commission announced regulation (EU) 2020/1400 – restricting the use of ethyl ester of β-apo-8'-carotenoic acid (generally known as 'apo-ester'). Starting on 26 October 2021, this legislation restricts the use of apo-ester in poultry feed to 5 mg/kg for laying hens and 15 mg/kg for broilers.

As apo-esters is a synthetic pigment – not naturally occurring in nature – this measure was taken because the authorities could not guarantee safety upon exposure to the user. Limiting the concentration in feed would reduce this risk to acceptable levels, according to the legislators' decision.

Why use apo-esters in the first place?

Apo-ester is a synthetic yellow colorant, with good stability in premixtures and complete feed. It also has a high deposition rate in the yolk, making it an effective egg yolk colorant.

Its ability to be applied through premix facilitates the proper dispersion in the final feed, which is relevant if micro-dosing systems are lacking in the feed mill.

Why was the legislative change necessary?

The legislative change which limits the use of synthetic apo-ester is based on the precautionary principle and in line with a broader market trend: away from synthetic (non-natural) components, towards the use of naturally occurring alternatives.

The alternative to apo-ester

Natural yellow pigments, typically based on lutein and zeaxanthin produced from marigold oleoresin, are available in the market and can be used to reach the egg yolk pigmentation desired by the consumer. In contrast to apo-ester, these natural solutions are functional antioxidants, further contributing to the egg's nutritious composition.

Challenges for natural alternatives

However, stability in premixtures and complete feed can be a challenge, with inconsistent yolk coloration as a risk. Safety can also be an issue, so it is important to ask for Quality Control measures routinely applied to avoid contamination with undesired substances (e.g., dioxins). To limit the risk of producing eggs with insufficient yolk coloration, it is important to select natural pigments with excellent stability and deposition efficiency.

What is the best natural alternative to apo-ester?

EW Nutrition's natural pigment Colortek® Yellow B, produced with a proprietary technology, withstands the harsh conditions in premixtures, while the unique saponification process provides unparalleled deposition rates.

Moreover, Colortek® Yellow B is the most concentrated natural pigment on the market, making it the perfect premix-delivered colorant in the egg industry. If you want to produce all-natural eggs without worrying about the stability of the product or the reliability of your egg coloration, please contact your local EW Nutrition person.

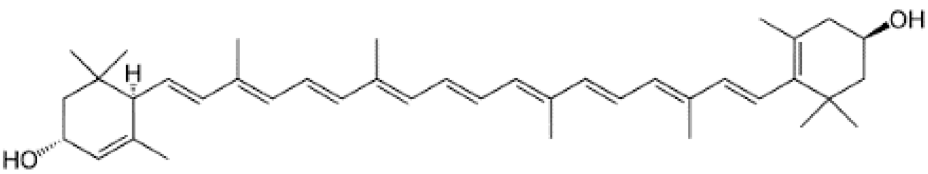
All-rounder lutein supports animals and humans

by Inge Heinzl, Editor, EW Nutrition

Lutein is a lipid-soluble pigment that can be found naturally in algae and plants. There, it is a component of the light-collecting complexes in the chloroplasts.

For example, kale contains a relatively high concentration of up to 0.25mg lutein per g wet weight. For industrial purposes, however, lutein is extracted from the petals of marigold; they contain up to 8.5mg/g wet weight.

In the animal organism, lutein occurs in the egg yolk, in milk, or the macula lutea ("yellow spot") of the animal/human eye. However, animals and humans cannot synthesize it.



Lutein belongs to the group of carotenoids, which is divided into carotenes and xanthophylls. Lutein, chemically expressed as "3,3'-dihydroxy-α-carotene", is a xanthophyll always accompanied by its isomer zeaxanthin. It is synthesized out of two α-carotenes through hydroxylation.

Lutein provides benefits for animals and humans

Due to its beneficial characteristics, lutein is an essential ingredient of plants and is used in animal nutrition as well as in human medicine.

