Evaluation of Egg Yolk Colour

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Abstract

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We compare visual evaluation of yolk colour estimated by the usual method applying La Roche scale with spectrophotometric determination of β-carotene by AOAC method, and by new rapid analyser iCheck^{TM} Egg photometr (Bio Analyt). The eggs under consideration were purchased on a current Czech market. The eggs originated from various countries and various types of breeding including some specialities. The yolk colour varied between the values of 4–13 of La Roche scale. The carotenoid content expressed as β-carotene measured by AOAC method varied between 11–87 mg/kg. The carotenoid content expressed as β-carotene measured with the analyser iCheck^{TM} Egg photometr was lower and varied between 7.5–68.5 mg/kg. The correlation between the colour hue measured visually and the carotenoid content was not proved. Slovak eggs from cages which contained 28.3 mg carotenoids in 1 kg of yolk had the darkest yolks (value 13), Czech bio eggs which contained 20.2 mg carotenoids in 1 kg of yolk had the palest yolks (value 6). The highest content of carotenoids was found in eggs from home hen breeding (72.5 mg carotenoids in 1 kg of yolk) whose colour hue had the value of 10.

Keywords: carotenoid determination; analyser iCheckTM Egg photometr; senzory visual evaluation

Colour plays a very important role in our perception of food. Colour is also a key aspect of the food quality. The most often used instrument for the colour evaluation is the sensory analysis. With regard to the sensory characteristics, the results of surveys performed over the last 10 years in a number of European countries indicate that consumers value a number of tangible characteristics of the egg, most especially the shell strength, albumen consistency, and yolk colour (Hernandez *et al*. 2005). Although consumer perception of egg yolk colour is generally linked to the geographical location, culture and traditions, it is true that consumers in most parts of the world prefer deeply hued yolks (Beardsworth *et al*. 2004).

Yolk colour in laying hens is primarily determined by the content and profile of pigmenting carotenoids present in their feed and can easily be adapted via feed ingredients (Hernandez *et al*. 2005).

Carotenoids are yellow, orange, and red pigments soluble in fats. Carotenoids are divided into two main groups – carotenes and xanthophylles (Velíšek & Hajšlová 2009). Xanthophylles like lutein and zeaxanthin have the greatest influence on the yolk colour. Beta carotene as a representative of carotenes is present only in small amount (Simeonovová *et al*. 2003). Each pigment has unique properties, e.g. colour hue and deposition efficiency. The proportion of the dietary intake of carotenoids that are absorbed and deposited in the egg yolk determines its real colour varying from pale yellow to dark orange (Beardsworth *et al*. 2004).

The egg producers need some simple method for egg yolk colour evaluation to meet the demands of consumers. The new rapid analyser iCheck™ Egg photometr (Bio Analyt GmbH, Teltow, Germany) was developed for this reason. The aim of this work was to compare the commonly used visual evaluation of the yolk colour by La Roche scale with spectrophotometric determination of β-carotene by AOAC method and with new rapid measurement by the analyser iCheck^{TM} Egg photometr, and to give the

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recommendation to the egg producers about which method is the most convenient for egg yolk colour evaluation with respect to the consumer.

MATERIAL AND METHODS

The eggs under consideration were purchased on current Czech market. The eggs have originated from various countries and from various types of breeding including some specialities. Most of eggs originated from the Czech Republic (CZ) and Slovakia (SK), the other ones originated from Poland (PL), Spain (ES), and Hungary (HU). The breeding types are indicated by numerical codes used in shell eggs marking (Commission Regulation (EC) No 589/2008) as follows: 0 – organic production; 1 – free range eggs; 2 – barn eggs; 3 – eggs from caged hens. The names of egg specialities such as omega (3 CZ), cereal (3 CZ), farmer (1 CZ), extra yellow (2 SK), wellness (1 SK), and grandmother (2 SK) accord with the trade names used in retail, the eggs for production were eggs used by egg manufacturer for egg product production, and home produced eggs originated from small breeders.

For all the evaluation, six eggs randomly selected from retail packing were used.

The egg yolk colour was evaluated visually by means of the usual La Roche scale (today also named as DSM Yolk Colour Fan) (Figure 1).

The content of carotenoids was measured with Varian Cary 100 Bio UV-Vis Spectrophotometer (BioAnalyt GmbH, Teltow, Germany).

