RESULTS & DISCUSSION

4- RESULTS AND DISCUSSION

4.1. Effect of dietary levels of vitamin A and E on plasma vitamin A, E, calcium and phosphorus:

The purpose of the present study was therefore, to determine the effect of different dietary levels of vitamin A and E on plasma vitamin A, E, calcium and phosphorus concentrations. Nine factorial dietary treatments consisted of three levels each of vitamins A and E were applied. They corresponded to deficient, optimum and excessive levels of each vitamin A and E as the stabilized form retinylacetate and tocopheryl acetate, respectively.

4.1.1. Plasma vitamin A and E concentrations:

Data concerning the effect of dietary vitamin A and E levels on plasma vitamin A and E concentrations of Hubbard broiler chicks were presented in Table (4) and illustrated graphically in Fig. (1 and 2).

Results obtained showed that, plasma vitamin A and E concentrations decreased in all experimental groups by advancing age up to 8th week, after which remarkable increase was pointed out at the 9th week (end of experimental period). Analysis of variance showed a significant effect ($P<0.01$) of age on plasma vitamin A and E concentrations (ANOVA Table 6).

Table (4): Effect of dietary vitamin A and E levels on plasma vitamin A and E concentrations of Hubbard broiler chicks.

Treatment of vitamins (IU/kg)		Plasma vitamin A (µg/100 ml ± S.E.)					Plasma vitamin E (µg/100 ml ± S.E.)				
A	E	5th wk	6th wk	7th wk	8th wk	9th wk	5th wk	6th wk	7th wk	8th wk	9th wk
1000	0	80.5±5.0	75.2± 4.1	75.0±8.0	39.2±2.1	73.1±10.0	362.5±27.4	274.4±20.5	238.9±22.1	144.5±15.1	220.2±12.9
	10	73.4±4.5	68.7± 4.1	57.9±4.9	39.7±4.9	69.9±11.5	757.2±27.1	621.7±21.3	593.2±33.1	480.6±20.8	554.6±32.8
	100	90.7±3.7	86.1± 6.7	80.2±7.9	52.2±2.9	88.4± 4.1	1703.6±59.2	1496.6±56.5	1143.9±55.9	819.7±42.0	1107.8±49.8
10,000	0	124.6±9.1	118.7± 9.7	89.4±5.1	52.1±6.5	96.5± 6.1	536.4±26.0	406.1±34.7	288.5±31.8	198.3± 8.5	256.3±24.3
	10	142.6±6.3	127.6± 8.2	92.3±3.3	53.1±6.1	103.1± 3.0	871.6±32.4	775.8±33.1	661.5±30.0	541.3±22.2	637.7±28.8
	100	166.1±7.1	157.8±14.9	140.4±2.6	108.1±3.2	131.9± 4.5	1159.4±28.0	863.1±16.8	797.3± 7.5	555.8±20.2	745.7±22.1
100,000	0	162.5±5.8	147.7±11.0	80.8±4.6	66.5±4.5	109.5±13.5	127.5±11.3	120.1±11.7	81.5± 4.2	69.8± 4.9	80.0± 4.4
	10	142.2±5.6	130.3± 4.1	78.6±3.7	60.2±6.6	62.4± 6.0	229.4±16.5	196.8±23.0	122.9±10.8	78.5± 3.3	118.6± 9.1
	100	182.6±8.4	173.6± 5.3	168.0±9.3	146.2±8.2	158.2± 7.3	825.9±43.2	649.1±22.6	535.4±23.7	400.5±10.2	497.3±36.7

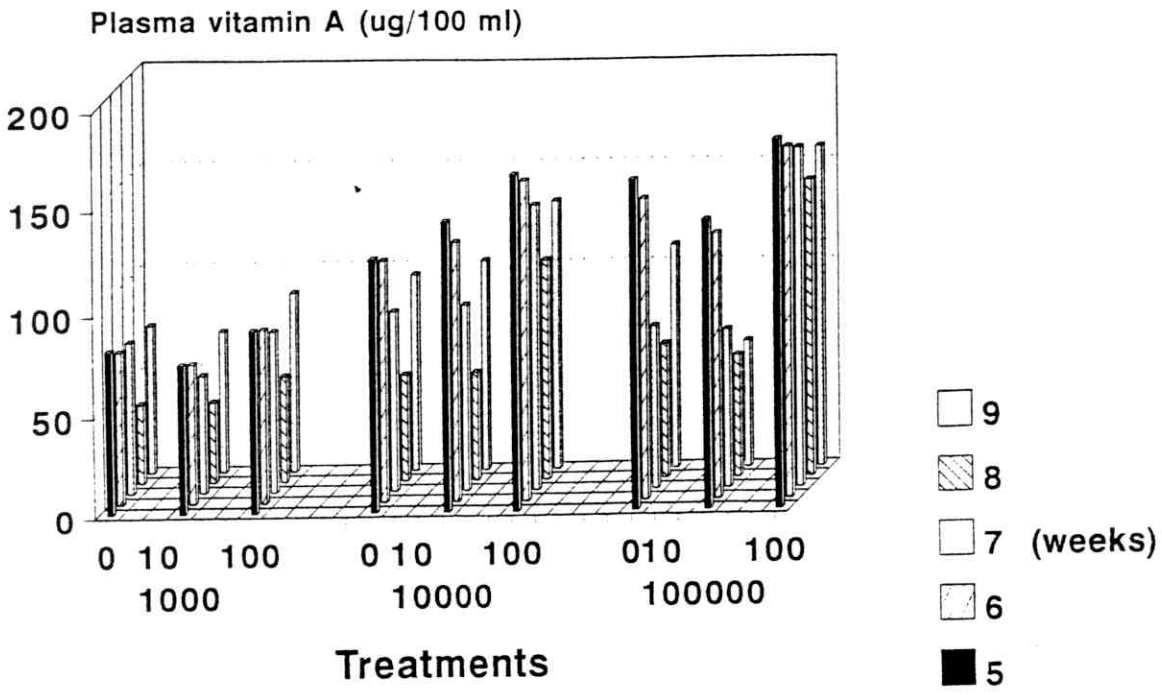


Fig.(1):Effect of dietary vitamin A and E levels on plasma vitamin A concentration of Hubbard broiler chicks

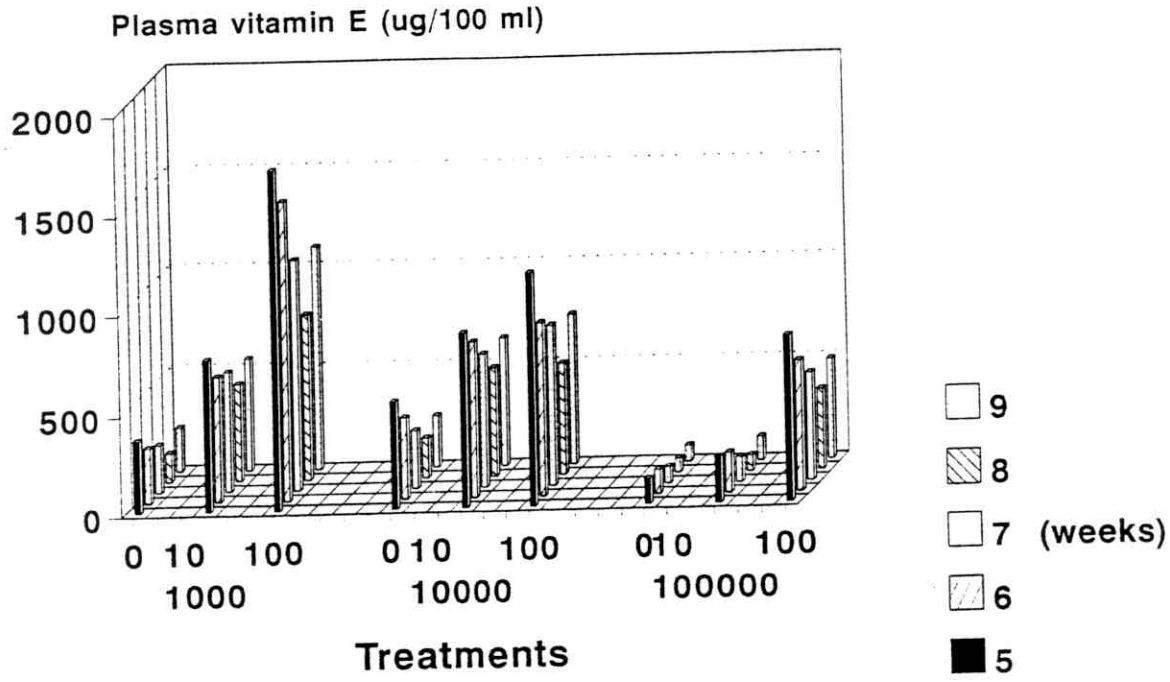


Fig.(2):Effect of dietary vitamin A and E levels on plasma vitamin E concentration of Hubbard broiler chicks

The significant decrease of plasma vitamin A and E with advancing age might be considered as an indication of the gradual increase of vitamin A and E requirements for the growing broiler chicks (Pudelkiewicz *et al.*, 1964a). Also, Bring *et al.* (1965) found a significant decrease ($P<0.01$) of serum vitamin A of rats with increasing age.

