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Effect of different concentrations of ionized water pH on qualitative characteristics of the egg of laying hens Lohmann strain

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Abstract

This experiment was conducted to study the effect of ionized water on qualitative characteristics of the egg of layer hen from the period 25/October/2020 to 13/March/2021 (20 weeks). 105 hens (Lohmann-classic) strains were randomly divided into 5 groups (21 hen / group). Each group was subdivided into 3 replicates (7 hen / replicates). Hens in the control group provide tap water with pH (7.14), while hens in the 2nd and 3rd groups provide alkaline ionized water with pH (8.5, 9.5) respectively, 4th and 5th groups provide acidic ionized water with pH (5, 4) respectively. Results showed yolk weight rate significantly increase in the alkaline ionized water group (T2) as compared with the control and no significant differences were observed between groups on other egg quality traits. In addition, ionized water good method to improve water quality and some qualitative characteristics of eggs.

Keywords: Ion water, qualitative traits, hen

Introduction

Poultry is one of the most important food sources because of its high nutritional value, cheap prices, and ease of preparation, in addition to the high-value protein it provides [1]. Water is considered one of the most important nutrients for poultry, but the quality of water is very important because of its effect on productive and physiological performance [2]. Water is an essential ingredient for life and is also involved in many essential physiological functions such as digestion, absorption, enzymatic function, nutrient transportation, and thermoregulation, lubrication of joints and organs, and elimination of waste. Good quality water is essential for the production of livestock and poultry. It is also an essential component of blood and tissues [3]. Separation or electrolysis of water is one of the new methods in nanotechnology that was initially used by [4] in Japan, who described it as a strong antibacterial and beneficial for food preservation. [5] gave a general description of the electrolysis device, which consists of a cylinder containing two electrodes under a direct electric current, the positive and negative ions pass through a semi-permeable partition separating the two electrodes, each electrode produces a different solution where the anode Anolyte With a pH (2.3–2.7) The oxidation-reduction potential (ORP) High (more than 1000) contains free chlorine ions, on the other electrode the cathode produces Catholyte It has a pH of

10.0–11.5 and dissolved hydrogen with redox potential (ORP) Very low (-800 to -900mV). The biggest advantage of using electrolyzed water is to stop the activity of pathogens and it has less impact on the environment and users due to the absence of chemicals [6] and the use of neutralized electrolytic water (ANK) in the water given to poultry, it is considered a new method of treatment because of its beneficial effect on the health status [7; 8].

Materials and methods

This experiment was conducted at the poultry farm / College of Agricultural Engineering Sciences / University of Baghdad during the period from 25/October/2020 to 13/March/2021 (20 weeks) to investigate the effect of different concentrations of ionized water pH on the qualitative characteristics of the egg. 105 laying hens (Lohmann Brown – Classic) strains were randomly divided into five treatments groups of 21 hens each. Each group was subdivided into three replicates with seven hens each. 105 hens (Lohmann-classic) strains were randomly divided into 5 groups (21 hen / group). Each group was subdivided into 3 replicates (7 hen / replicates). Hens in the control group provide tap water with pH (7.14), while hens in the 2nd and 3rd groups provide alkaline ionized water with pH (8.5, 9.5) respectively, 4th and 5th group provide acidic ionized water with pH (5, 4) respectively. Birds are reared on the floor system and fed a balanced diet (table 1) according to [9]. both acidic and alkaline Ionized water are produced by Bawell apparatus (Figure 1). Qualitative traits of eggs (Yolk weight, Yolk high, Yolk diameter, Yolk index, Albumin weight, Albumin high, Albumin diameter, Haugh unit, Shell weight and Shell thickness) are measured according to [10]. Statistical analyses were performed using SAS software [11] Analyses used a completely randomized design (CRD), Means with significant differences were compared using Duncan's multiple range test [12].

