EFFECT OF SUPPLEMENTATION OF LAYERS' DIET WITH MIXTURES OF DIFFERENT PEPPER SPECIES ON EGG QUALITY

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ABSTRACT

Eighty-eight point of lay birds in 11 dietary groups were used to evaluate the effect of supplementation of commercial layer's mash (CLM) with various combinations of *Capsicum annum* ('atarodo' -RD) and *C. frutescens* (shombo-SH) at two levels on internal and external qualities of eggs. A feeding trial lasting 56 days was carried out at the end of the of which 88 intact newly laid eggs, 8 per treatment, were collected over 4 days and the physical characteristics determined. There was no advantage ($P > 0.05$) of supplemented diets over the solely commercial diet on mean egg weight (g), maximal equatorial diameter (cm), surface area (cm²), shell weight (g), albumen weight (g), albumen index, Haugh unit and yolk weight (g). With the exception of diet 3 in which 0.25% of the CLM was supplemented with 60% RD + 40%SH, all other supplemented diet had significantly higher yolk colour rating than the control diet. Eggs laid by birds that were fed diet 6, 0.5% 50%RD + 5.0% SH, had significantly higher percent yolk and yolk colour than those from birds that were fed the control and some supplemented diet combination. The physical characteristics of the eggs that were laid by birds on diet 6 were also comparable with that of those in other experimental diets, with or without supplementation.

Keywords: Pepper mixtures, supplementation, layers' diet, egg quality

INTRODUCTION

The poultry industry has shown sustained growth in recent times by producing a wide

range of quality products to meet consumers' demand. Great interests have been generated in the quality of the egg and a number of researchers have used various materials to improve the quality of eggs of which pepper is a recent area of interest. Carotenoids and ascorbic acid are components of peppers. The red colour of ripe pepper (*Capsicum spp*) is known to contain a mixture of carotenoids (Abimbola, 1994) which enhances pigmentation of egg yolk as well as increasing the yolk size. The ascorbic acid, on the other hand, boosts egg production, decrease mortality and may also enhance the size of egg and other quality traits. (Brown, 1996).

Of the sources of pigmentation of egg yolk colour previously used, only pepper was reported to have significantly increased yolk size. Faruga *et al.* (1976) reported that the inclusion of pepper (Paprika) at 0.4% level led to significantly higher yolk weight and consequently heavier eggs. Brown (1996) supplemented layers ration with 2.0% 'shombo' (*C. frutescens*) and observed significantly improvement in productive performance rather than egg physical characteristics, whereas supplementation with 2.0% 'atarodo' (*C. annum*) enhanced physical characteristics but not productive performance of the birds.

In the study being reported herein, commercial layers' mash was supplemented with combinations of 'shombo' (*C. frutescens*) and 'atarodo' (*C. annum*) at two levels and fed to point of lay birds. Our objective was to find the level of combination or mixture of both (*C. frutescens*) and (*C. annum*) that will enhance both internal and external characteristics of eggs.

MATERIALS AND METHODS

Fresh sample of two pepper varieties 'shambo' (*C. frutescens*) and 'atarodo' (*C. annum*) were purchased from an open market near Ile-Ife. The peppers were oven-dried at 70°C for 72 hours and were separately ground using a small Modelle Depose Blender (type 241.2.00). The blended samples were mixed in the following proportions (%) on weight basis: RD : SH - 70:30, 60:40, 50:50, 40:60, 30:70.

Chemical analysis of peppers and their mixtures

Sole and mixed samples of pepper were analyzed for dry matter (DM), crude fibre (CF), ether extract (EE), ash, organic matter (OM) and nitrogen-free extract (NFE) as described by AOAC (1984) using a Kjeltex System Digester (Tecator Model 1002). Gross energy was determined using a ballistice bomb calorimeter. The indophenol method of Ruck (1963) was used for ascorbic acid determination.

