

Supplementary material

Appendix 1

Table S1 Correlation matrix of egg and yolk mass (g), relative yolk mass (%), concentrations of individual and total yolk antioxidants ($\mu\text{g/g}$) and the amount of antioxidants per yolk (μg). Values for individual females from multiple years were averaged before calculation of the correlation coefficients to avoid pseudoreplication ($N = 128$).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Egg mass	1.00	0.60***	-0.23**	0.19*	0.05	0.03	0.01	0.03	0.05	0.18*
(2) Yolk mass		1.00	0.64***	0.06	-0.15	-0.03	-0.02	-0.04	-0.12	0.09
(3) Relative yolk mass			1.00	-0.07	-0.23**	-0.08	-0.04	-0.06	-0.20*	-0.07
(4) LOG vitamin A				1.00	0.59***	0.40***	0.18*	0.29***	0.65***	0.66***
(5) LOG vitamin E					1.00	0.49***	0.31***	0.31***	0.97***	0.94***
(6) LOG lutein						1.00	0.55***	0.14	0.66***	0.66***
(7) LOG zeaxanthin							1.00	0.03	0.41***	0.40***
(8) LOG β -carotene								1.00	0.31***	0.30***
(9) LOG total antioxidants									1.00	0.97***
(10) LOG antioxidants per yolk										1.00

Asterisks denote significance at *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$; significant correlations are in bold.

Table S2 Results of the linear mixed models relating yolk characteristics to
A) the factors of the environment,
B) female traits (i.e., feather colouration, condition, and age), and
C) male traits (i.e., feather colouration, condition, and age). DDF = denominator degrees of freedom calculated by the Satterthwaite method. Numerator DF is always 1. Statistically significant factors are in bold. For female and male age (1y old or older), the "older" is a reference category for parameter estimates.
All analyses of yolk mass were done without one outlying observation; all analyses of antioxidants in relation to male traits were done without one outlying observation.

A – Factors of the environment

	DDF	F	P	Estimate (SE)
Yolk mass (N = 161)				
Intercept				0.33 (0.01)
Laying date	153	5.3	0.023	0.001 (0.001)
Laying temperature	143	8.5	0.004	0.005 (0.002)
Breeding density	147	0.2	0.637	-0.001 (0.001)
Territory quality	149	<0.1	0.896	0.0003 (0.003)
Female variance component				0.0006 (0.0002)
Nest box variance component				0.00
Residual variance component				0.0006 (0.0001)
PC1Antioxidant (N = 153)				
Intercept				-0.61 (0.32)
Laying date	140	7.9	0.006	0.05 (0.02)
Laying temperature	147	0.3	0.595	0.03 (0.05)
Breeding density	142	1.0	0.312	0.04 (0.04)
Territory quality	78.9	0.1	0.829	0.02 (0.08)
Female variance component				0.19 (0.14)
Nest box variance component				0.12 (0.17)
Residual variance component				0.60 (0.21)
PC2Antioxidant (N = 153)				
Intercept				0.43 (0.23)
Laying date	130	2.3	0.133	-0.02 (0.01)
Laying temperature	134	1.9	0.176	0.04 (0.03)
Breeding density	148	2.4	0.127	-0.05 (0.03)
Territory quality	104	0.4	0.531	-0.04 (0.06)
Female variance component				0.03 (0.08)
Nest box variance component				0.21 (0.07)
Residual variance component				0.22 (0.09)
Total antioxidants (N = 153)				
Intercept				-0.02 (0.06)
Laying date	128	0.3	0.586	-0.002 (0.003)
Laying temperature	127	1.5	0.226	0.01 (0.01)
Breeding density	148	<0.1	0.880	0.0012 (0.0082)
Territory quality	98	0.6	0.457	0.01 (0.02)
Female variance component				0.00
Nest box variance component				0.018 (0.006)
Residual variance component				0.018 (0.004)

Antioxidants per yolk (N = 153)				
Intercept				-0.04 (0.06)
Laying date	129	<0.1	0.898	0.0008 (0.0033)
Laying temperature	128	3.6	0.061	0.02 (0.01)
Breeding density	148	<0.1	0.994	-0.00002 (0.00813)
Territory quality	97.3	0.6	0.424	0.02 (0.01)
Female variance component				0.00
Nest box variance component				0.017 (0.006)
Residual variance component				0.018 (0.004)

B – Female traits

	DDF	F	P	Estimate (SE)
Yolk mass (N = 140)				
Intercept				0.37 (0.07)
UV chroma	103	0.3	0.613	-0.15 (0.29)
Carotenoid chroma	113	<0.1	0.879	-0.01 (0.07)
Breast band	104	0.6	0.429	0.003 (0.004)
White cheek	117	0.5	0.491	-0.03 (0.05)
Condition	132	0.4	0.550	0.003 (0.005)
Age	120	0.5	0.480	0.004 (0.006)
Female variance component				0.0007 (0.0002)
Nest box variance component				0.00
Residual variance component				0.0005 (0.0002)
PC1Antioxidant (N = 132)				
Intercept				2.41 (2.09)
UV chroma	115	1.4	0.236	-10.83 (9.09)
Carotenoid chroma	109	0.2	0.623	-1.02 (2.06)
Breast band	116	1.4	0.236	0.13 (0.11)
White cheek	121	0.6	0.459	-1.04 (1.40)
Condition	117	0.1	0.773	-0.04 (0.13)
Age	97.2	4.3	0.040	-0.33 (0.16)
Female variance component				0.14 (0.14)
Nest box variance component				0.32 (0.17)
Residual variance component				0.46 (0.19)
PC2Antioxidant (N = 132)				
Intercept				-0.34 (1.29)
UV chroma	103	0.3	0.592	-3.03 (5.63)
Carotenoid chroma	93.4	<0.1	0.914	0.14 (1.27)
Breast band	106	1.2	0.272	-0.07 (0.07)
White cheek	116	4.7	0.033	1.90 (0.88)
Condition	111	0.3	0.618	0.04 (0.08)
Age	91	1.5	0.220	-0.12 (0.10)
Female variance component				0.002 (0.064)
Nest box variance component				0.179 (0.064)
Residual variance component				0.194 (0.078)