Analysis of variance (Table 6) showed a significant increase ($P<0.01$) in plasma vitamin A concentration corresponded to increasing dietary vitamin A at all ages. i.e., at 9th week (end of experimental period) plasma vitamin A concentration increased from 73.1 ± 10.0 to 109.5 ± 13.5 µg/100 ml with increasing dietary vitamin A level from 1000 to 100,000 IU/kg without vitamin E. These results are in agreement with those reported by Donoghue *et al.* (1979).

Increasing dietary levels of vitamin E significantly ($P<0.01$) enhanced plasma vitamin A concentrations at all levels of dietary vitamin A. However, the enhancing effect was more pronounced at moderate level (10,000 IU/kg) when compared with high level (100,000 IU/kg) of vitamin A. These results agreed with that obtained by Abawi and Sullivan (1989) since increasing levels of vitamin E enhanced plasma vitamin A concentration to a greater extent with higher dietary vitamin A supplementation (1000 to 100,000 IU/kg). The increase in plasma vitamin A concentration with increasing dietary vitamin E may be attributed to the effect of

vitamin E in enhancing the intestinal absorption of vitamin A (Arnich and Arthur, 1980).

Increasing dietary levels of vitamin E significantly ($P<0.01$) enhanced plasma vitamin E concentrations at all levels of dietary vitamin A, i.e., increasing dietary vitamin E levels from 0 to 100 IU/kg increased plasma vitamin E levels from 220.2±12.9 to 1107.8±49.8 µg/100 ml in broiler fed deficient vitamin A (1000 IU/kg) at 9th week (end of the experimental period) and from (256.3±24.2 and 80.0±4.4) to (745.7±22.1 and 497.3±36.7) µg/100 ml, respectively in broiler fed moderate (10,000 IU/kg) and excessive (100,000 IU/kg) levels of dietary vitamin A at 9th week. These results agreed with those of Abawi and Sullivan (1989). However, levels of vitamin E were reduced in a linear fashion with increasing dietary levels of vitamin A, i.e. it decreased from 1107.8±49.8 to 745.7±22.1 µg/100 ml with increasing dietary vitamin A from 1000 to 10,000 IU/kg and decreased from 745.7±22.1 to 497.3±36.7 µg/100 ml with increasing dietary vitamin A from 10,000 to 100,000 IU/kg diet in broiler fed high levels of vitamin E (100 IU/kg) at 9th week (end of the experimental period).

The significant decrease ($P<0.01$) of plasma vitamin E with increasing dietary vitamin A levels may be attributed to the high intakes of vitamin A either directly or indirectly interfere with the absorption of tocopherol or destroy it in the intestine

(Pudelkiewicz *et al.*, 1964a). A similar loss of vitamin E can be reasonably postulated from the role of vitamin E in protecting vitamin A from oxidation destruction (Alderson *et al.*, 1971). Three possibilities were postulated by Bieri *et al.* (1981) which might declare the significant reduction of plasma vitamin E with increasing dietary vitamin A levels: 1) increased turnover of α-tocopherol in the blood and tissue, 2) decreased intestinal absorption of vitamin E; and 3) increased destruction of vitamin E in the intestine. Also, Sklan and Donoghue (1982) indicated that high levels of dietary vitamin A increased oxidation of dietary vitamin E in the starting part of the small intestine and increased vitamin E turnover. Moreover, vitamin A significantly depresses the utilization of all forms of vitamin E fed, as measured by plasma vitamin E levels (Combs, 1978).

4.1.2. Plasma calcium and phosphorus concentrations:

Data concerning the effect of dietary vitamin A and E levels on plasma calcium and phosphorus concentrations of Hubbard broiler chicks were presented in Table (5) and illustrated graphically in Fig. (3 and 4).

Results obtained showed that, plasma calcium and phosphorus concentrations decreased in all experimental groups by advancing age up to the end of the experimental period. Analysis of variance showed significant effect ($P<0.01$) of ages on plasma calcium and phosphorus concentrations (ANOVA Table, 6).

Table (5): Effect of dietary vitamin A and E levels on plasma calcium and phosphorus concentrations of Hubbard broiler chicks.

Treatment of vitamins (IU/kg)		Plasma calcium (mg/100 ml ± S.E.)					Plasma phosphorus (mg/100 ml ± S.E.)				
A	E	5th wk	6th wk	7th wk	8th wk	9th wk	5th wk	6th wk	7th wk	8th wk	9th wk
1000	0	8.15±0.42	7.29±0.37	6.11±0.62	5.35±0.28	3.73±0.07	4.10±0.12	3.86±0.07	3.34±0.20	2.67±0.20	1.82±0.23
	10	6.39±0.23	6.57±0.31	5.34±0.13	3.93±0.09	3.59±0.06	3.37±0.19	2.84±0.13	2.28±0.14	1.98±0.08	1.48±0.16
	100	6.08±0.08	5.43±0.12	5.32±0.27	5.02±0.19	3.93±0.09	3.02±0.16	2.57±0.17	2.48±0.18	2.46±0.19	1.79±0.12
10,000	0	9.34±0.46	8.36±0.70	6.14±0.06	4.50±0.09	3.29±0.06	4.49±0.20	4.06±0.13	3.41±0.15	2.40±0.21	1.51±0.15
	10	6.26±0.22	5.84±0.45	5.50±0.14	4.78±0.44	4.57±0.18	3.04±0.19	2.82±0.15	2.78±0.16	2.43±0.21	2.42±0.15
	100	6.55±0.25	5.93±0.15	5.61±0.16	4.35±0.15	4.07±0.03	3.12±0.18	2.51±0.17	2.49±0.20	2.32±0.16	2.02±0.14
100,000	0	9.56±0.21	7.50±0.89	6.08±0.09	5.93±0.36	5.83±0.18	4.50±0.20	3.91±0.16	2.96±0.20	2.59±0.15	2.47±0.13
	10	6.67±0.24	6.07±0.22	5.86±0.17	4.00±0.13	4.06±0.03	3.26±0.15	2.56±0.19	2.43±0.16	1.78±0.11	1.75±0.12
	100	6.69±0.22	5.75±0.21	4.89±0.04	4.75±0.25	3.77±0.28	3.41±0.16	2.51±0.18	2.49±0.18	2.44±0.15	1.78±0.13