Lutein has antioxidant protective properties

Under normal conditions, the cells in the animal and human organism control ROS (reactive oxygen species) levels. Usually, there is a balance between the generation of ROS and their elimination by scavenging systems. However, the high performance levels in modern animal production can easily lead to high ROS levels, translated into oxidative stress and leading to cell damage. Cell damage contributes to the generation of cancer and early aging in humans. In animals, the negative impact of oxidative stress can be responsible for lower performance and inferiority of meat and eggs.

Antioxidants stop ROS by taking up their energy

Through the uptake of energy, molecules can get into an excited state. One example is singlet excited oxygen, a highly reactive form of oxygen able to destroy proteins, lipids, and DNA. Carotenoids can intervene in this process: by exchanging electrons, the singlet excited oxygen gets neutralized, and the carotenoid gets into this excited state with higher energy. Once able to release this energy as heat into the environment, the carotenoid gets back to its normal state and can once again start acting as an antioxidant.

In this way, carotenoids, including lutein, ‘quench’ the energy of excited molecules and prevent the adverse effects of ROS (reactive oxidative substances).

Antioxidant properties profitably used

The antioxidant character of lutein plays an important role in the treatment or prophylaxis of macular degeneration in humans (Landrum & Bone, 2001). There is also evidence that lutein can be used to improve the visual and retinal function in dogs (Wang et al., 2016). In the eye, lutein and zeaxanthin, occurring in the retina and the macula, neutralize free radicals produced due to the ultraviolet light and thereby prevent damage to the macula.

Further possible applications are against cardiovascular diseases (Dwyer et al., 2001) and various types of cancer (e.g., breast cancer, Gong et al., 2018).

Lutein is important in infant nutrition

Lutein and its isomer zeaxanthin are the two primary carotenoids found in human milk (Giordano and Quadro, 2018). Stringham and co-workers (2019) postulate that lutein plays an important role in children's visual and cognitive development/optimization. They report that a lutein supplementation of the mother can lead to a higher concentration of this substance in the milk and, consequently, in the child's plasma (Sherry et al., 2014). In dairy cows, an increased level of lutein in the milk can also be observed (Xu et al., 2014), suggesting that lutein could also be essential in calf development.

Lutein stimulates the immune system

Another benefit of lutein is its positive influence on the immune system.

On the one hand, lutein stimulates the production of antibodies. In dogs, Guimarães Alarça et al. (2016) could show an increase of CD4+ and CD8+ T-lymphocyte subtypes. Kim et al. (2000) demonstrated the increase of lymphocytes and cells expressing CD5, CD4, CD8, and major histocompatibility complex class II (MHC II) molecules. Bédécarrats and Leeson (2006) provoked a higher secondary antibody response to infectious bronchitis vaccination in laying hens.

Besides, lutein acts as an anti-inflammatory agent, as shown in vitro by Chao et al. (2015) and in broiler chickens by Moraes and team (2016).

Lutein improves the attractivity of poultry products

In the marketing of poultry products, appearance and color are of central importance for evaluating quality. Egg yolk coloration is to a large extent a matter of regional preferences, however it is clear that an egg with a yolk that does not have the typical color is classified as inferior by the consumer. In areas with traditional corn growing, a white-skinned chicken is not commercially viable. Even when pullets are bought, the shanks and beaks should be yellow.

The use of xanthophylls like lutein and zeaxanthin enables producers to safely control the color of the egg yolk and of the broiler skin. It also leads to a healthy color of the shanks and beaks of the birds.

Lutein in a nutshell

Lutein is a true all-rounder: a substance that delivers benefits across the board. In plants, it helps fruits and petals become attractive for insects and other animals. It positively influences the animal, acting as an antioxidant, promoting infant development, and stimulating the immune system. As a pigment, it makes poultry and poultry products look more attractive to the consumer. Through its presence in eggs and milk, lutein provides clear and clean benefits to both animals and humans.

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