Preparation of experimental diets

Commercial layers' mash (CLM) was obtained from Animal Care Feeds Plc and the experimental diets were prepared by adding combinations of peppers to the mash at 0.25 and 0.50% (on weight basis) as follows:

- Diet 1 = CLM + 0.25% of 70 RD : 30 SH
- Diet 2 = CLM + 0.50% of 70 RD : 30 SH
- Diet 3 = CLM + 0.25% of 60 RD : 40 SH
- Diet 4 = CLM + 0.50% of 60 RD : 40 SH
- Diet 5 = CLM + 0.25% of 50 RD : 50 SH
- Diet 6 = CLM + 0.50% of 50 RD : 50 SH
- Diet 7 = CLM + 0.25 % of 40 RD : 60 SH
- Diet 8 = CLM + 0.50% of 40 RD : 60 SH
- Diet 9 = CLM + 0.25% of 30 RD : 70 SH
- Diet 10 = CLM + 0.50% of 30 RD : 70 SH
- Diet 11 = CLM (control)

Proximate fractions of the diets were determined using the methods of previously described for the peppers and their mixtures.

Feeding trials and determination of egg qualities

Experimental diets were fed to pullets of laying age for a period of 56 days. 88 ISA Brown layers (18 weeks old) were used for this trial.

Birds were randomly assigned to the 11 dietary groups with 8 birds per diet treatment and four replications of 2 birds each per replicate. At the end of 56 days a total of 88 (8 per treatment) intact, newly laid eggs were collected over a period 4 days and their physical characteristics were determined as follows: each egg was weighed to the nearest 0.1g on a top loading Sartorius Electric balance. The length and maximum width of each egg were measured to the nearest 0.1cm using 12cm Vernier Calipers and shape index of an egg was calculated as the proportion of the maximum width to the length. Eggs were then broken out into a flat glass surface for the determination of internal quality traits. Albumen and yolk lengths were measured, as described by Brown (1996), using a Rabon Chestermen Chrome Face Ruler to the nearest 0.5cm. The widths of albumen and yolk were also measured using a pair of dividers and their indices calculated by dividing the heights with the respective widths (Sharp and Powell, 1930). Egg weight and albumen height was used to calculate the Haugh Unit following the method proposed by Haugh (1937).

Yolk and albumen of each egg were separated with the aid of an egg separator and the weights were taken separately. Shell weight per surface was calculated by dividing the weight of individual intact shell by its calculated surface area, where surface area = $2.9782 \times (\text{egg weight})^{0.7062}$ days cm^2 . The yolk colour was determined using a Roche Colour Fan (a series of 15 coloured plastic tabs arranged as a fan corresponding to the range of yolk colour found in eggs.) Shell thickness was measured using an NSK Micrometer Screw Gauge with a ball anvil to the nearest 0.01mm. Analysis of variance procedure and Duncan's Multiple range Test (Steel and Torrie, 1980) were used to compare the treatment groups for egg quality traits.

RESULTS AND DISCUSSION

'Shombo' (SH) contained more gross energy, organic matter, ether extract and vitamin C than 'atarodo' (RD), while RD contained more ash than SH (table 1). Mixes with more RD consistently contained more ash while those with more of SH than RD contained more vitamin C. Crude fibre content of all experimental diets with pepper supplementation was higher than that of the control diet that was not supplemented at all (Table 2). Except diet, 10, 0.5% supplementation enhanced the organic matter content of the diets than 0.25% supplementation. Again, no definite trend in the content of the various proximate fractions of the supplemented diets was noticeable when compared with the control diet that had no pepper supplementation. The non-additivity of the various constituents, by not following a definite, predictable trend may be partly attributed to the influence of other chemical constituents outside those analyzed for like other vitamins, proportions of the minerals to one another in the pepper species and thus the supplemented diets (personal communication with S.A. Adisa, Chief Technologist, Department of Animal Science, O.A. U., Ile-Ife).