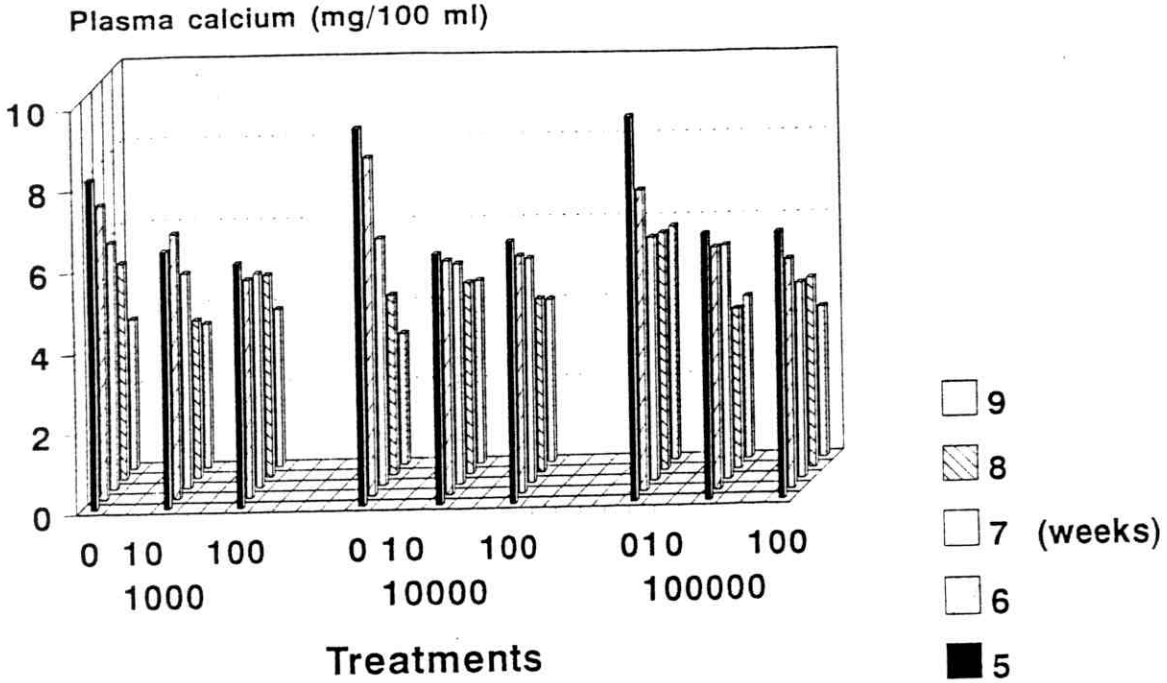


Fig.(3):Effect of dietary vitamin A and E levels on plasma calcium concentration of Hubbard broiler chicks

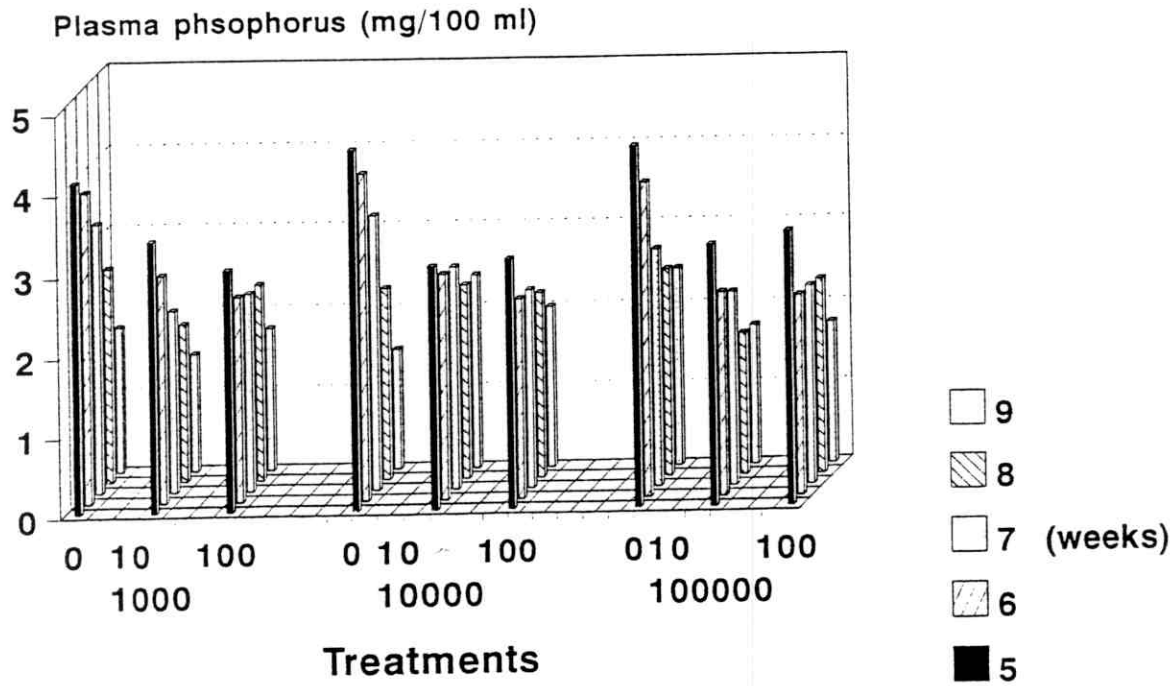


Fig.(4):Effect of dietary vitamin A and E levels on plasma phosphorus concentration of Hubbard broiler chicks

Table (6): ANOVA of effect of dietary vitamin A and E levels on plasma vitamin A, E, calcium and phosphorus concentrations of Hubbard broiler chicks.

S.O.V.	d.f.	Vitamin A (M.S.)	Vitamin E (M.S.)	Calcium (M.S.)	Phosphorus (M.S.)
Replication	3	325.967	9048.100	0.359	0.106
Vitamin A	2	49931.242**	3063154.264**	0.813	0.210
Vitamin E	2	30812.193**	6638498.041**	23.924**	10.304**
A xE	4	4632.468**	635220.010**	0.309	0.314*
Age	4	19538.953**	693874.833**	61.832**	14.035**
A x age	8	1764.518**	30333.214**	1.284**	0.359**
E x age	8	947.874**	95030.224**	6.129**	1.646**
A x E x age	16	440.684**	15242.339**	1.448**	0.304**
Error	132	155.573	3028.096	0.358	0.107

* $P < 0.05$, ** $P < 0.01$.

ANOVA: analysis of variance. S.O.V.: Source of variation. d.f.: degree of freedom M.S.: means square.

Results obtained did not show any significant effect of dietary vitamin A levels on plasma calcium and phosphorus concentrations. Conversely, vitamin E had significant effect ($P<0.01$) and the interaction of vitamins A x E ($P<0.05$) on plasma calcium and phosphorus concentrations (ANOVA Table, 6). Increasing the level of vitamin E in the diet lead to a significant decrease ($P<0.01$) in plasma calcium and phosphorus concentrations by advancing age up to 7th week. The decrease in plasma calcium was pointed out from (8.15±0.42 to 6.08±0.08), (9.34±0.46 to 6.55±0.25) and (9.56±0.21 to 6.69±0.22) mg/100 ml in broiler fed deficient, optimum and excessive levels of dietary vitamin A respectively at 5th week old broiler chicks.

At 9th week (end of the experimental period) increasing dietary vitamin E had no effect on plasma calcium concentration of broiler fed deficient dietary vitamin A level. However, feeding broilers excessive vitamin A level led to depression of plasma calcium from 5.83±0.18 to 3.77±0.28 mg/100 ml. Conversely, plasma calcium concentration increased from 3.29±0.06 to 4.07±0.03 mg/100 ml with increasing dietary vitamin E from 0 to 100 IU/kg in broiler fed moderate vitamin A level.

A general trend towards decrement of total plasma phosphorus was observed with increasing levels of dietary vitamin E. It decreased from (4.10±0.12 to 3.02±0.16), (4.49±0.20 to 3.12±0.18) and (4.50±0.20 to 3.41±0.16) mg/100 ml in broiler

fed deficient, optimum and excessive levels of vitamin A, respectively with increasing dietary vitamin E from 0 to 100 IU/kg at 5th week old broiler chicks. At 9th week (end of the experimental period) increasing dietary vitamin E had no effect on plasma phosphorus concentration of broiler fed deficient vitamin A level. However, the broiler fed excessive vitamin A induced depression of plasma phosphorus level (from 2.47±0.13 to 1.78±0.13 mg/100 ml). Conversely, broilers fed moderate vitamin A levels increased plasma phosphorus from 1.51±0.15 to 2.02±0.14 mg/100 ml with increasing dietary vitamin E level from 0 to 100 IU/kg.

It can be concluded that, excess vitamin E significantly lowered ($P<0.01$) the concentrations of plasma calcium and phosphorus. Therefore, it is postulated that vitamin D is dissolved in the unhydrolyzed and possibly nonsolubilized tocopheryl acetate which passes through the gut in an unabsorbed form. This may explain the vitamin E x vitamin D interactions (Murphy *et al.*, 1981). Consequently, deficient vitamin D significantly lowered plasma calcium and phosphorus levels. These results support the evidence presented by March *et al.* (1973) that excess vitamin E increases the requirement for vitamin D by the chick. The increasing plasma calcium and phosphorus concentrations in broiler fed moderate levels of vitamin A with increasing dietary vitamin E levels at 9th week (end of the experimental period) may be attributed to the increased turnover of calcium and phosphorus

levels in bones of broiler chicks fed high dietary vitamin E levels for prolonged period (Yang and Desai, 1977).