The content of carotenoids was measured also with iCheck^{TM} Egg photometr and set iEx^{TM} Egg – Rapid Extraction Kit (BioAnalyt GmbH, Teltow, Germany).

The content of carotenoids expressed as β-carotene was determined by modified AOAC spectrophotometric method (Latimer 2007).

2 g of egg yolk
↓
+ 7 × 3 ml acetone (sequential extraction)
↓
centrifugation (6000 rpm, 2 min)
↓
filtration (dense filter paper)
↓
measurement of absorbance at 450 nm
↓
subtraction of β-carotene content (calibration curve)

The content of carotenoids expressed as β-carotene was determined also by the new rapid method for the determination of total carotenoid concentration in egg yolk with iCheck^{TM} Egg photometr and set iEx^{TM} Egg – Rapid Extraction Kit (BioAnalyt 2011).

0.1–0.8 g of egg yolk
↓
+ buffer (to total weight 2 g)
↓
400 μl of sample (→ extraction vial)
↓
extraction of carotenoids,
sedimentation of coagulate (5 min)
↓
measurement of absorbance at 450 nm
calculation of beta carotene content by apparatus

RESULTS AND DISCUSSION

In the evaluation of egg yolk colour visually by the usual La Roche scale, the least intensive colour was found in the bio eggs which on the contrary, the most intensive colour was found in some special varieties of eggs, e.g. extra yellow eggs or free range farmer eggs (Figure 2). The colour of the egg yolk varied between the values of 4–13 of La Roche scale. This method is widely spread in common practise as a simple method for the egg yolk quality assessment. Marked differences exist in the preference of egg yolk colour hue between the consumers in various European countries. Consumers in Germany, Netherlands, Spain, and Belgium prefer yolks with the values of 13–14 of La Roche scale, in France, south England, and Finland with the value of 11–12 of La Roche scale, and in Ireland, north England, and Sweden with the value of 8–9 of La Roche scale (DSM 2011).

The carotenoid content expressed as β-carotene measured by AOAC method varied between 11 to 87 mg/kg, mostly between 20–30 mg/kg (Figure 3A). A particularly high content of carotenoids was found in the eggs from home hen breeding (72.5 mg carotenoids in 1 kg of yolk) whose colour hue however, had visually only the value of 10. The carotenoid content expressed as β-carotene measured by AOAC method is not directly proportional to the visual colour hue.

Figure 1. La Roche scale

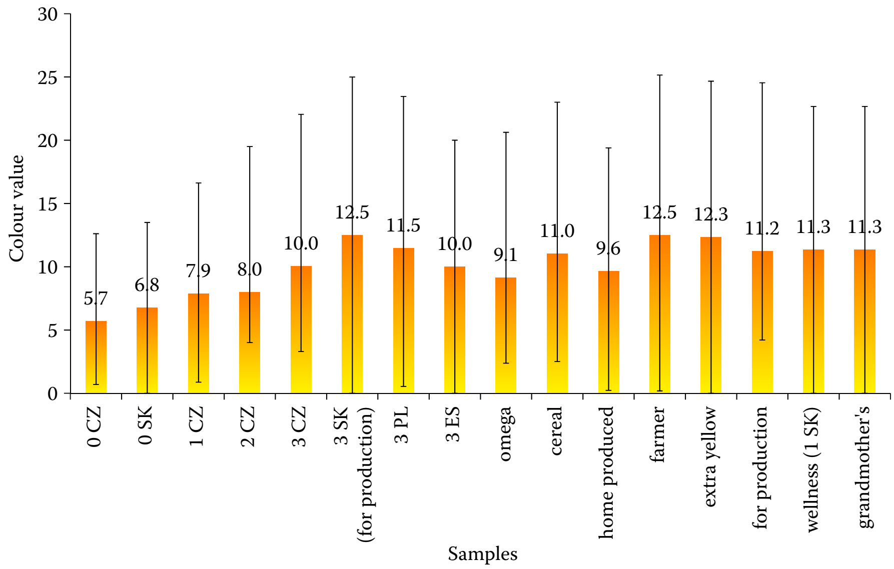

Figure 2. Egg yolk colour evaluated visually by the usual La Roche scale

The colour hue depends on the carotenoids composition which can be diversified. Carotenoids have three characteristic absorption maxima in UV and visible spectra (Table 1) which are used for their identification and quantification. Most of carotenoids have the main peak of absorption spectra at λ_{max} 450 nm like β-carotene. Red carotenoids which are primarily responsible for the deep golden orange colour have the main peak of absorption spectra at a higher wave length. Because the carotenoid content measured by AOAC method is determined only at λ_{max} 450 nm corresponding to β-carotene, the red carotenoids with

