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# INTEGRATED ASSESSMENT OF QUALITY OF CHICKEN ORGANIC EGGS BY MEASUREMENT OF DARK LUMINESCENCE

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In general, consumers believe that quality of organic food is superior to conventionally produced one. For organic food an integrated assessment of quality seems to be necessary. In the early 20th century it was observed that living organisms emit light (photons). Different hypotheses were developed to describe this phenomenon. The most prominent one is that the observed biophotons are coming from an intercellular communication system. This effect is meanwhile described as dark luminescence due to the very low intensity of radiation. In first experiments with eggs it was found that eggs from hens of free range systems and from organic production showed higher maximal emissions of biophotons with a slower decline over time. The objective of the present experiment was, therefore, to run a long-term (1 year) evaluation of egg quality from different production systems (cage, barn, free range, organic) on the basis of conventional quality criteria (shell breaking strength, egg mass, albumen height, yolk colour, proportion of yolk, fatty acid profile) and emission of biophotons. First results indicate that organic eggs show higher emissions of biophotons with a slower decline, higher albumen height, paler yolk colour, and higher content of omega-3 fatty acids in yolks. Obviously, measurement of dark luminescence may be a suitable method for an integrated assessment of the quality of organic eggs.

## INTRODUCTION

In general, consumers believe that quality of organic food is superior to conventionally produced one. When applying conventional quality criteria in the comparison of quality of organic and conventional food only minor differences can be observed. This may be due to the fact that only single aspects of product quality are considered. For organic food an integrated assessment of quality seems to be more appropriate. In the early 20th century Gurwitsch [1932] observed that living organisms emit light quants continuously (photons), which show a high degree of coherence. Different hypotheses were developed to describe this phenomenon. Although, many scientists believed that observed biophotons are waste products from metabolism [Bischof, 1998; Niggli, 1992; Niggli *et al*., 2001], Popp [1984] stated that biophotons are coming from an intercellular communication system, with DNA being the main source of radiation [Rattemeyer, 1981; Popp, 2001]. This was defined as mitogenic radiation and is meanwhile described as dark luminescence due to the very low intensity of radiation. In different experiments with plants it was shown that organic products are capable to store more photons and to emit the photons for a longer time. Meanwhile, it is believed that measurement of biophotons is a fast, non-destructive method for an integrated assessment of quality of natural food.

The method was already applied in the assessment of egg quality [Köhler, 2001]. In first experiments was found that eggs from hens of free range systems, from hens with access to grass intake and from organic production showed higher maximal emissions of biophotons with a slower decline over time. Furthermore, a significant positive correlation was observed for feathering condition of hens (higher emissions and better feathering) and for mortality (higher emissions and lower mortality).

Based on the previous experiments a new experiment was planned. The objectives for the new experiment were to run a long-term (1 year) evaluation of egg quality from different production systems on the basis of conventional quality criteria and emission of biophotons.

## MATERIALS AND METHODS

Eggs of investigation were coming from 8 farms with 12 different production and/or husbandry systems: 2 conventional cages, 4 barn, 2 free range and 4 organic. Farms were located in the different areas of Germany (North, Middle, South). The experiment started in May 2006 and ended in April 2007. In monthly intervals 24 eggs were collected from each house the day after lay. Half of the eggs were used for determination of conventional quality criteria and the second half for measurement of biophotons which was done at the Institute for Biophysics in Neuss (Germany). Besides, egg production, feed consumption, feed conversion and mortality data were recorded.

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**Conventional quality criteria.** Shell breaking strength with an Instron Model 4301, egg mass, albumen height, yolk colour (with DSM yolk colour fan and Minolta Chromameter 300), proportion of yolk, fatty acid profile of yolk [Steinhilber, 2003], lipid oxidation in yolk [TBARS; Steinhilber, 2003].

**Measurement of biophotons.** For measurement of biophotons only yolks were used. After breaking of eggs yolks were separated and filled in a quartz cuvette (Suprasil) as a whole. Then the cuvette was put in the measuring chamber. The sample was illuminated for 30 sec. with a halogen lamp. Emission of biophotons was measured over a period of 60 sec. in intervals of 50 ms. Each yolk was measured once, as light emission declines after separating of yolks. The maximum emission of biophotons (SI) and the decline curve (ChiHyp) were recorded.