4.2. Effect of dietary levels of vitamin A and E on lipid composition and liver function of Hubbard broiler chicks:

4.2.1. Lipid composition of Hubbard broiler chicks:

4.2.1.1. Plasma total lipids and triglycerides:

Table (7) shows the effect of dietary levels of vitamin A and E on plasma total lipids and trigylcerides of Hubbard broiler chicks. Data are illustrated graphically in Fig. (5 and 6).

Results obtained show that plasma total lipids and triglycerides decreased in all experimental groups by advancing age up to 8th week, after which a remarkable increase in the 9th week (end of the experimental period). Analysis of variance showed a significant effect of age ($P<0.01$) on plasma total lipids and triglycerides requirements (ANOVA Table, 9). The significant decrease of plasma total lipids and triglycrides with advancing age may be indicative for the gradual increase in the total lipids and triglycerides requirements of the growing broiler chicks.

Analysis of variance showed a significant effect ($P<0.01$) of dietary levels of vitamin A and E and the interaction of vitamin A with E on plasma total lipids and trigylcerides. These results are correspondence with those of Bring *et al.* (1965).

Table (7): Effect of dietary vitamin A and E levels on plasma total lipids and triglycerides concentrations of Hubbard broiler chicks.

Treatment of vitamins (IU/kg)		Plasma total lipids (mg/100 ml ± S.E.)					Plasma triglycerides (mg/100 ml ± S.E.)				
A	E	5th wk	6th wk	7th wk	8th wk	9th wk	5th wk	6th wk	7th wk	8th wk	9th wk
1000	0	463.8±10.5	409.2±11.2	387.1±13.1	336.3±7.1	386.8±6.2	179.4±6.2	155.8±8.9	154.0±5.8	122.9±6.0	150.3±7.1
	10	404.2± 8.3	374.4±4.7	353.7±7.1	294.7±8.3	348.6±7.3	160.9±7.1	153.0±6.2	146.8±9.2	110.7±6.5	132.6±6.1
	100	512.6±10.9	464.8±8.4	421.8±8.7	372.1±8.5	410.9±7.5	200.1±7.0	184.1±6.6	175.1±7.1	140.9±9.0	172.6±8.6
10,000	0	606.1± 8.8	539.6±4.3	499.7±7.9	430.0±9.3	485.7±8.9	225.2±9.5	201.0±7.5	189.4±6.5	177.5±6.9	180.3±7.8
	10	527.6±10.5	477.5±6.5	448.7±9.1	398.0±10.3	438.9±6.5	191.7±6.7	190.9±7.7	173.7±8.1	162.1±5.9	167.1±8.4
	100	435.9± 8.4	407.6±9.3	372.8±8.8	337.0±9.2	378.7±11.7	169.4±8.5	158.0±8.1	142.1±7.7	123.2±7.9	145.7±7.8
100,000	0	554.1± 7.1	516.1±8.5	437.3±10.3	422.6±8.8	492.7±7.1	201.5±8.0	188.9±7.2	174.9±7.8	150.7±6.8	180.8±6.3
	10	492.6± 6.7	449.3±8.0	421.8±7.9	372.0±8.1	427.4±8.0	182.3±8.6	172.7±7.1	161.2±6.9	148.1±8.1	167.4±8.0
	100	689.9± 9.7	638.1±9.1	587.9±6.5	524.9±6.7	586.7±6.5	238.1±8.0	228.1±8.6	212.9±6.5	200.3±8.2	220.8±7.6

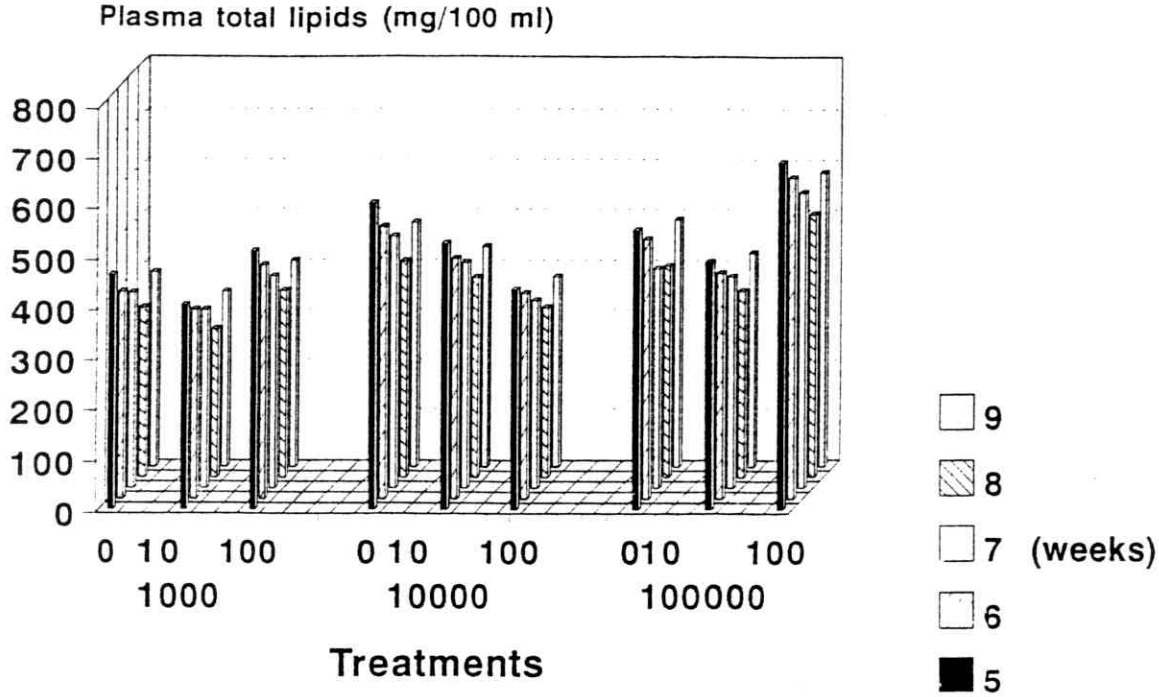


Fig.(5):Effect of dietary vitamin A and E levels on plasma total lipids concentration of Hubbard broiler chicks

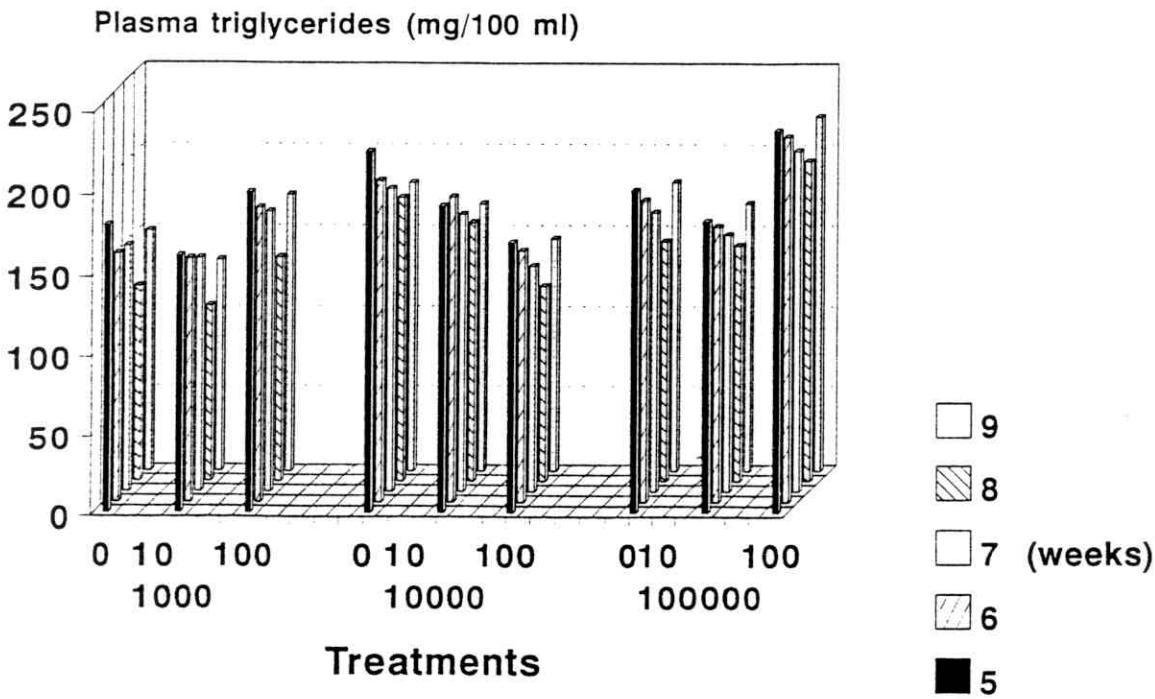


Fig.(6):Effect of dietary vitamin A and E levels on plasma triglycerides concetration of Habbard broiler chicks

The obtained results (Table, 7) showed that, increasing dietary vitamin A from 1000 to 100,000 IU/kg significantly increased ($P<0.01$) plasma total lipids from 386.8±6.2 to 492.7±7.1, from 348.6±7.3 to 427.4±8.0 and from 410.9±7.5 to 586.7±6.5 mg/100 ml in broiler fed deficient, optimum and excessive levels of vitamin E respectively at 9th week (end of the experimental period). These increments of plasma total lipids with increasing dietary vitamin A may be attributed to the effects of excess vitamin A on the stimulation of the adrenal gland activity, resulting in increased corticosteriod synthesis and secretion, consequently increasing lipid metabolism (Ram and Misra, 1975).

