Yolk colour – an important egg quality attribute

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There is no doubt that colour plays a very important role in our perception of food.

Bright, fresh, typical colours stimulate the appetite and enhance our enjoyment of food whereas, if the colour of a food deviates from what we expect, then it is likely that we will reject it in favour of an alternative.

Therefore, colour is a key aspect of food quality that should not be underestimated.

It is well recognised that yolk colour is important to consumers. Recent surveys in a number of different European countries (France, Germany, Italy, UK, Spain, Poland and Greece) have confirmed that yolk colour is one of the main parameters by which the quality of eggs is judged.

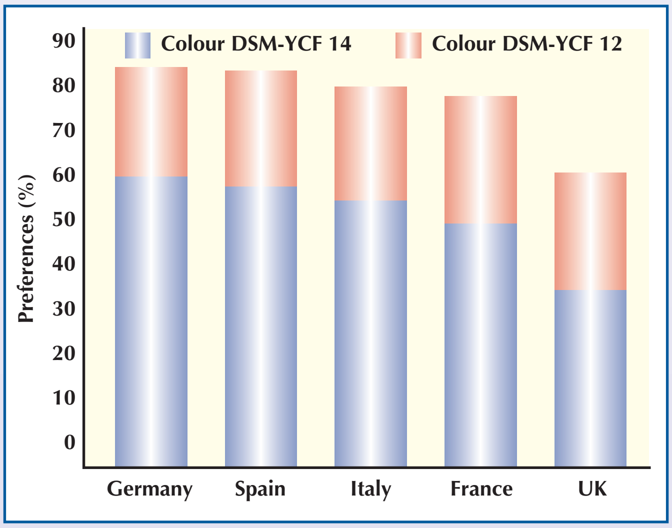
Although consumer perception as to what constitutes a good, appetising egg yolk colour is generally linked to geographical location, culture and traditions, it is certainly true that consumers in most parts of the world prefer deeply hued yolks.

In this regard, it is interesting to note that, when presented with samples of eggs with yolk colours corresponding to Colour Fan scores of 8, 10, 12 and 14, most of the consumers questioned in the European surveys expressed a preference for the darkest colours (see Fig. 1).

They also believed it important that all eggs in a package or bought at the same time have the same or similar yolk colour, considering homogeneity among eggs an indication of consistent good quality.

Therefore, given the preferences expressed by consumers regarding yolk colour and egg quality in general, it is important that the industry produces eggs that reliably and consistently meet their expectations.

Fig. 1. Criteria for a quality egg yolk.



Measurement of yolk colour

The Roche Yolk Colour Fan (RYCF) is widely accepted throughout the food chain as the standard for measuring yolk colour on a routine and reliable basis.

Each fan blade contains a colour that has been measured objectively and can thus be reproduced in the yolk. By using the fan to define the desired yolk colour and by formulating the hens' feed accordingly, the target yolk colour can not only be achieved but also reproduced consistently.

In 2003, Roche Vitamins became DSM Nutritional Products and as part of the ongoing process to update our services to reflect our new DSM identity, the RYCF will be replaced by the new DSM Yolk Colour Fan (DSM-YCF).

This change will have no influence on how the fan is used as the format (the number and colour of fan blades) of the new DSM-YCF remains identical to that of the RYCF it replaces.

The DSM Yolk Colour Fan.

Producing the required colour

As with all birds, yolk colour is primarily determined in the laying hen by the content and profile of pigmenting carotenoids present in the feed.

Thus, once a particular yolk colour target or DSM-YCF score has been defined, it is a relatively straightforward process to control, via feed specification/formulation, the carotenoid content in the feed required to achieve that target.

Carotenoids can be included in the diet by the use of particular raw materials, for example maize or grass meal, and/or the addition of specific feed additives.

Thus, the nutritionist can determine, based on local raw material cost/availability and target yolk colour, the most cost effective approach to be taken to produce eggs of the required colour to meet the quality criteria of the market chain.