Figure (1): Bawell apparatus

Table (1): Formulation and chemical composition of experimental diet

Components %	First diet from age 32 to 45 week	Second diet from age 46 to 51 week
Yellow corn	32	30
Wheat	30.3	28.8
Soybean meal (48% C.P)	21	22
Protein concentration	5	5
Sunflower oil	2	3
Limestone	8.5	10
DCP	0.7	0.7
NaCl	0.3	0.3
Colivit	0.2	0.2
Metabolizable energy	2822.3	2816.66
Crude protein	18.41	18.20
Ca	3.64	4.21
Po_4	0.44	0.44
Lysine	1.01	1.02
Methionine	0.42	0.42
Methionine+ cysteine	0.65	0.65

Results and Discussion

Table 2 shows that there were no significant differences between the groups during the first, second, and third periods of the study in yolk weight rate. During the fourth and fifth periods, T4 was significant differences (P<0.05) in yolk weight rate, while no significant differences were observed between the groups T2, T3, and T5 as compared with the control group, and during the total period of the study (20 weeks), it was noticed that T2 and T4 were significant differences (P<0.05) in yolk weight rate as compared with other groups.

Table (2): Effect of ionized water (alkaline and acidic) on yolk weight rate for laying hens during the periods (32 to 51) weeks of age. (Mean±SE)

Treat-ments	Periods					Total period (32-51) week
	first period (32-35) week	second period (36-39) week	third period (40-43) week	fourth period (44-47) week	fifth period (48-51) week	
T1	± 15.00 0.58	± 14.73 0.64	± 16.83 0.83	± 16.75 ^{b}1.46	± 15.46 ^{b}1.00	± 15.75 ^{b}0.81
T2	± 16.67 0.67	± 16.28 1.39	± 18.64 1.11	± 19.46 ^{ab}0.60	± 18.45 ^{ab}0.29	± 17.90 ^{a}0.22
T3	± 16.33 1.86	± 14.75 0.29	± 17.46 0.49	± 18.47 ^{ab}0.94	± 16.81 ^{ab}1.31	± 16.77 ^{ab}0.24
T4	± 15.33 0.66	± 17.85 1.95	± 18.04 0.75	± 19.83 ^{a}0.41	± 19.10 ^{a}1.04	± 18.03 ^{a}0.63
T5	± 15.33 0.33	± 15.86 0.39	± 17.76 0.60	± 18.63 ^{ab}0.54	± 17.36 ^{ab}0.98	± 16.99 ^{ab}0.27
Signifi-cant level	N.S	N.S	N.S	*	*	*

*: Means with different superscripts in each column differ significantly (P<0.05), N.S: No significant differences between treatments. T1(control): drinking tap water (pH 7.14), T2:drinking alkaline ionized water (pH 8.5), T3:drinking alkaline ionized water (pH 9.5), T4:drinking acidic ionized water (pH 5), T5:drinking acidic ionized water (pH 4).

Table 3 shows that there were no significant differences between the groups during all study periods on yolk high rate, except during the second period T4 was significantly different (P<0.05) on yolk high rate as compared with a control group and other groups.

Table 4 shows Significantly different (P<0.05) in yolk diameter rate as compared with other groups during the second period of the study, while no significant differences were observed between the groups during other periods as well as during the total period of this study.

Table (3): Effect of ionized water (alkaline and acidic) on yolk high rate for laying hens during the periods (32 to 51) weeks of age (Mean±SE)

Treatments	Periods					Total period (32-51) week
	first period (32-35) week	Second period (36-39) week	Third period (40-43) week	fourth period (44-47) week	fifth period (48-51) week	
T1	± 19.46 0.35	± 19.43 ^{b}0.20	± 20.05 0.21	0.28 ± 18.50	± 19.38 0.15	± 19.36 0.18
T2	± 19.61 0.72	± 19.61 ^{b}0.13	± 19.50 0.79	1.47 ± 18.78	± 20.29 0.13	± 19.56 0.32
T3	± 19.64 0.26	± 19.15 ^{b}0.49	± 20.31 0.04	0.61 ± 19.55	± 19.74 0.48	± 19.68 0.28
T4	± 19.68 0.64	± 20.83 ^{a}0.26	± 19.83 0.57	0.61 ± 19.46	± 19.62 0.53	± 19.88 0.44
T5	± 20.30 0.08	± 19.18 ^{b}0.57	± 20.02 0.19	0.93 ± 18.75	± 19.33 0.53	± 19.51 0.24
Significant level	N.S	*	N.S	N.S	N.S	N.S