Increasing dietary levels of vitamin E from 0 to 10 IU/kg resulted in a significant decrease ($P<0.01$) in plasma total lipids from 386.8±6.2 to 348.6±7.3, from 485.7±8.9 to 438.9±6.5 and from 492.7±7.1 to 427.4±8.0 mg/100 ml in broiler fed deficient, under optimum and excessive levels of vitamin A, respectively at the end of experimental period. From the same results it is clear that excessive level of vitamin E (100 IU/kg) led to an increase in plasma total lipids in broiler fed high vitamin A levels from 492.7±7.1 to 586.7±6.5 mg/100 ml. The effect of excessive vitamin E on plasma total lipids in broiler fed highest levels of vitamin A resulted from increasing the intestinal absorption of vitamin A by increasing dietary vitamin E (Arnich and Arthur, 1980).

Plasma trigylcerides significantly increased ($P<0.01$) with increasing dietary vitamin A. It increased from 150.3±7.1 to 180.8±6.3, from 132.6±6.1 to 167.4±8.0 and from 172.6±8.6 to 220.8±7.6 mg/100 ml with increasing dietary vitamin A from 1000 to 100,000 IU/kg in broiler fed deficient, optimum and excessive levels of dietary vitamin E respectively as shown in Table (7). These results are in agreement with those reported by Erdman *et al.* (1977). Also, plasma triglycerides increased from 150.3±7.1 to 172.6±8.6 and from 180.8±6.3 to 220.8±7.6 mg/100 ml in broiler fed deficient and excessive levels of vitamin A with increasing dietary vitamin E from 0 to 100 IU/kg till the end of experimental period. These results are in accordance with those reported by Arnich and Arthur (1980).

4.2.1.2. Plama phospholipids and cholesterol:

Table (8) shows the effect of dietary vitamin A and E levels on plasma phospholipids and cholesterol of Hubbard broiler chicks. The obtained results show that plasma phospholipids and cholesterol gradually and significantly decreased ($P<0.01$) by advancing age up to 8th week, after which a remarkable increase was pointed out at 9th week (end of the experimental period). These results coincid with those reported by Bring *et al.* (1965).

Table (8): Effect of dietary vitamin A and E levels on plasma phospholipids and cholesterol concentrations of Hubbard broiler chicks.

Treatment of vitamins (IU/kg)		Plasma phospholipids (mg/100 ml ± S.E.)					Plasma cholesterol (mg/100 ml ± S.E.)				
A	E	5th wk	6th wk	7th wk	8th wk	9th wk	5th wk	6th wk	7th wk	8th wk	9th wk
1000	0	148.8±5.5	134.4±5.2	124.3±6.2	114.4±5.9	127.8±7.6	121.4±5.8	119.1±6.6	109.2±7.3	95.9±5.4	102.6±8.6
	10	124.3±6.1	114.1±6.0	103.1±5.7	95.9±4.6	113.3±5.6	109.7±6.1	107.5±5.8	99.1±6.8	76.7±7.3	94.4±6.1
	100	180.6±6.8	154.3±7.8	130.7±8.1	115.8±6.3	125.6±6.5	133.6±5.9	120.7±7.0	113.2±6.6	108.4±7.7	113.6±5.9
10,000	0	196.8±5.4	179.8±6.5	158.9±7.0	123.2±5.9	154.8±8.4	179.2±7.1	165.8±7.0	143.5±8.9	117.9±6.7	149.5±8.3
	10	181.1±7.3	161.1±7.9	150.8±7.0	124.1±6.5	149.1±8.1	149.2±7.6	138.0±7.2	122.0±8.3	112.2±6.3	118.5±6.3
	100	137.0±4.7	123.6±4.6	121.9±5.4	102.6±5.3	119.7±7.6	120.5±7.9	118.0±9.5	101.7±6.3	105.2±8.0	109.0±6.0
100,000	0	182.8±7.4	168.1±7.0	162.1±8.0	138.1±5.4	160.2±8.1	163.7±8.7	159.1±6.8	141.5±7.8	127.5±6.7	145.3±8.7
	10	165.1±5.7	150.0±6.8	130.1±6.3	114.8±6.1	132.6±4.5	147.1±6.2	126.5±8.4	120.9±7.8	108.8±6.3	121.2±7.5
	100	240.6±8.5	200.3±8.1	186.8±5.4	152.9±6.1	191.3±7.7	200.7±8.2	176.4±5.8	161.5±7.2	150.4±7.3	170.8±8.2

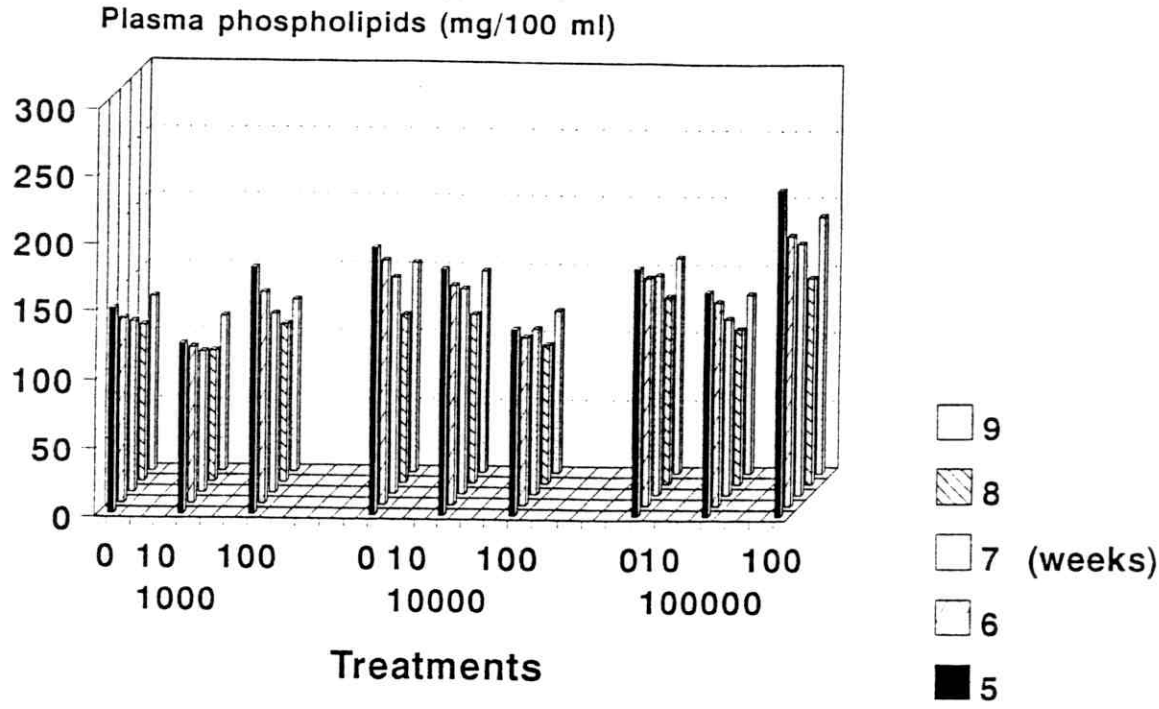


Fig.(7):Effect of dietary vitamin A and E levels on plasma phospholipids concentration of Hubbard broiler chicks