There was no advantage ($P>0.05$) of the diets supplemented with pepper over the commercial layers' mash on mean egg weight (g), albumen index, Haugh unit and yolk weight (g) of eggs produced by birds fed with the diets. Percent albumen and albumen : yolk ratio of birds on diet 1-10, which had pepper supplementation, were comparable; but for diets 1 and 6, significantly lower values than that of the control diet was observed. Diet 6 supplemented with 0.0% of 50% RD + 50% SH ranked highest ($P<0.05$) in yolk colour and percent yolk. With the exception of diet 3, all other supplemented diets had

significantly coloured yolk than the control diet.

Contrary to the reports of Faruga *et al.* (1976) and Brown (1996) that diets with RD enhanced physical characteristics of eggs than diets with SH, we did not observe such enhancements in eggs laid by birds fed with diets containing more of RD (diet 1-4) than SH (diets 7-10). This further strengthens our opinion that other unidentified constituents of the different peppers and their mixes may equally be exerting significant influence and may need to be properly taken into consideration. The difference in the results reported herein and that of previous works involving supplementation with the peppers sole may also be partly attributed to this reason. Although there was no significant difference ($P>0.05$) in size of egg, shell surface area and shell weight of eggs laid by all the birds, the numerical differences (for example 3.10g in mean egg weight for diets 9 and 4) could be due to fluctuations in ambient temperature. It is known that at high temperatures, laying birds produce eggs of lighter weight than at lower ambient temperatures. Variations in shell weight could be attributed to heat stress. Egg produced by birds at 38°C have thin shells that may lead to 100% breakage. At such temperatures, there is a reduced ability of the birds to carry calcium ions (Smith 1995).

Though not statistically different, birds fed with diets that contained more SH (diets 7-10) produced eggs with lower yolk weights compared with those of birds fed diets 1-4. Huyghebaert (1991) had reported that the response of yolk to dietary *C. frutescens* carotenoid increments followed the law of diminishing return as a result of decline in solubility, metabolism and deposition.

Diet 6 containing 0.5% 50% RD + 50% SH clearly exhibited superiority in enhancing egg shape index, percent yolk and yolk

TABLE 1: CHEMICAL COMPOSITION OF PEPPERS AND THEIR BLENDS

	RD ^a	SH ^b	Mix 1 ^c	Mix 2 ^d	Mix 3 ^e	Mix 4 ^f	Mix 5 ^g
Dry matter (% DM)	98.1	98.3	97.3	96.6	97.0	96.9	96.0
Gross Energy (Kcal/kg)	5104.5	5395.0	5478.0	5395.0	5021.5	5395.0	5519.5
Analyses (% of DM)							
Ash (%)	8.3	5.6	7.3	7.4	6.4	6.7	6.8
Organic matter(%)	91.7	94.4	92.7	96.6	93.6	93.3	93.2
Crude Protein(%)	11.4	12.4	11.9	11.8	11.6	12.3	12.0
Ether Fibre(%)	34.9	32.3	34.4	32.9	30.2	31.6	32.3
N-Free Extract(%)	11.1	13.7	13.2	13.0	13.5	12.9	14.1
Vitamin C (mg/100g)	97.0	152.6	89.0	82.2	118.6	118.6	133.6

^a 'Atarodo'—RD (*Capsicum annum*)^b 'Shombo'—SH (*C. frutescens*)^c Mix 1 contains 70% RD and 30% SH^d Mix 2 contains 60% RD and 40% SH^e Mix 3 contains 50% RD and 50% SH^f Mix 4 contains 40% RD and 60% SH^g Mix 5 contains 30% RD and 70% SHPEPPER IN LAYER¹ DIETSTABLE 2: CHEMICAL COMPOSITION OF EXPERIMENTAL DIETS CONTAINING COMBINATIONS AND LEVELS OF *Capsicum* SPECIES