*: Means with different superscripts in each column differ significantly ($P<0.05$), N.S: No significant differences between treatments. T1(control): drinking tap water (pH 7.14), T2:drinking alkaline ionized water (pH 8.5), T3:drinking alkaline ionized water (pH 9.5), T4:drinking acidic ionized water (pH 5), T5:drinking acidic ionized water (pH 4).

Table (4): Effect of ionized water (alkaline and acidic) on yolk diameter rate for laying hens during the periods (32 to 51) weeks of age. (Mean±SE)

Treatments	Periods					Total period (32-51) week
	first period (32-35) week	second period (36-39) week	third period (40-43) week	fourth period (44-47) week	fifth period (48-51) week	
T1	± 40.86 1.98	± 39.07 ^{b}0.34	± 39.74 0.99	1.40 ± 40.35	± 40.70 1.86	± 40.15 0.97
T2	± 42.48 2.29	± 39.42 ^{b}0.49	± 40.96 0.17	0.26 ± 40.87	± 42.95 2.05	± 41.34 0.36
T3	± 40.91 2.26	± 37.83 ^{b}1.17	± 40.15 1.77	0.24 ± 40.64	± 40.70 1.33	± 40.04 0.85
T4	± 40.77 1.06	± 43.97 ^{a}1.81	± 39.56 1.30	0.72 ± 41.33	± 39.17 1.01	± 40.96 0.71
T5	± 39.44 1.60	± 41.15 ^{ab}1.02	± 40.70 0.57	1.05 ± 41.10	± 41.36 0.13	± 40.75 0.52
Significant level	N.S	*	N.S	N.S	N.S	N.S

*: Means with different superscripts in each column differ significantly ($P<0.05$), N.S: No significant differences between treatments. T1(control): drinking tap water (pH 7.14), T2:drinking alkaline ionized water (pH 8.5), T3:drinking alkaline ionized water (pH 9.5), T4:drinking acidic ionized water (pH 5), T5:drinking acidic ionized water (pH 4).

Table 5 shows there were no significant differences between the groups during all the study periods in the yolk index rate.

Table (5): Effect of ionized water (alkaline and acidic) on yolk index rate for laying hens during the periods (32 to 51) weeks of age. (Mean±SE)

Treat-ments	Periods					Total period (32-51) week
	first period (32-35) week	second period (36-39) week	Third period (40-43) week	fourth period (44-47) week	fifth period (48-51) week	
T1	0.02 ± 0.48	0.01 ± 0.50	0.01 ± 0.51	0.01 ± 0.46	0.02 ± 0.48	0.01 ± 0.48
T2	0.02 ± 0.46	0.01 ± 0.50	0.02 ± 0.48	0.03 ± 0.46	0.02 ± 0.47	± 0.47 0.004
T3	0.03 ± 0.48	0.03 ± 0.51	0.02 ± 0.51	0.02 ± 0.48	0.01 ± 0.48	0.02 ± 0.49
T4	0.01 ± 0.48	0.01 ± 0.47	0.01 ± 0.50	0.02 ± 0.47	0.01 ± 0.50	0.01 ± 0.49
T5	0.02 ± 0.52	0.02 ± 0.47	0.01 ± 0.49	0.03 ± 0.46	0.01 ± 0.47	± 0.48 0.004
Signifi-cant level	N.S	N.S	N.S	N.S	N.S	N.S

N.S: No significant differences between treatments .T1(control): drinking tap water (pH 7.14), T2:drinking alkaline ionized water (pH 8.5), T3:drinking alkaline ionized water (pH 9.5), T4:drinking acidic ionized water (pH 5), T5:drinking acidic ionized water (pH 4)

Table 6 indicates that there were no significant differences between the experimental groups during the study periods, except during the second period of this study alkaline and acidic ionized water groups were significantly different ($P<0.05$) as compared with the control group in Albumin weight rate.