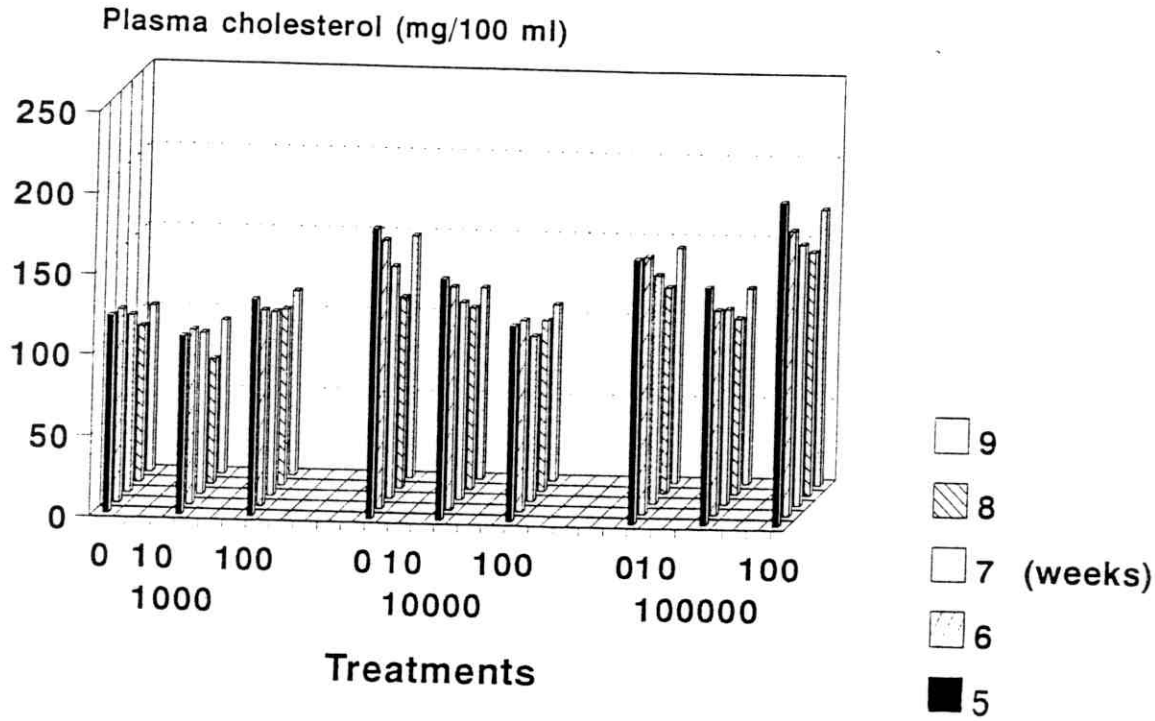


Fig.(8):Effect of dietary vitamin A and E levels on plasma cholesterol concentration of Hubbard broiler chicks

Table (9): ANOVA of effect of dietary vitamin A and E levels on plasma total lipids, triglycerides, phospholipids and cholesterol concentrations of Hubbard broiler chicks.

S.O.V.	d.f.	Total lipids (M.S.)	Triglycerides (M.S.)	Phospholipids (M.S.)	Cholesterol (M.S.)
Replication	3	290.680	315.977	94.634	2457.192
Vitamin A	2	198844.027**	15971.334**	20808.047**	23763.101**
Vitamin E	2	64946.939**	6004.825**	6246.597**	6597.296**
A xE	4	100518.327**	13430.936**	12094.431**	7380.182**
Age	4	86728.819**	10350.097**	14062.766**	6708.522**
A x age	8	204.619	283.631	241.378	142.258
E x age	8	419.141	132.025	173.468	144.808
A x E x age	16	695.577**	58.723	362.256*	163.522
Error	132	284.352	244.260	175.297	156.923

* $P < 0.05$, ** $P < 0.01$.

Analysis of variance showed a significant interaction effect ($P<0.01$) of dietary vitamin A and E levels on plasma phospholipids and cholesterol (ANOVA Table, 9). A significant increase ($P<0.01$) in plasma phospholipids with increasing level of dietary vitamin A. It increased from 127.8±7.6 to 160.2±8.1, from 113.3±5.6 to 132.6±4.5 and from 125.6±6.5 to 191.3±7.7 mg/100 ml with increasing dietary vitamin A from 1000 to 100,000 IU/kg in broilers fed deficient, optimum and excessive levels of dietary vitamin E, respectively at 9th week. These results are in agreement with those reported by Mathur *et al.* (1974) and Misra (1974).

On the contrary, increasing dietary levels of vitamin E from 0 to 10 IU/kg led to a significant decrease in plasma phospholipids from 127.8±7.6 to 113.3±5.6, from 154.8±8.4 to 149.1±8.1 and from 160.2±8.1 to 132.6±4.5 mg/100 ml in broiler fed deficient, optimum and excessive levels of dietary vitamin A, respectively. Increasing vitamin E from 0 to 100 IU/kg diet had no significant effect on plasma phospholipids of broiler fed deficient vitamin A. On the other hand, increasing dietary vitamin E levels from 10 to 100 IU/kg led to an increase in plasma phospholipids from 132.6±4.5 to 191.3±7.7 mg/100 ml of broiler fed excessive vitamin A at 9th week old broiler chicks. These results are almost similar to those reported by Arinch and Arthur (1980).

Results obtained (Table, 8) showed significant effect ($P<0.01$) of vitamin A on plasma cholesterol of Hubbard broiler chicks. Plasma cholesterol increased from 102.6±8.6 to 145.3±8.7, from 94.4±6.1 to 121.2±7.5 and from 113.6±5.9 to 170.8±8.2 mg/100 ml with increasing dietary vitamin A from 1000 to 100,000 IU/kg in broiler fed deficient, optimum and excessive levels of vitamin E, respectively till 9th week old chicks. These results are in agreement with those of Misra (1974) who reported that vitamin A may be necessary for complete synthesis of cholesterol. Also, Wiss *et al.* (1961) showed that vitamin A functions in the biosynthesis of cholesterol in one or more reactions needed for the conversion of squalene to cholesterol.

Results showed a decrease in plasma cholesterol with increasing dietary level of vitamin E, i.e., a decrease from 102.6±8.6 to 94.4±6.1, from 149.5±8.3 to 118.5±6.3 and from 145.3±8.7 to 121.2±7.5 mg/100 ml with increasing dietary vitamin E from 0 to 10 IU/kg in broiler fed deficient, optimum and excessive levels of dietary vitamin A at 9th week old chicks. Conversely, increasing dietary vitamin E to 100 IU/kg increased plasma cholesterol in broiler fed deficient and excessive levels of vitamin A from 102.6±8.6 to 113.6±5.9 and from 145.3±8.7 to 170.8±8.2 mg/100 ml, respectively.

Finally, it could be concluded from the previous results that, the increase of total lipids, triglycerides, phospholipids and

cholesterol in plasma with increasing dietary vitamin A might be attributed to the effect of stimulation of the adrenal gland activity which led to an increase in corticosteroid synthesis and secretion (Singh *et al.*, 1969). Consequently, such process induced changes of lipid concentrations led to the noticed increase in total lipids, triglycerides, phospholipids and cholesterol (Ram and Misra, 1975). Also, the incremental effect of excessive vitamin E on plasma total lipids, triglycerides, phospholipids and cholesterol in broiler fed the highest level of vitamin A may be attributed to the increase occurred in the intestinal absorption of vitamin A by increasing dietary vitamin E (Arnich and Arthur, 1980).

4.2.2. Effect of dietary levels of vitamin A and E on liver function of Hubbard broiler chicks:

The current experiment is mainly concerned with determination of glutamic oxalacetic transaminase (GOT), glutamic pyruvic transaminase (GPT) and alkaline phosphatase activity (APA) enzymes in plasma as a criteria of liver function. Chicks were fed vitamin A and E at different levels during 3 to 9 weeks of age.

4.2.2.1. Plasma GOT:

Data concerning the effect of dietary vitamin A and E levels on the average plasma glutamic oxalacetic transaminase (GOT) of Hubbard broiler chicks are presented in Table (10) and illustrated

.

Table (10): Effect of dietary vitamin A and E levels on plasma glutamic oxalacetic transaminase (GOT) activity of Hubbard broiler chicks.