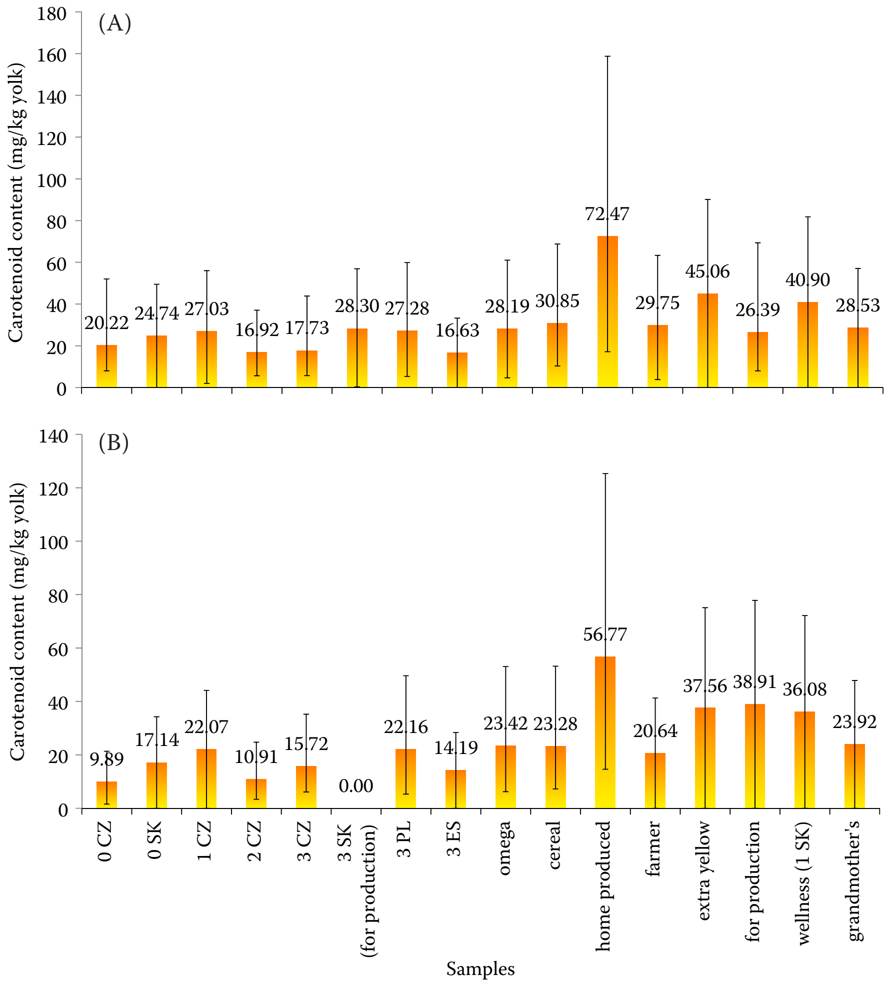

Figure 3. Egg yolk carotenoid content expressed as β-carotene determined by (A) the modified AOAC spectrophotometric method and (B) new rapid method for the determination of total carotenoid concentration in egg yolk with iCheck^{TM} Egg photometer and set iEx^{TM} Egg – Rapid Extraction Kit

Table 1. Ultraviolet and visible absorption data for some carotenoids present in egg yolk (Rodrigez-Amaya 2001)

Carotenoid	λ_{max} (in ethanol)			λ_{max} (in acetone)		
β-carotene	425	450	478	429	452	478
Lutein	422	445	474			
Zeaxanthin	428	450	478	430	452	479
Lycopene	446	472	503	448	474	505
Astaxanthin	–	478	–	–	480	–
Cantaxanthin	–	474	–			

higher wave lengths are not completely included in these results. In comparison with the visual evaluation, the higher content of carotenoids in some cases is not conform with the higher intensity of the colour hue (Figure 4).