Total antioxidants (N = 132)				
Intercept				-0.09 (0.36)
UV chroma	90.9	0.4	0.534	-0.99 (1.59)
Carotenoid chroma	80.6	0.5	0.467	0.26 (0.36)
Breast band	89.8	0.9	0.337	0.02 (0.02)
White cheek	103	0.3	0.537	0.14 (0.25)
Condition	112	<0.1	0.961	-0.001 (0.023)
Age	72.9	10.0	0.002	-0.09 (0.03)
Female variance component				0.00
Nest box variance component				0.020 (0.006)
Residual variance component				0.013 (0.004)
Antioxidants per yolk (N = 132)				
Intercept				-0.08 (0.37)
UV chroma	95.5	0.4	0.544	-0.99 (1.63)
Carotenoid chroma	84.5	0.7	0.393	0.32 (0.37)
Breast band	96.2	0.8	0.390	0.02 (0.02)
White cheek	109	<0.1	0.889	0.04 (0.25)
Condition	109	0.1	0.719	0.01 (0.02)
Age	78.7	7.9	0.006	-0.08 (0.03)
Female variance component				0.001 (0.005)
Nest box variance component				0.018 (0.006)
Residual variance component				0.014 (0.006)

C – Male traits

	DDF	F	P	Estimate (SE)
Yolk mass (N = 87)				
Intercept				0.37 (0.12)
UV chroma	79.1	0.1	0.734	-0.18 (0.53)
Carotenoid chroma	74.9	1.7	0.198	-0.13 (0.10)
Breast band	66.3	10.8	0.002	0.010 (0.003)
White cheek	68.6	0.2	0.681	0.02 (0.05)
Condition	64.1	0.6	0.462	0.003 (0.005)
Age	75.9	1.5	0.232	-0.011 (0.009)
Female variance component				0.0005 (0.0005)
Nest box variance component				<0.0001 (0.0004)
Residual variance component				0.0008 (0.0006)
PC1Antioxidant (N = 83)				
Intercept				-6.04 (3.46)
UV chroma	76	7.5	0.008	40.88 (14.92)
Carotenoid chroma	74.7	<0.1	0.850	0.56 (2.94)
Breast band	74	0.1	0.812	0.02 (0.09)
White cheek	75.4	<0.1	0.992	-0.02 (1.49)
Condition	75.3	1.1	0.305	-0.14 (0.13)
Age	75.4	2.6	0.112	-0.42 (0.26)
Female variance component				0.02 (0.27)
Nest box variance component				0.00
Residual variance component				0.95 (0.31)

PC2Antioxidant (N = 83)				
Intercept				0.13 (2.43)
UV chroma	75.6	<0.1	0.976	-0.32 (10.50)
Carotenoid chroma	76	0.1	0.745	0.68 (2.08)
Breast band	75.3	0.4	0.546	-0.04 (0.06)
White cheek	73.9	0.4	0.542	-0.64 (1.04)
Condition	69.9	0.1	0.771	0.03 (0.09)
Age	72.3	0.7	0.411	0.15 (0.18)
Female variance component				0.00
Nest box variance component				0.21 (0.12)
Residual variance component				0.29 (0.12)
Total antioxidants (N = 83)				
Intercept				-0.69 (0.63)
UV chroma	75.9	4.5	0.037	5.82 (2.73)
Carotenoid chroma	76	0.2	0.668	-0.23 (0.54)
Breast band	75.1	<0.1	0.974	0.001 (0.017)
White cheek	75	<0.1	0.865	0.05 (0.27)
Condition	72.7	0.9	0.359	-0.02 (0.02)
Age	73.9	0.1	0.729	-0.02 (0.05)
Female variance component				0.00
Nest box variance component				0.010 (0.009)
Residual variance component				0.023 (0.009)
Antioxidants per yolk (N = 83)				
Intercept				-0.46 (0.64)
UV chroma	76	3.7	0.060	5.30 (2.77)
Carotenoid chroma	76	1.1	0.301	-0.60 (0.55)
Breast band	75	0.6	0.436	0.01 (0.02)
White cheek	75.4	<0.1	0.940	-0.02 (0.28)
Condition	73.9	0.6	0.435	-0.02 (0.02)
Age	74.5	0.5	0.465	-0.03 (0.05)
Female variance component				0.00
Nest box variance component				0.007 (0.010)
Residual variance component				0.027 (0.010)

Sample size for a particular correlation can be obtained by comparing sample sizes of the two traits in a correlation and taking the smaller number of the two. For instance, sample size for the correlation between female UV chroma and male UV chroma is 96, because 96 (male UV chroma) is less than 116 (female UV chroma).

Some females were sampled more than once during our study. Thus, to avoid pseudoreplication when calculating correlation coefficients, we averaged values from different seasons for females that were sampled repeatedly (in two or three years).

Colour legend:

	Correlations among environmental factors and female traits
	Correlations among environmental factors and male traits
	Correlations among female and male traits