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8	Diet 9	Diet 10	Diet 11
Dry matter (%DM)	91.1	91.9	92.6	90.9	91.0	93.2	78.7	93.2	91.9	92.8	92.2
Analyses (% DM)											
Ash (%)	13.9	13.0	15.7	14.4	16.9	11.2	17.4	14.9	13.9	15.8	15.5
Organic matter(%)	86.1	87.0	84.4	85.6	83.0	88.8	82.6	85.1	86.1	84.2	84.5
Crude Protein(%)	18.7	18.7	18.9	17.7	18.1	18.4	20.4	17.2	18.3	17.3	18.6
Crude Fibre(%)	6.1	4.7	4.8	6.9	5.4	7.6	11.0	4.8	8.2	7.6	4.4
Ether Extract (%)	5.0	4.8	6.9	4.3	6.2	8.8	6.9	4.9	6.2	5.7	5.7
N-Free Extract(%)	47.5	50.9	46.4	47.6	44.4	47.2	23.1	51.5	45.5	46.4	48.0
Vitamin C(mg/100g)	14.6	8.4	11.9	11.0	11.4	11.2	16.0	10.0	6.2	7.1	10.3

CLM = Commercial layers' mash

RD = 'Atarodo' (*C. annum*)SH = 'Shombo' (*C. frutescens*)