**Statistical analysis.** As the experiment was just recently finished no extended statistical analysis of data could be done. For preliminary statistical analysis an one-factorial analysis of variance (factor production system: cage, barn, free range, organic) was applied using the statistical programme package JMP [SAS Institute, 2003].

## RESULTS

First results indicate that organic eggs show higher emissions of biophotons (Figure 1) with a slower decline (Figure 2). Except for August SI was significantly higher for organic eggs than for conventional ones. SI from free range eggs did not differ from eggs from barn or cage systems. In general, emission of biophotons was higher in summer time than in winter time.

For conventional quality criteria higher albumen height, paler yolk colour, and partly higher content of omega-3 fatty acids in yolks was observed for organic eggs. Especially, during summer time organic eggs showed a more favourable n-6/n-3 ratio than eggs form the other production systems (Figure 3). But, considering the whole experimental period n-6/n-3 ratios were 10.8, 12.8, 11.7 and 12.3 for cage, barn, free range and organic eggs, respectively. The rate of lipid oxidation in yolks from organic eggs was lower in nearly all months (Figure 4). The average content of TBARS amounted to 1.38, 1.45, 1.52 and 1.06 nmol/mg yolk for cage, barn, free range and organic eggs, respectively.

## DISCUSSION

Preliminary results were in agreement with the findings of Köhler [2001]. Only minor differences in classical quality criteria could be observed between eggs form conventional and organic production. The paler yolk colour of organic eggs is due to the fact that colouring feed additives are prohibited in organic production [Grashorn & Grimrath, 2005]. In accordance with Köhler [2001] the maximum emission of photons was higher and the decline was slower in organic eggs than in conventional ones, especially during summer time. This is reflecting the higher light intensity and more intensive cell activity in summer. The observed lower content of n-3 fatty acids in organic eggs (as indicated by the less favourable n-6/n-3 ratio) may indicate that the grass growing in the pasture is no good source of n-3 fatty acids. In general, yolk fatty acid profiles reflect dietary fat sources. In conventional production dietary fat sources rich in n-3 fatty acids may also be used. In contrary, the level of lipid oxidation was generally lower in organic eggs than in conventional ones. This is partly caused by the in average less favourable n-6/n-3 ratio of organic eggs, but, does not explain