Treatment (IU/kg)		U/liter ± S.E.				
A	E	5th wk	6th wk	7th wk	8th wk	9th wk
1,000	0	27.00±0.40	50.50±3.70	36.00±2.48	70.50±5.50	64.25±2.25
	10	28.25±3.39	45.00±2.85	31.25±3.70	55.25±5.72	60.50±5.23
	100	23.50±1.89	35.00±0.81	19.75±2.32	54.25±6.98	54.00±0.70
10,000	0	29.25±0.85	59.75±4.09	37.00±1.08	63.50±3.86	70.00±2.12
	10	28.50±0.50	52.00±2.54	32.00±3.94	77.50±2.50	67.50±4.50
	100	25.50±1.55	36.50±5.56	30.00±2.67	65.25±5.17	65.00±3.48
100,000	0	33.00±0.40	68.00±3.34	38.00±3.08	77.50±4.90	95.00±4.60
	10	28.75±1.10	58.00±3.89	45.50±1.04	77.25±5.39	77.00±3.18
	100	25.50±0.64	47.00±1.08	38.25±3.01	77.25±1.65	74.50±2.50

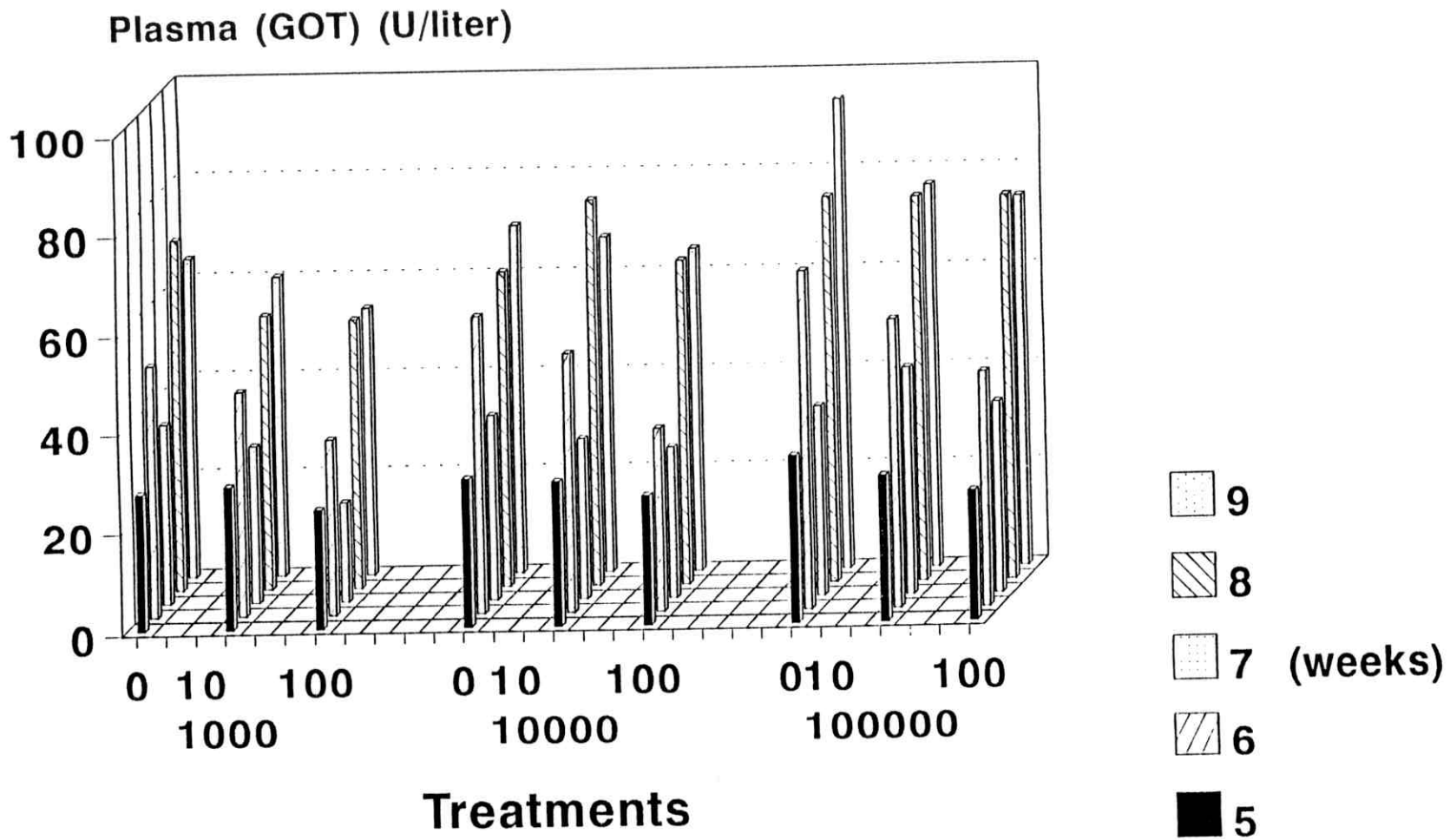


Fig.(9):Effect of dietary vitamin A and levels on plasma (GOT) of Hubbard broiler chicks

graphically in Fig. (9). Increasing dietary vitamin A levels led to a significant increase ($P<0.01$) in plasma GOT all over the experimental period (ANOVA Table 13). Increasing dietary vitamin A from 1000 to 10,000 IU/kg led to an increase in plasma GOT from 64.25±2.25 to 70.00±2.12 µ/liter at the end of experimental period in broiler fed deficient vitamin E. Also, a greater increase in plasma GOT from 70.00±2.12 to 95.00±4.60 µ/liter with increasing dietary vitamin A from 10,000 to 100,000 IU/kg diet. Theses results are in agreement with those reported by Donoghue *et al.* (1979). The great increase in the release GOT from the liver in rats was due to excess vitamin A intake (Ludwing, 1962). Rivetz *et al.* (1977) attributed such phenomenon to hypervitaminotic A which cause some damage of the spleen and liver.

Analysis of variance showed a significant decrease ($P<0.01$) in plasma GOT of Hubbard broiler chicks all over the experimental period with increasing dietary vitamin E levels. Results obtained Table (10) showed a decrease in plasma GOT from 64.25±2.25 to 60.50±5.23, from 70.00±2.12 to 67.50±4.50 and from 95.00±4.60 to 77.00±3.18 µ/liter in broilers fed deficient, optimum and excessive levels of dietary vitamin A, respectively with increasing dietary vitamin E from 0 to 10 IU/kg at 9th week old broilers. Also, a greater decrease in plasma GOT with increasing dietary vitamin E from 10 to 100 IU/kg diet at all vitamin A levels. These results are agree with those of Nieman

and Obbink (1954) who noticed an increase in GOT with tocopherol deficiency. Also, Zamora *et al.* (1991) came to the same conclusion with both GOT and GPT.

Analysis of variance showed a significant effect ($P<0.01$) of age on plasma GOT of Hubbard broiler chicks (ANOVA Table, 13). Results obtained (Table, 10) showed that weekly average of plasma GOT was increased by advancing age.

4.2.2.2. Plasma GPT:

Data concerning the effect of dietary vitamin A and E levels on the activity of plasma glutamic pyruvic transaminase (GPT) of Hubbard broiler chicks is presented in Table (11) and illustrated graphically in Fig. (10). On the contrary of GOT a decreased plasma GPT from 19.75 ± 0.43 to 15.35 ± 1.54, from 19.60 ± 0.49 to 14.50 ± 0.20 and from 19.32 ± 0.69 to 15.87 ± 1.51 μ/liter in broiler fed deficient, optimum and excessive levels of dietary vitamin A respectively at 9th week with increasing dietary vitamin E from 0 to 10 IU/kg. Also, a general decrease was noticed as shown in (Table, 11) in plasma GPT with increasing dietary vitamin E from 10 to 100 IU/kg diet all over the experimental period. In this respect, Zamora *et al.* (1991) reported similar results.

Analysis of variance showed a significant effect ($P<0.01$) of age on plasma GPT activity of Hubbard broiler chicks. Plasma GPT tended to increase with advancing age.

and Obbink (1954) who noticed an increase in GOT with tocopherol deficiency. Also, Zamora *et al.* (1991) came to the same conclusion with both GOT and GPT.

Analysis of variance showed a significant effect ($P<0.01$) of age on plasma GOT of Hubbard broiler chicks (ANOVA Table, 13). Results obtained (Table, 10) showed that weekly average of plasma GOT was increased by advancing age.

