MULTIDISCIPLINARY CONFERENCE ON SUSTAINABLE DEVELOPMENT 2024

UNIVERSITY OF LIFE SCIENCES
"KING MIHAI I" FROM Timisoara
Multidisciplinary Conference on Sustainable Development 30-31 May 2024

EFFECTS OF DIETARY INCLUSION OF MARIGOLD AND PAPRIKA EXTRACT ON LAYING HENS' EGG QUALITY PARAMETERS DURING DIFFERENT STORAGE TEMPERATURE

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ABSTRACT

Natural pigments in animal nutrition represents an alternative to synthetic pigments utilization. This 6-weeks study on 168 hens LOHMANN-BROWN (45-week-old) evaluated the natural carotenoids effects on egg quality. The hens were divided in 4 groups, and fed with: C (control-standard diet), E1 (standard diet+0.07% ME - marigold extract), E2 (standard diet+0.07% PE - paprika extract) and E3 (standard diet+0.02% ME+0.05% PE), and accommodated in 3-tier battery cages. A total number of 216 egg samples (18 eggs/group) were collected and analyzed at the final of the trial and after 28 days, stored at room (20°C) vs. refrigerated (4°C) temperature. At the end of the study, E1 (6.89), E2 (8.78), and E3 (8.4) groups registered a significantly ($p<0.05$) increased yolk color compared to C group (4.5). No significant differences were observed for the yolk color in eggs stored for 28 days at 4°C, while for eggs kept at 20°C after 28 days of storage, the color and albumen pH values increased significantly ($p<0.05$), correlated with a significant decreasing of Haugh Unit (HU). In conclusion, both natural extracts can be used in layers nutrition and are suitable for intensify yolk color.

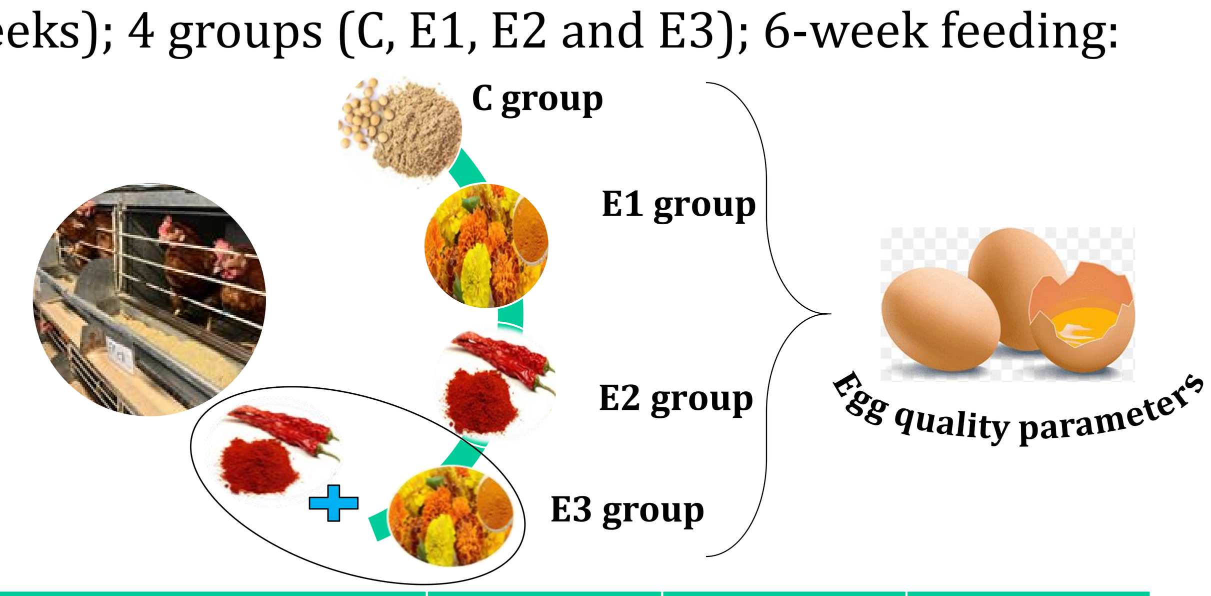
INTRODUCTION

Eggs are a highly nutritious food (*Paulino et al. 2022*), but their quality can deteriorate significantly under different storage conditions due to various factors such as temperature, humidity, storage time, and light exposure (*Silva et al. 2015*). Because the yolk's colour typically corresponds to the egg's nutritional content and general quality, it's also a factor in customer decision-making and an indicator of internal quality (*Volp et al. 2009*).