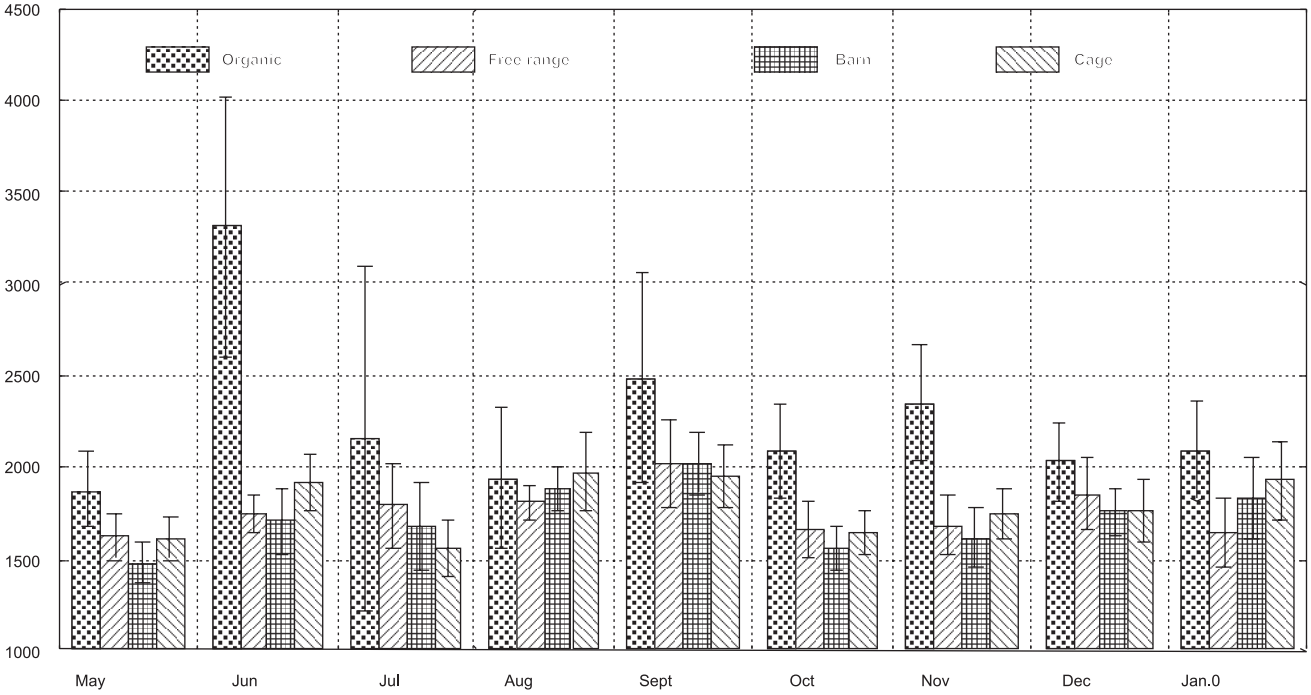


FIGURE 1. Emission of photons (SI; counts/ 55 s) between Mai 2006 and January 2007 from yolks of organic, free range, barn and cage eggs (9-20 yolks/sample).

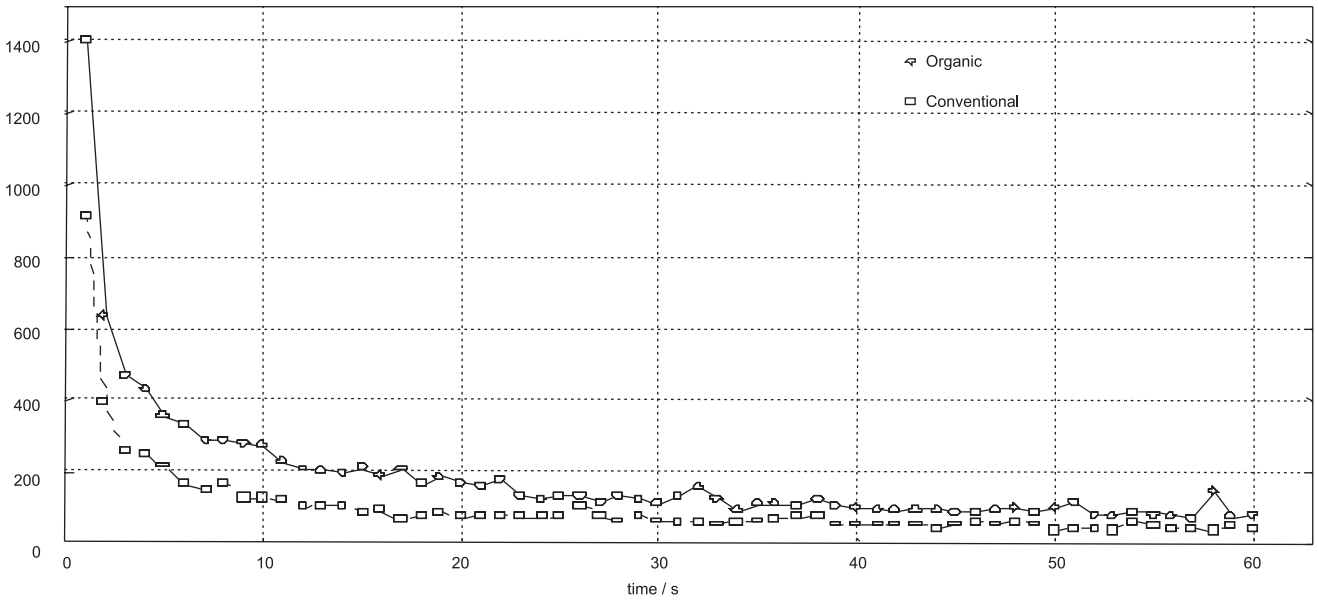


FIGURE 2. Decline curve of emission of biophotons (ChyHyp; counts/ 55 s) for organic and conventional yolks.