The rapid method of the carotenoid content determination with the analyser iCheck™ Egg photometr works on the same principle like AOAC method but yields lower results (Figure 3B) relating to the less efficient extraction. The carotenoid content expressed as β-carotene measured with the analyser iCheck™ Egg photometer varied between 7.5–68.5 mg/kg.

The influence of the breeding type and country of origin on the total carotenoid content (expressed as β-carotene) was also studied. The lowest carotenoid content from all the eggs analysed was found in the bio eggs while the highest one was found in the eggs from home hen breeding (Figure 4A5). The total carotenoid content varied in the eggs coming from various countries that are obtainable on the Czech market. High carotenoid contents were

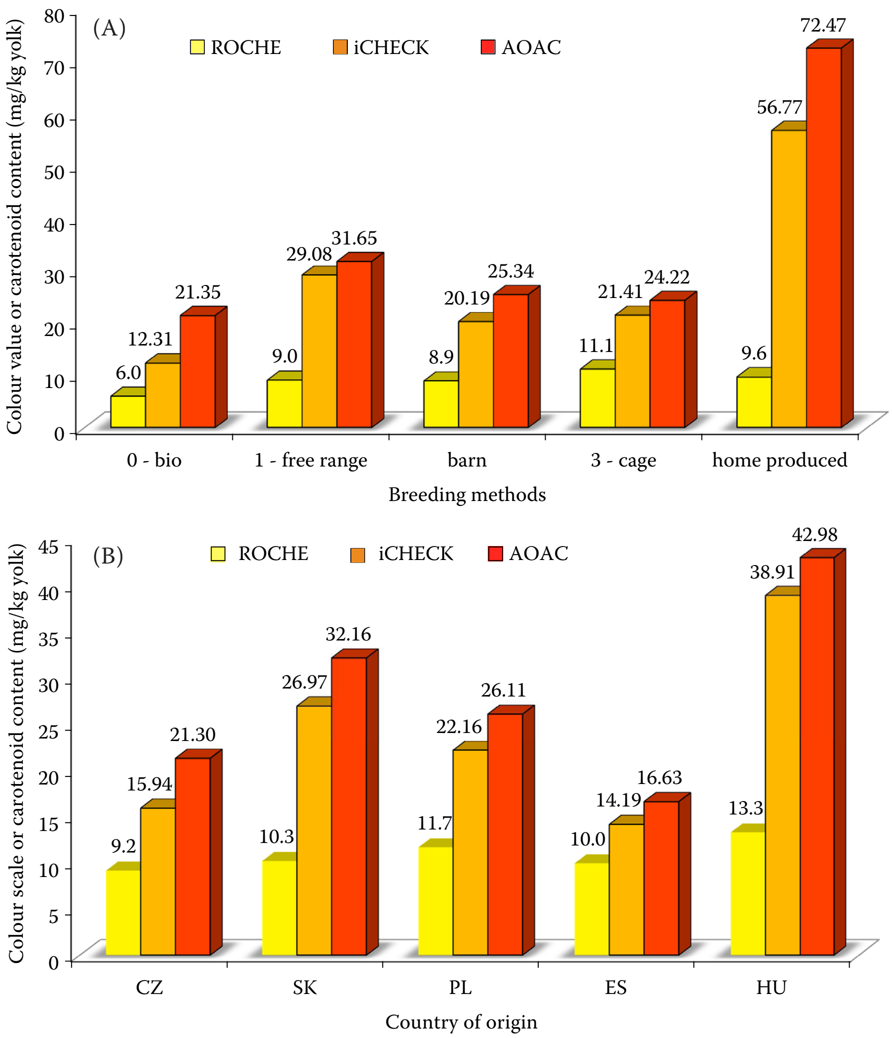

Figure 4. The influence of (A) breeding and (B) the country of origin on the egg yolk colour and carotenoid content in egg yolk

found in Hungarian and Slovak eggs because in this group some special eggs were present (Figure 4B). The carotenoid contents in Czech and Polish eggs which are mostly marketed in the Czech Republic were comparable.

CONCLUSION

For the common practice in the poultry industry and commerce, the visual evaluation of the egg yolk colour by La Roche scale is more convenient than the measurement of the carotenoids content expressed as beta carotene. The visual evaluation gives prompt unmistakable information and corresponds better with the sensorial perception of egg yolk colour.

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