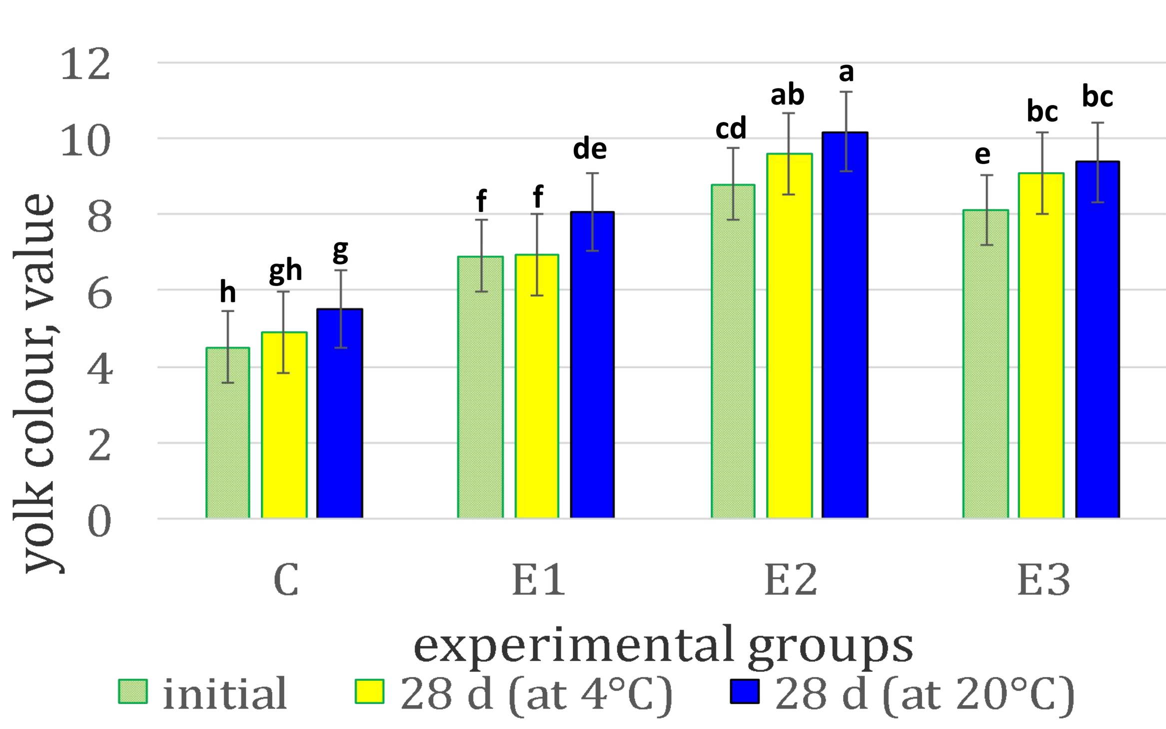
- *The aim of this study* was to evaluate the effects of storage time on quality parameters of the eggs by using natural extracts of marigold and paprika in the feed of laying hens.

MATERIALS AND METHODS

Experimental design: 168 Lohmann Brown layers (38 weeks); 4 groups (C, E1, E2 and E3); 6-week feeding:



Parameter			L*	a*	b*
Initial		C	42.06^{de}	0.12^{f}	21.52^{bc}
		E1	39.77^{f}	2.21^{e}	28.18^{a}
		E2	40.13^{ef}	3.52^{bc}	19^{cde}
		E3	39.74^{f}	3^{cd}	22.67^{b}
28 days	4°C	C	44.16^{bcd}	0.44^{f}	17.43^{ef}
		E1	43.79^{bcd}	2.38^{de}	21.19^{bcd}
		E2	42.3^{cde}	3.67^{abc}	14.66^{f}
		E3	42.65^{cd}	3.18^{bcd}	17.61^{def}
	20°C	C	46.79^{a}	0.86^{f}	22.03^{bc}
		E1	46^{ab}	3.1^{cd}	26.87^{a}
		E2	43.72^{bcd}	4.61^{a}	19.3^{bcde}
		E3	44.55^{abc}	4.1^{ab}	22.62^{b}
Interaction (p-Value)					
period			0.0001	0.0001	0.0001
group			0.0001	0.0001	0.0001
temperature			0.0001	0.0001	0.0001
group*period			0.006	0.959	0.071
group*temperature			0.0001	0.0001	0.0001
period*temperature			0.818	0.696	0.940
group*period*temperature			0.818	0.696	0.940



RESULTS AND DISCUSSIONS

Parameter			EW (g)	AW (g)	YW (g)	pH-A	AH (mm)	HU	pH-Y	YH (mm)	YD (mm)	YI
Initial		C	61.29^{cd}	38.95^{abc}	15.07^{b}	8.85^{bc}	7.16^{ab}	83.6^{ab}	6.33^{cd}	17.92^{bcd}	39.91^{c}	0.45^{a}
		E1	62.14^{abcd}	39.4^{ab}	15.4^{ab}	8.62^{d}	7.76^{a}	87.18^{a}	6.25^{d}	18.32^{abc}	40.67^{c}	0.45^{a}
		E2	61.32^{cd}	38.97^{ab}	15.22^{ab}	8.67^{cd}	6.68^{ab}	80.67^{ab}	6.22^{d}	17.51^{cd}	41.21^{c}	0.43^{ab}
		E3	60.87^{de}	38.07^{abc}	15.64^{ab}	8.69^{cd}	7.18^{ab}	83.9^{ab}	6.16^{d}	17.16^{d}	41.63^{bc}	0.41^{b}
28 days	4°C	C	61.62^{bcd}	37.1^{bcd}	16.8^{ab}	8.69^{cd}	6.46^{ab}	79.38^{ab}	6.78^{ab}	19.07^{a}	41.39^{bc}	0.46^{a}
		E1	63.27^{abc}	38.88^{abc}	16.79^{ab}	8.66^{cd}	7.02^{ab}	82.53^{ab}	6.42^{bcd}	18.63^{ab}	41.28^{bc}	0.45^{ab}
		E2	64.37^{a}	40.2^{a}	16.47^{ab}	8.75^{cd}	6.67^{ab}	78.7^{ab}	6.82^{ab}	18.28^{abc}	41.2^{bc}	0.45^{ab}
		E3	63.9^{ab}	39.22^{abc}	17.19^{a}	8.59^{d}	6.07^{bc}	75.61^{b}	6.57^{abcd}	18.04^{abcd}	42.61^{bc}	0.42^{ab}
	20°C	C	57.7^{f}	34.76^{d}	15.85^{ab}	9.14^{a}	3.32^{d}	51.18^{c}	6.89^{a}	12.24^{e}	44.24^{ab}	0.28^{c}
		E1	58.88^{ef}	35.18^{d}	16.42^{ab}	9.02^{ab}	3.92^{d}	58.05^{c}	6.87^{ab}	17.78^{e}	44.18^{ab}	0.29^{c}
		E2	60.91^{cde}	36.44^{cd}	16.92^{ab}	9.03^{ab}	4.56^{cd}	61.81^{c}	6.90^{a}	12.32^{e}	46.36^{a}	0.27^{c}
		E3	59.92^{def}	35.15^{d}	17.14^{ab}	9.01^{ab}	4.32^{d}	59.5^{c}	6.69^{abc}	12.74^{e}	45.83^{a}	0.28^{c}
Multiple Effects												
Group												
C			60.474^{b}	37.44^{b}	15.7	8.88^{a}	6.02^{b}	74.44^{b}	6.58^{a}	16.79^{ab}	41.36^{c}	0.41^{a}
E1			61.605^{a}	38.22^{ab}	16	8.73^{b}	6.61^{a}	78.73^{a}	6.45^{ab}	17.01^{a}	41.7^{bc}	0.41^{a}
E2			61.980^{a}	38.65^{a}	15.96	8.78^{b}	6.15^{ab}	75.46^{ab}	6.54^{ab}	16.4^{bc}	42.5^{ab}	0.39^{b}
E3			61.391^{a}	37.62^{b}	16.4	8.74^{b}	6.19^{ab}	75.73^{ab}	6.39^{b}	16.27^{c}	42.93^{a}	0.38^{b}
SEM_{group}			0.244	0.258	0.206	0.0219	0.151	1.11	0.0428	0.112	0.288	0.0041
Period												
Day 0 (initial)			61.41	38.85^{a}	15.33^{b}	8.7^{b}	7.19^{a}	83.84^{a}	6.24^{b}	17.72^{a}	40.85^{b}	0.44^{a}
Day 28			61.32	37.12^{b}	16.7^{a}	8.86^{a}	5.29^{b}	68.35^{b}	6.74^{a}	15.51^{b}	43.39^{a}	0.36^{b}
SEM_{period}			0.154	0.163	0.131	0.0138	0.0954	0.702	0.0270	0.0711	0.182	0.0026
Temperature												
4°C			62.347^{a}	38.85^{a}	16.07	8.69^{b}	6.87^{a}	81.45^{a}	6.44^{b}	18.11^{a}	41.24^{b}	0.44^{a}
20°C			60.378^{b}	37.11^{b}	15.96	8.88^{a}	5.61^{b}	70.74^{b}	6.54^{a}	15.12^{b}	43^{a}	0.36^{b}
$SEM_{temperature}$			0.174	0.184	0.147	0.0156	0.107	0.790	0.0304	0.0800	0.205	0.0029
Interaction (p-Value)												
Period (P)			0.724	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Group (G)			0.0001	0.004	0.125	0.0001	0.035	0.042	0.010	0.0001	0.0001	0.0001
Temperature (T)			0.0001	0.0001	0.577	0.0001	0.0001	0.0001	0.029	0.0001	0.0001	0.0001
G*P			0.0001	0.003	0.933	0.025	0.014	0.063	0.227	0.073	0.772	0.266
P*T			0.0001	0.0001	0.577	0.0001	0.0001	0.0001	0.029	0.0001	0.0001	0.0001
G*T			0.927	0.652	0.680	0.475	0.260	0.159	0.376	0.125	0.439	0.351
G*P*T			0.927	0.652	0.680	0.475	0.260	0.159	0.0376	0.125	0.439	0.351