Table (6): Effect of ionized water (alkaline and acidic) on Albumin weight rate for laying hens during the periods (32 to 51) weeks of age. (Mean±SE)

Treat-ments	Periods					Total period (32-51) week
	first period (32-35) week	second period (36-39) week	Third period (40-43) week	fourth period (44-47) week	Fifth period (48-51) week	
T1	± 44.66 1.45	± 41.82 [b]2.23	± 42.98 1.82	0.73 ± 43.59	± 43.02 2.19	± 43.22 1.55
T2	± 42.00 2.00	± 46.82 [ab]1.00	± 44.56 1.21	1.82 ± 43.48	± 46.03 1.01	± 44.58 1.10
T3	± 43.00 1.73	± 45.24 [ab]2.58	± 43.33 0.23	2.58 ± 41.65	± 43.09 0.08	± 43.26 1.15
T4	± 43.67 2.85	± 52.66 [a]4.99	± 45.98 2.44	2.03 ± 42.05	± 41.70 1.88	± 45.21 0.05
T5	± 42.33 3.38	± 45.49 [ab]2.85	± 43.86 1.04	2.92 ± 46.53	± 44.01 1.16	± 44.44 1.25
Signifi-cant level	N.S	*	N.S	N.S	N.S	N.S

*: Means with different superscripts in each column differ significantly (P<0.05), N.S: No significant differences between treatments. T1(control): drinking tap water (pH 7.14), T2:drinking alkaline ionized water (pH 8.5), T3:drinking alkaline ionized water (pH 9.5), T4:drinking acidic ionized water (pH 5), T5:drinking acidic ionized water (pH 4).

Table 7 shows there are no significant differences between groups on Albumin high rate during all periods of this study.

Table (7): Effect of ionized water (alkaline and acidic) on Albumin high rate for laying hens during the periods (32 to 51) weeks of age. (Mean±SE)

Treat-ments	Periods					Total period (32-51) week
	first period (32-35) week	second period (36-39) week	third period (40-43) week	fourth pe-riod (44-47) week	fifth period (48-51) week	
T1	0.69 ± 8.94	1.19 ± 7.75	0.45 ± 7.99	0.50 ± 6.32	0.37 ± 8.48	0.44 ± 7.89
T2	0.11 ± 9.11	0.13 ± 8.79	0.68 ± 7.89	0.29 ± 6.23	0.77 ± 8.14	0.18 ± 8.03
T3	0.53 ± 9.34	1.15 ± 8.44	0.51 ± 7.97	0.91 ± 6.33	0.51 ± 7.03	0.55 ± 7.82
T4	0.30 ± 9.76	0.02 ± 10.12	0.98 ± 7.06	0.63 ± 6.47	0.57 ± 6.64	0.27 ± 8.01
T5	0.06 ± 9.23	0.69 ± 8.36	1.14 ± 8.45	0.79 ± 5.94	0.62 ± 7.32	0.36 ± 7.86
Signifi-cant level	N.S	N.S	N.S	N.S	N.S	N.S

N.S: No significant differences between treatments. T1(control): drinking tap water (pH 7.14), T2:drinking alkaline ionized water (pH 8.5), T3:drinking alkaline ionized water (pH 9.5), T4:drinking acidic ionized water (pH 5), T5:drinking acidic ionized water (pH 4).

The results of table 8 indicate that there were no significant differences in Albumin diameter rate among the groups throughout all study periods.

