Improved emulsification contributes to pigmentation

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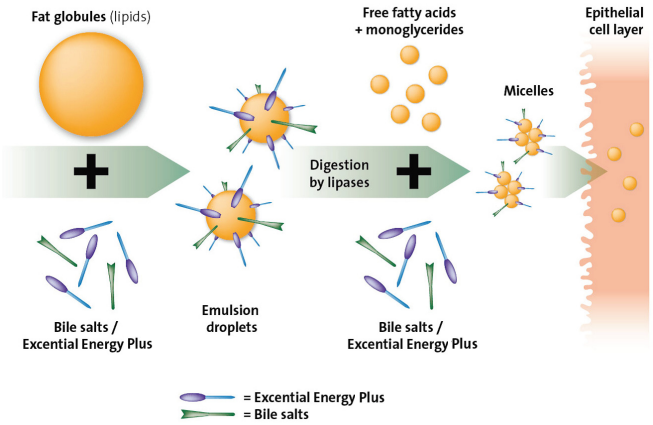
One of the most important parameters affecting consumer's choice is the appearance of animal products. To improve consumer's acceptance of eggs and broiler meat, pigments are supplemented to broiler and layer feed. This is to complement the low natural levels available in feed ingredients. Unfortunately, these supplemented pigments can be expensive and their absorption suboptimal. Also, recent EU legislation will come into force later this year reducing the maximum allowed inclusion of these compounds. Luckily, their fat-solubility provides an opportunity. Nutritional emulsifiers are feed additives able to increase fat digestibility, both significantly and economically. Whilst improving the energy uptake and metabolization, the activity of a nutritional emulsifier also increases, indirectly, the uptake of these fat-soluble pigments. It is worthwhile investigating this effect of nutritional emulsifiers in more detail.

Mode of action

An emulsifier is a molecule with a water-soluble (hydrophilic) part and a fat-soluble (lipophilic) part. The combination of these two components in one molecule gives it a unique property. The emulsifier can dissolve in fat as well as in water and can aid in mixing these two factions. In the animal, fat digestion occurs in a few steps (Figure 1). Initially, large fat globules are emulsified in the watery environment of the gut. Normally, fat and water do not mix, and therefore, bile salts assist in this mixing process as natural emulsifiers. Smaller fat droplets are formed and increase the contact surface for the lipase enzyme. This enzyme, produced by the pancreas, breaks down fat. The next step is the formation of micelles. Micelles are water-soluble aggregates of lipid molecules (e.g. carotenoids) containing both polar and non-polar groups. When micelles come into contact with the micro villous membrane, they are disrupted and the fatty acids are absorbed by the lipophilic cell membrane. Bile salts and monoglycerides aid as natural emulsifiers in the formation of micelles. Nevertheless, the capacity of these natural emulsifiers can be a limiting factor for fat digestion. Nutritional emulsifiers can therefore assist in improving fat digestibility and energy efficiency. Results show that a nutritional emulsifier is able to increase crude fat digestibility by 2.81% on average. Its positive effect will be more pronounced at higher fat levels. Even with highly digestible fats (e.g. soybean oil) significant effects are shown.

Figure 1: Fat digestion in 3 steps: (1) formation of small emulsion droplets, (2) hydrolysis by lipase, and (3) formation of micelles and uptake in epithelial cell layer. Emulsifiers (bile salts and nutritional emulsifier, Excential Energy Plus) aid in the fat digestion process



Effect on egg yolk

Orffa investigated the effect of a specific nutritional emulsifier (Excential Energy Plus, Orffa Additives BV, The Netherlands) in laying hen diets. A corn-based diet without canthaxanthin was used as a control diet. Two dietary treatments with canthaxanthin were formulated , with or without the nutritional emulsifier. After two weeks of adaptation, eggs were collected for one week. Egg yolk was

analysed on CIE (Commission Internationale de l'Eclairage) laboratory parameters (Table 1). Lowest L-value (brightness) was obtained when laying hens were fed the nutritional emulsifier supplemented diet. Significantly higher levels for a (redness) and C (saturation) were achieved when the nutritional emulsifier was supplemented. It can be concluded from this trial that combining the nutritional emulsifier with canthaxanthin increased the pigmentation of the egg yolk. Subsequent practical trials in broilers proved the tendency of the nutritional emulsifier to improve skin pigmentation. Based on these findings a patent was granted.

Table 1: Effect of a nutritional emulsifier on egg yolk pigmentation ($p < 0.05$)

	Control	Control + Canthaxanthin	Control + Canthaxanthin + Nutritional Emulsifier
L-value (brightness)	$64.82^{a} \pm 0.28$	$58.68^{b} \pm 0.34$	$56.81^{c} \pm 0.37$
a (redness)	$10.98^{c} \pm 0.20$	$25.50^{b} \pm 0.34$	$27.32^{a} \pm 0.29$
b (yellowness)	$63.19^{a} \pm 0.72$	$57.20^{b} \pm 0.49$	$61.18^{a} \pm 0.63$
C (saturation)	$64.14^{b} \pm 0.73$	$62.64^{b} \pm 0.52$	$67.01^{a} \pm 0.66$
Hue angle	$80.14^{a} \pm 0.15$	$65.97^{b} \pm 0.27$	$65.92^{b} \pm 0.18$

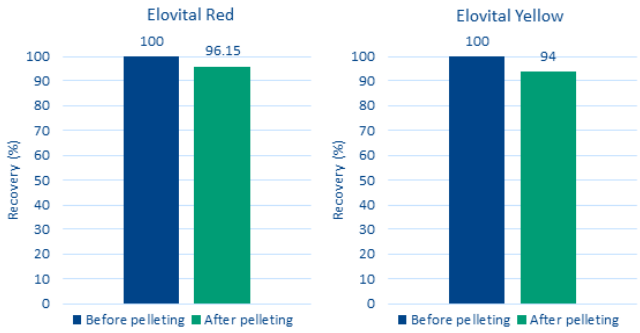
Table 2. Effect Elovital Red on egg yolk colour analyzed with the Roche colour fan ($p < 0.001$)

Treatment	Product	Dosage (ppm)	Calculated Roche colour fan
Control	-	-	8.2c
2	ELOVITAL RED	3.5	13.9a
3	Competitor	3.5	13.0b

Stable and high quality pigments are essential for required coloration

Supplementation of pigments to diets is crucial to obtain consumer's preferred egg yolk and broiler meat colour, as animals cannot synthesize pigments themselves. However, for a controlled and uniform colouring of animal products, a high quality and stable pigment is essential. Natural pigments, like carotenoids, are largely used but have a poor stability and are highly sensitive to oxidants (e.g. oxygen), heat and humidity. The synthesized pigments, Elovital Red (10% canthaxanthin) and Elovital Yellow (10% apocarotenoic ester) (Orffa Additives BV, The Netherlands), have a high stability during storage as pure product, in premixes, and after pelleting (Figure 2). The spherical form of the granulates ensures an equal distribution of the pigment within the feed, contributing to a homogeneous mixture. These features of Elovital Red and Elovital Yellow enhance bioavailability and assure efficacy of the pigments (Table 2).

Figure 2: Stability of Elovital Red and Elovital Yellow after pelleting at 85°C



Conclusion

Nutritional emulsifiers provide an economically interesting way to improve the pigmentation of animal products. Their efficiency in improving fat digestion enables an increased absorption of fat-soluble pigments and their subsequent deposition in target tissues. Further research should be executed regarding other fat-soluble compounds, such as certain vitamins, and their absorption.