Diet 1 = CLM + 0.25% of 70 RD : 30SH

Diet 2 = CLM + 0.50% of 70 RD : 30 SH

Diet 3 = CLM + 0.25% of 60 RD : 40SH

Diet 4 = CLM + 0.50% of 60 RD : 40SH

Diet 5 = CLM + 0.25% of 50RD : 50SH

Diet 6 = CLM + 0.50% of 50RD : 50SH

Diet 7 = CLM + 0.25% of 40RD : 60SH

Diet 8 = CLM + 0.50% of 40RD : 60 SH

Diet 9 = CLM + 0.25% of 30RD : 70 SH

Diet 10 = CLM + 0.50% of 30 RD : 70 SH

Diet 11 = CLM (Control diet); CLM = Commercial layers' mash

TABLE 3: PHYSICAL CHARACTERISTICS OF EGGS BY PULLETS FED WITH DIETS SUPPLEMENTED WITH PEPPERS

Overall Summary	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8	Diet 9	Diet 10	Diet 11
Egg weight(g)	52.62±1.70	53.4±1.97	52.73±2.23	51.37±2.46	53.67±2.64	52.65±3.86	52.50±4.74	52.04±5.49	54.47±1.80	51.89±1.59	52.16±2.31
Maximal length(cm)	5.32±0.08ab	5.48±0.10a	5.36±0.20ab	5.47±0.15a	5.44±0.15ab	5.35±0.21ab	5.40±0.3.21ab	5.22±0.49b	4.44±0.13ab	5.42±0.14ab	5.41±0.51ab
Maximal equatorial diameter (cm)	4.13±0.07	4.11±0.06	4.13±0.08	4.06±0.11	4.12±0.13	4.17±0.26	4.09±0.13	4.08±0.07	4.18±0.07	4.09±0.10	4.11±0.09
Egg shape index	0.78±0.02ab	0.75±0.01ab	0.77±0.03ab	0.74±0.02b	0.76±0.04ab	0.78±0.03a	0.76±0.03ab	0.79±0.09a	0.77±0.03ab	0.75±0.03ab	0.76±0.03ab
Surface area (cm ²)	65.24±1.55	65.76±1.47	65.41±1.93	64.21±3.03	65.96±2.31	65.32±3.38	65.16±4.09	64.76±4.80	66.92±1.55	65.01±1.41	64.92±2.02
Shell weight(g)	7.22±0.34	7.00±0.40	6.86±0.24	6.83±0.46	7.24±0.43	7.05±0.46	7.10±0.38	7.08±0.67	7.14±0.40	7.23±0.35	6.92±0.29
% Shell	13.74±0.56ab	13.06±0.60b	13.00±0.38	13.31±0.94ab	13.55±0.79ab	13.39±0.72ab	13.55±0.75ab	13.65±1.11ab	13.31±0.74ab	13.94±0.65a	13.26±0.37ab
Shell thickness(mm)	0.53±0.19a	0.40±0.03b	0.42±0.03b	0.42±0.03b	0.42±0.03b	0.43±0.02b	0.43±0.03b	0.43±0.05b	0.43±0.03b	0.44±0.02b	0.45±0.13ab
Shell weight/surface area (g/cm ²)	0.11±0.005ab	0.10±0.005ab	0.10±0.005ab	0.10±0.055b	0.11±0.01a	0.10±0.01ab	0.11±0.01ab	0.11±0.01a	0.11±0.005ab	0.11±0.005ab	0.10±0.005ab
Albumen weight(g)	31.20±2.13	32.44±1.63	32.55±1.85	30.99±2.48	32.50±2.02	31.13±3.40	32.51±2.86	31.78±3.71	33.72±1.21	31.80±1.45	32.55±1.96
% Albumen	59.39±2.81b	60.76±2.97ab	61.11±1.74ab	60.26±0.99ab	60.85±1.40ab	59.45±4.66b	61.99±1.22ab	60.91±1.46ab	61.91±1.70ab	61.26±1.67ab	62.30±1.92a
Albumen index	0.10±0.002	0.10±0.02	0.11±0.02	0.09±0.02	0.12±0.02	0.10±0.02	0.10±0.02	0.10±0.03	0.11±0.02	0.10±0.02	0.10±0.02
Haugh unit	55.01±13.84	58.70±14.09	67.59±14.41	55.04±13.91	66.06±12.64	56.30±14.66	62.27±15.00	60.89±14.09	64.77±9.68	62.77±13.36	63.56±12.76
Yolk weight(g)	14.09±1.22	13.97±1.95	13.51±0.89	13.55±0.90	13.96±0.79	14.29±2.59	12.88±1.72	13.31±1.57	13.48±1.18	13.23±0.79	12.62±0.99
% Yolk	26.84±2.61ab	26.09±3.08a b	25.54±1.68ab	26.37±0.87ab	25.40±1.11ab	27.09±4.30a	24.49±1.43b	25.20±1.21ab	24.70±1.54abc	25.48±1.80abc	24.10±1.83c
Yolk index	0.47±0.04ab	0.48±0.03ab	0.46±0.03b	0.44±0.04b	0.51±0.05a	0.48±0.05ab	0.48±0.02ab	0.45±0.04b	0.45±0.06b	0.47±0.02ab	0.46±0.04b
Yolk colour	8.75±1.67ab	6.62±1.51ab	7.62±2.07	8.50±1.93ab	8.75±1.16ab	9.75±0.46	8.62±1.60a	9.37±0.74ab	8.62±1.68ab	9.25±1.49ab	6.37±1.41c
Albumen	2.24±0.32b	2.36±0.32ab	2.40±0.21	2.28±0.09b	2.40±0.15ab	2.25±0.47b	2.54±0.19ab	2.42±0.17ab	2.51±0.22ab	2.41±0.21ab	2.59±0.8a
Yolk ratio											
CLM	= Commercial layers' mash										
RD	= 'Aarodo' (C annum)										
SH	= 'Shombo' (C frutescens)										
Diet 1	= CLM + 0.25% of 70 RD : 30 SH										
Diet 2	= CLM + 0.50% of 70 RD : 30 SH										
Diet 3	= CLM + 0.25% of 60 RD : 40 SH										
Diet 4	= CLM + 0.50% of 60 RD : 40 SH										
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Diet 8	= CLM + 0.50% of 40 RD : 60 SH										
Diet 9	= CLM + 0.25% of 30 RD : 70 SH										
Diet 10	= CLM + 0.50% of 30 RD : 70 SH										
Diet 11	= CLM (Control diet)										

colour. This may be attributed to the higher ether extract content of the diet compared with that of other diets. Diets with high fat contents are known to enhance the uptake and metabolism of carotenoids necessary for egg yolk pigmentation. Brown (1996) made similar observation. The Pepper species used for this study (*C. annum* and *C. frutescens*) could be used as carotenoid and vitamin C supplements in layers diets to enhance qualities of eggs that will be produced. Supplementation with 0.5% 50% RD + 50% SH will enhance internal qualities of egg, notably yolk characteristics, better than other combinations and equally enhance external qualities as much as any diet with or without supplementation.

during storage as indicated by the yolk.

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