Table (8): Effect of ionized water (alkaline and acidic) on Albumin diameter rate for laying hens during the periods (32 to 51) weeks of age. (Mean±SE)

Treatments	Periods6					Total period (32-51) week
	first period (32-35) week	second period (36-39) week	third period (40-43) week	fourth period (44-47) week	fifth period (48-51) week	
T1	± 76.66 3.88	± 74.62 0.93	± 80.40 4.11	4.88 ± 83.79	± 81.94 4.73	± 79.48 1.69
T2	± 79.73 1.68	± 78.87 1.75	± 73.75 1.66	2.15 ± 79.92	± 77.84 2.97	± 78.02 1.14
T3	± 76.41 3.23	± 77.98 6.64	± 77.50 2.00	4.03 ± 79.67	± 80.96 5.25	± 78.50 3.03
T4	± 70.91 3.15	± 78.46 3.75	± 76.87 2.54	3.63 ± 82.41	± 75.75 2.42	± 76.88 1.16
T5	± 74.49 4.91	± 79.75 4.69	± 72.88 4.00	3.28 ± 81.96	± 80.28 3.81	± 77.87 1.23
Significant level	N.S	N.S	N.S	N.S	N.S	N.S

N.S: No significant differences between treatments .T1(control): drinking tap water (pH 7.14), T2:drinking alkaline ionized water (pH 8.5), T3:drinking alkaline ionized water (pH 9.5), T4:drinking acidic ionized water (pH 5), T5:drinking acidic ionized water (pH 4).

Table 9 shows on the fifth period T2 was significantly different ($P<0.05$) as compared with a control group on Haugh unit rate while no significant differences were observed between other groups as compared with the control group at the same period, and at the end of this study the results indicated that there are no significant differences between the groups in Haugh unit rate.

Table (9): Effect of ionized water (alkaline and acidic) on Haugh unit rate for laying hens during the periods (32 to 51) weeks of age. (Mean±SE)

Treatments	Periods					Total period (32-51) week
	first period (32-35) week	second period (36-39) week	third period (40-43) week	fourth period (44-47) week	fifth period (48-51) week	
T1	2.33 ± 87.37	1.86 ± 84.99	1.02 ± 88.84	1.48 ± 88.47	[b]2.24 ± 87.45	1.38 ± 87.42
T2	2.65 ± 86.70	0.63 ± 91.16	1.36 ± 91.39	1.40 ± 91.34	[a]1.05 ± 92.76	0.90 ± 90.67
T3	3.48 ± 87.03	2.25 ± 87.34	0.43 ± 89.19	2.18 ± 88.54	[ab]1.60 ± 88.05	1.15 ± 88.03
T4	2.89 ± 85.70	3.52 ± 92.04	2.34 ± 92.19	1.96 ± 90.45	[ab]1.14 ± 88.79	1.50 ± 89.83
T5	4.04 ± 85.70	3.67 ± 89.70	0.90 ± 90.28	2.55 ± 94.18	[ab]0.78 ± 89.80	1.77 ± 89.93
Significant level	N.S	N.S	N.S	N.S	*	N.S

*: Means with different superscripts in each column differ significantly ($P<0.05$), N.S: No significant differences between treatments. T1(control): drinking tap water (pH 7.14), T2:drinking alkaline ionized water (pH 8.5), T3:drinking alkaline ionized water (pH 9.5), T4:drinking acidic ionized water (pH 5), T5:drinking acidic ionized water (pH 4).

Table 10 shows that there are no significant differences between groups on shell weight rate during all periods of this study.