*a-d, show significant differences ($P \leq 0.05$) from C, E1, E2 and E3, where EW=egg weight; AW= albumen weight; YW= yolk weight; pH-A=pH-albumen; AH=albumen height; HU= Haugh Units; pH-Y= pH-Yolk; YH=yolk height; YD= yolk diameter; YI=yolk index

When comparing eggs stored at different temperatures, the paler appearance of refrigerated eggs might be more noticeable because they are typically compared directly to room temperature eggs that might have undergone slight concentration of pigments due to moisture loss. Thus, at 28 days (20°C), E2 group registered a intensification of egg yolk color (10.17) due to egg degradation.

The primary reason for the decrease in egg weight over time is the loss of moisture through the porous shell. Storage temperature significantly affects the rate of this moisture loss. Refrigerated eggs lose moisture more slowly, maintaining their weight and quality longer. Eggs stored at room temperature or higher lose moisture more quickly, leading to a faster decline in weight and overall quality.

CONCLUSIONS

Utilizing natural pigments in the diets of laying hens effectively enhances egg yolk color, meeting consumer preferences for yolks. These pigments, primarily carotenoids from sources like marigold petals and paprika, not only improve aesthetic appeal but also contribute to the nutritional value of the eggs through their antioxidant properties. Despite challenges such as cost and variability in pigment concentration, natural pigments align with trends towards sustainable and natural food production. Importantly, eggs with enhanced yolk color maintain their quality and appeal over typical shelf times, providing a market advantage. Continued research and innovation can help optimize this practice, ensuring consistent and cost-effective outcomes for egg producers.

ACKNOWLEDGEMENT

This research was funded by the Ministry of Research, Innovation and Digitalization, Project PN 23 – 20.0101