The development of yolk colour can be viewed as a two phase process. The first phase ('saturation') is the setting of a good yellow base by the deposition of yellow carotenoids and the second phase ('colour') is the addition of a red carotenoid to tone the colour to the golden-yellow.

There are three main yellow carotenoids (lutein, zeaxanthin and apo-ester) and three main red carotenoids (canthaxanthin, citranaxanthin and capsanthin/capsorubin) used for egg yolk pigmentation, each having unique properties (for example colour hue and deposition efficiency – the proportion (%) of the dietary intake that is absorbed and deposited in the egg yolk) which determine its' pigmenting efficiency.

The primary criterion for yellow carotenoids is the provision of a strong yellow base which is important for the development of a good final colour.

A poor base can result in problems such as 'off' colours (too reddish or even pink) and high colour variability.

As such, the most important characteristic of the yellow carotenoids during the saturation phase is their deposition efficiency which for apo-ester (~40-50%) is approximately three

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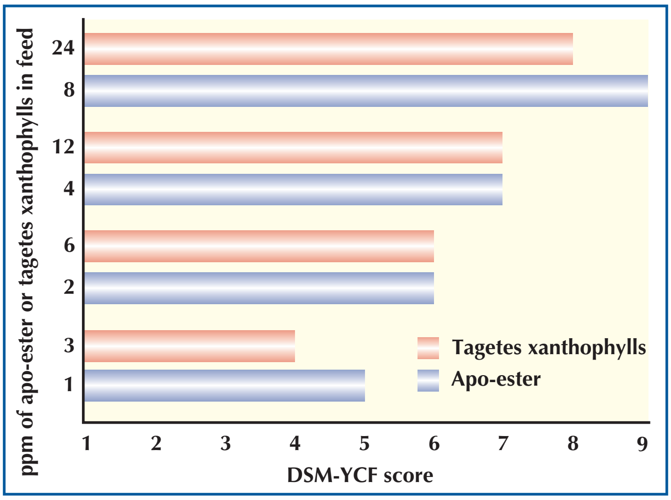

Fig. 2. Pigmenting efficiency of apo-ester and tagetes xanthophylls in the egg yolk.

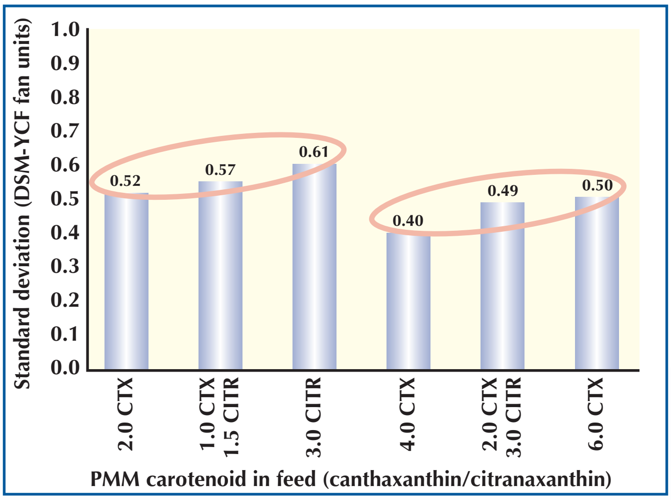

Fig. 3. Yolk colour homogeneity when using different canthaxanthin/citranaxanthin blends in layer feed.

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times that of either lutein or zeaxanthin (~10-20%).

Thus, three times more lutein/zeaxanthin than apo-ester is required in the feed to provide the same degree of yellow pigmentation in the egg yolk as can be seen in the data outlined in Fig. 2.

In this trial apo-ester and tagetes xanthophylls (90% lutein: 10% zeaxanthin) were included in layer feeds at various inclusion rates and the resultant yolk colours measured.

At each dose rate of apo-ester, three times more tagetes xanthophylls were required in the feed to achieve the same colour in the yolk.

Importance of carotenoids

As the red carotenoids are primarily responsible for the development of the golden yellow colour from the yellow base in the yolk, then both the deposition efficiency and the colour properties of the individual carotenoids are important.