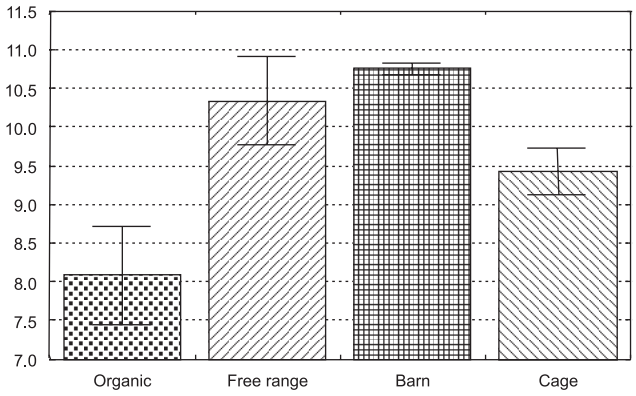


FIGURE 3. n-6/n-3 fatty acid ratios in yolks during May–July.

the whole difference. Maybe, the organic production conditions in combination with the access to free range improve the anti-oxidative capacity of the organism. This assumption may be proven if there will be a clear correlation with the emission of biophotons. But, the whole outcome of the experiment can only be assessed after the final statistical evaluation of data.

## CONCLUSIONS

Conventional quality criteria are less suitable for quality assessment of organic food, as they do not consider the integrated production conditions. Obviously, measurement of dark luminescence may be a more suitable method for an integrated assessment of the quality of organic eggs. In the present experiment organic eggs show higher and longer emission rates of biophotons reflecting a more balanced product. More research is necessary to proof the general suitability of this method.

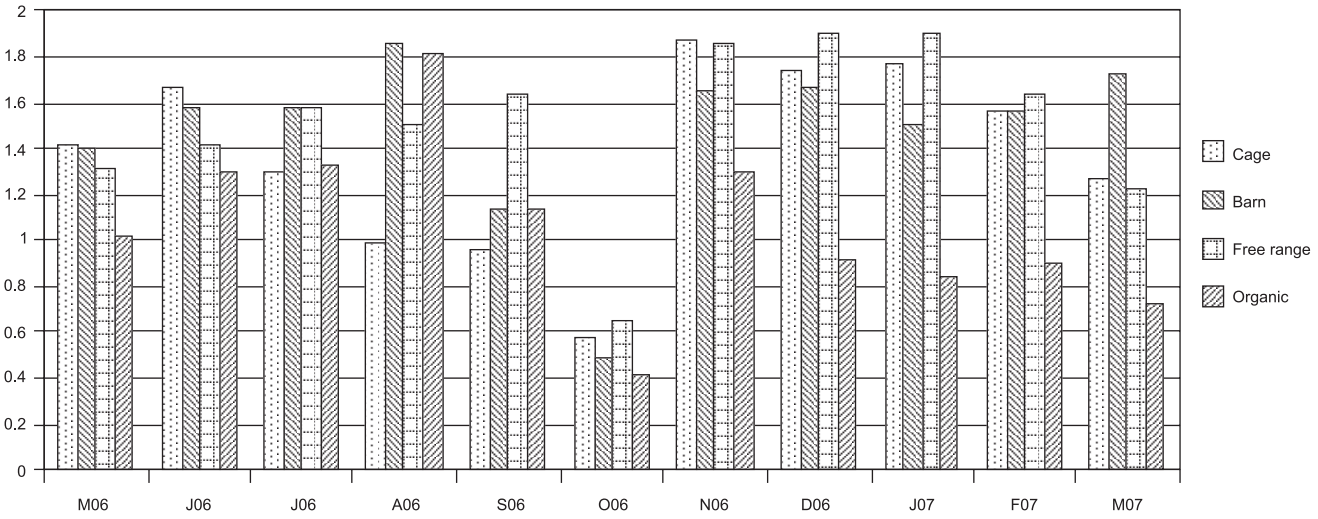


FIGURE 4. TBARS (nmol MDA/mg) in yolks of eggs from different production systems over a one year cycle.

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