Table (10): Effect of ionized water (alkaline and acidic) on shell weight rate for laying hens during the periods (32 to 51) weeks of age. (Mean±SE)

Treatments	Periods					Total period (32-51) week
	first period (32-35) week	second period (36-39) week	third period (40-43) week	fourth period (44-47) week	fifth period (48-51) week	
T1	0.58 ± 7.00	0.58 ± 6.74	0.35 ± 6.33	0.36 ± 6.43	0.64 ± 6.28	0.20 ± 6.56
T2	0.33 ± 6.33	0.37 ± 7.36	0.18 ± 6.49	0.25 ± 6.69	0.21 ± 6.58	0.09 ± 6.69
T3	1.00 ± 7.00	0.36 ± 6.66	0.17 ± 6.70	0.53 ± 6.72	0.36 ± 6.46	0.06 ± 6.71
T4	0.58 ± 7.00	0.19 ± 6.50	0.19 ± 6.47	0.35 ± 6.86	0.06 ± 6.28	0.12 ± 6.62
T5	0.33 ± 6.33	0.49 ± 6.65	0.41 ± 6.96	0.36 ± 6.32	0.38 ± 6.73	0.34 ± 6.60
Significant level	N.S	N.S	N.S	N.S	N.S	N.S

N.S: No significant differences between treatments .T1(control): drinking tap water (pH 7.14), T2:drinking alkaline ionized water (pH 8.5), T3:drinking alkaline ionized water (pH 9.5), T4:drinking acidic ionized water (pH 5), T5:drinking acidic ionized water (pH 4).

Table 11 shows t4 was a significant difference ($P<0.05$) in shell thickness rate during the 1st period and in the 4th period T2 was significantly differences ($P<0.05$) on shell thickness as compared with other groups while no significant differences observed in the 2nd, 3rd, 5th and total period between groups on shell thickness rate.

Table (11): Effect of ionized water (alkaline and acidic) on shell thickness rate for laying hens during the periods (32 to 51) weeks of age. (Mean±SE)

Treatments	Periods					Total period (32-51) week
	first period (32-35) week	Second period (36-39)week	Third period (40-43) week	fourth period (44-47) week	fifth period (48-51) week	
T1	ab0.01 ± 0.59	0.03 ± 0.57	0.02 ± 0.53	ab0.03 ± 0.55	0.04 ± 0.57	0.01 ± 0.56
T2	ab0.05 ± 0.59	0.01 ± 0.60	0.00 ± 0.50	a0.04 ± 0.63	0.02 ± 0.53	0.02 ± 0.57
T3	ab0.01 ± 0.54	0.03 ± 0.54	0.02 ± 0.55	ab0.02 ± 0.56	0.002 ± 0.52	0.01 ± 0.54
T4	a0.03 ± 0.62	0.02 ± 0.61	0.02 ± 0.53	b0.01 ± 0.52	0.01 ± 0.52	0.01 ± 0.56
T5	b0.02 ± 0.52	0.03 ± 0.58	0.02 ± 0.54	b0.02 ± 0.54	0.01 ± 0.56	0.01 ± 0.55
Significant level	*	N.S	N.S	*	N.S	N.S

*: Means with different superscripts in each column differ significantly (P<0.05), N.S: No significant differences between treatments. T1(control): drinking tap water (pH 7.14), T2:drinking alkaline ionized water (pH 8.5), T3:drinking alkaline ionized water (pH 9.5), T4:drinking acidic ionized water (pH 5), T5:drinking acidic ionized water (pH 4).

The results of this study are in agreement with [13;14] who noted an increase in the egg's qualitative characteristics when the magnetic technique was used to treat the water. magnetization of water leads to enhancing the activity of thyroid gland of its secretion of the hormone thyroxine, which leads to an increase in feed consumed and metabolism of protein and fats [15]. The use of ionized water is very good because of its properties such as having a smaller particle size than ordinary water molecules in addition to having a potential value of oxidation and reduction, and it works to balance the acid and base conditions in the body and keeps it in a stable state, although it is alkaline, not good for the digestive tract because it helps to growth of pathogenic bacteria, but alkaline ionized water is rich in hydrogen ions, which are destructive to pathogenic bacteria, and the presence of hydrogen ions in alkaline water improves public health by preventing diseases caused by harmful bacteria [16]. Acidification of water by adding organic acids leads to better digestion and absorption of nutrients [17] and re-absorption of mineral elements such as phosphorous [18] and regulation of lipid metabolism [19].

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