The deposition efficiency of canthaxanthin is substantially higher than those of either citranaxanthin or capsanthin/capsorubin.

Figures of 39, 17 and <9% respectively have been reported in the literature.

Canthaxanthin is a reddish-orange colour, whereas citranaxanthin and capsanthin/capsorubin both have deep red colours.

Thus, when the deposition efficiency and colour properties of the different red carotenoids are translated into relative pigmenting efficiencies, 1.5 times more citranaxanthin than canthaxanthin and 2.5 times more capsanthin/capsorubin than canthaxanthin would be required in the feed to achieve the same degree of red pigmentation in the egg yolk as can be seen in the data outlined in Figs. 3 and 4.

Huyghebaert fed laying hens with diets containing either canthaxanthin alone (2 or 4 ppm) or with a partial (50%) or total replacement with citranaxanthin.

Results of the trial confirmed once more the relative pigmenting efficiency of the two carotenoids as 1.5:1 and also showed that those diets containing a higher proportion of canthaxanthin produced a more homogenous yolk colour (Fig. 3).

Blanch and Hernandez (Fig. 4) reported data from a trial in which laying hens were fed diets containing a range of different levels of either canthaxanthin or capsanthin/capsorubin ranging from 0.5-8ppm.

For each carotenoid, a dose response curve for yolk colour was determined and the levels in feed required to achieve DSM-YCF scores of 10-15 were calculated. The relative pigmenting efficiency for capsanthin/capsorubin: canthaxanthin was then determined for each yolk score and found to be in the range 2.6-2.8: 1.

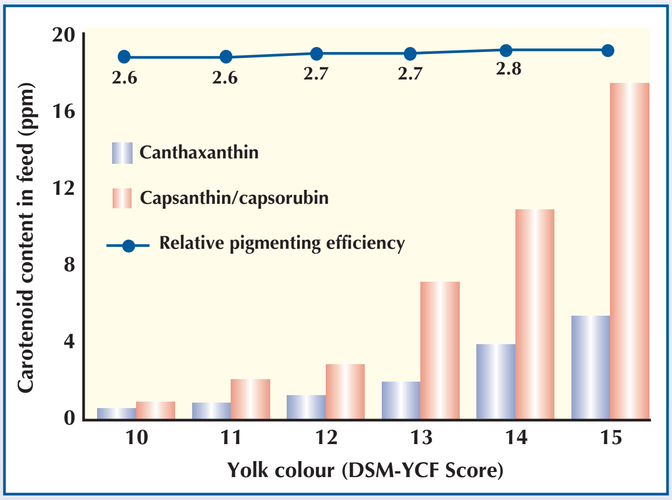
However, it is important to note that the data outlined above refers primarily to the comparative pigmentation characteristics of the different yellow and red carotenoids per se.

It does not take into account other factors such as those relating to the product form or raw material in which they are used (for example stability, bio-availability, content, consistency) which should also be considered when comparing/substituting different carotenoid sources as these can ultimately affect the amount of a particular carotenoid a bird finally receives.

A simple method of evaluating different carotenoid programmes, taking into account the factors mentioned above, is provided by the DSM Yolk Colour Optimiser (DSM-YCO) spreadsheet, which was formerly known as the Roche Yolk Colour Optimiser (RYCO).

This practical tool allows the user to quickly evaluate alternative pigmenting formulae, optimise feed levels and identify potential cost savings in order to produce consistently, the required yolk colour in the most cost efficient way.

Fig. 4. Relative pigmenting efficiency between canthaxanthin and capsanthin/capsorubin.



Summary

It is clear that yolk colour is one of the main criteria by which consumers judge the quality of eggs.

By using the DSM Yolk Colour Fan to define and subsequently measure the desired yolk colour and by formulating the hens' feed accordingly, taking into account the differences between the various carotenoid sources available, a target yolk colour that meets the customers requirement can not only be achieved but also reproduced consistently, thus giving the consumer the quality egg they desire. ■

References are available from the author on request