4.2.2.2. Plasma GPT:

Data concerning the effect of dietary vitamin A and E levels on the activity of plasma glutamic pyruvic transaminase (GPT) of Hubbard broiler chicks is presented in Table (11) and illustrated graphically in Fig. (10). On the contrary of GOT a decreased plasma GPT from 19.75±0.43 to 15.35±1.54, from 19.60±0.49 to 14.50±0.20 and from 19.32±0.69 to 15.87±1.51 μ/liter in broiler fed deficient, optimum and excessive levels of dietary vitamin A respectively at 9th week with increasing dietary vitamin E from 0 to 10 IU/kg. Also, a general decrease was noticed as shown in (Table, 11) in plasma GPT with increasing dietary vitamin E from 10 to 100 IU/kg diet all over the experimental period. In this respect, Zamora *et al.* (1991) reported similar results.

Analysis of variance showed a significant effect ($P<0.01$) of age on plasma GPT activity of Hubbard broiler chicks. Plasma GPT tended to increase with advancing age.

Table (11): Effect of dietary vitamin A and E levels on the activity of plasma glutamic pyruvic transaminase (GPT) of Hubbard broiler chicks.

Treatment (IU/kg)		U/liter ± S.E.				
A	E	5th wk	6th wk	7th wk	8th wk	9th wk
1,000	0	10.25±0.58	11.32±0.42	9.90±0.20	13.80±1.80	19.75±0.43
	10	8.95±0.44	10.30±0.44	8.62±0.42	13.65±1.54	15.35±1.54
	100	7.92±0.36	9.57±0.33	7.65±0.33	12.20±0.94	13.30±0.36
10,000	0	10.97±0.45	12.45±0.53	10.45±0.34	15.05±0.39	19.60±0.49
	10	9.20±0.41	10.35±0.25	8.77±0.39	12.37±0.37	14.50±0.20
	100	8.82±0.36	9.85±0.42	8.37±0.39	12.27±0.83	13.45±0.74
100,000	0	10.15±0.25	11.17±0.30	9.67±0.29	12.55±1.15	19.32±0.69
	10	8.87±0.39	9.42±0.43	8.65±0.29	12.57±0.42	15.87±1.51
	100	8.67±0.25	8.80±0.36	8.35±0.30	13.12±0.82	16.50±1.06

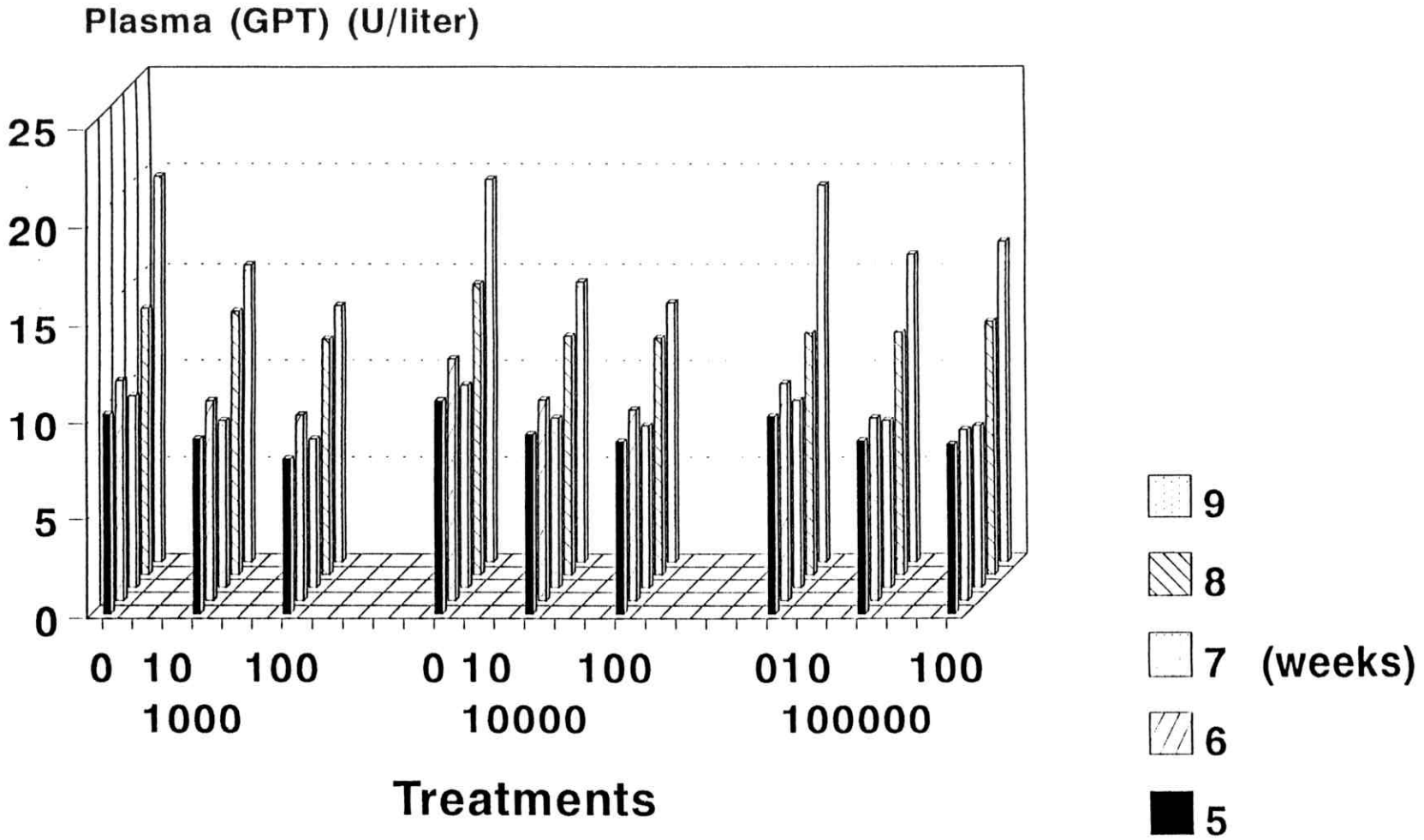


Fig.(10):Effect of dietary vitamin A and E levels on plasma (GPT) of Hubbard broiler chicks

4.2.2.3. Plasma APA:

The effect of dietary vitamin A and E levels on plasma alkaline phosphatase activity (APA) of Hubbard broiler chicks are presented in Table (12) and illustrated graphically in Fig. (11).

Analysis of variance showed significant effect ($P<0.01$) of dietary vitamin A levels on plasma (APA) of Hubbard broiler chicks all over the experimental period (ANOVA Table, 13). Increasing dietary vitamin A levels from moderate (10,000) to excessive level (100,000) IU/kg diet led to a significant decrease ($P<0.01$) of plasma (APA) from 77.80 ± 1.72 to 65.40 ± 3.49 μ/100 ml at the end of experimental period in broiler fed deficient vitamin E. These results coincide with those of Baker *et al.* (1967).

Results obtained in Table (12) showed a significant effect ($P<0.05$) of dietary vitamin E levels on plasma (APA) of Hubbard broiler chicks. Increasing dietary vitamin E from 0 to 100 IU/kg possessed an increase in plasma (APA). Broilers fed deficient and excessive vitamin A levels were associated with increases in their plasma (APA) from 66.85 ± 6.17 to 76.85 ± 0.72 and from 65.40 ± 3.49 to 77.50 ± 0.08 μ/100 ml, respectively till the end of experimental period. These results are in corresponde with those of Franchini *et al.* (1988).

Table (12): Effect of dietary vitamin A and E levels on plasma alkaline phosphatase activity (APA) Hubbard broiler chicks.

Treatment (IU/kg)		U/100 ml ± S.E.				
A	E	5th wk	6th wk	7th wk	8th wk	9th wk
1,000	0	173.65±29.13	147.10±16.91	122.15± 9.33	109.35±23.66	66.85±6.17
	10	196.52±10.78	189.02±16.33	182.45±24.49	124.75±15.03	76.15±1.30
	100	207.35± 1.77	206.71± 6.65	206.85±12.74	131.17±13.55	76.85±0.72
10,000	0	144.17±17.80	138.55±10.50	131.47± 9.39	139.75±11.51	77.80±1.72
	10	193.20±12.51	193.30± 3.56	193.92± 8.64	57.22± 7.85	53.52±3.62
	100	185.90±28.81	180.12±10.99	148.92±24.77	70.60±12.94	55.00±5.83
100,000	0	169.52±26.60	168.62±19.27	169.95±11.84	80.45±11.97	65.40±3.49
	10	168.65±25.70	160.15±12.67	149.27± 1.23	76.57± 3.32	70.52±3.88
	100	124.67± 9.52	115.05± 3.67	104.32±11.77	46.52± 5.89	77.50±0.08

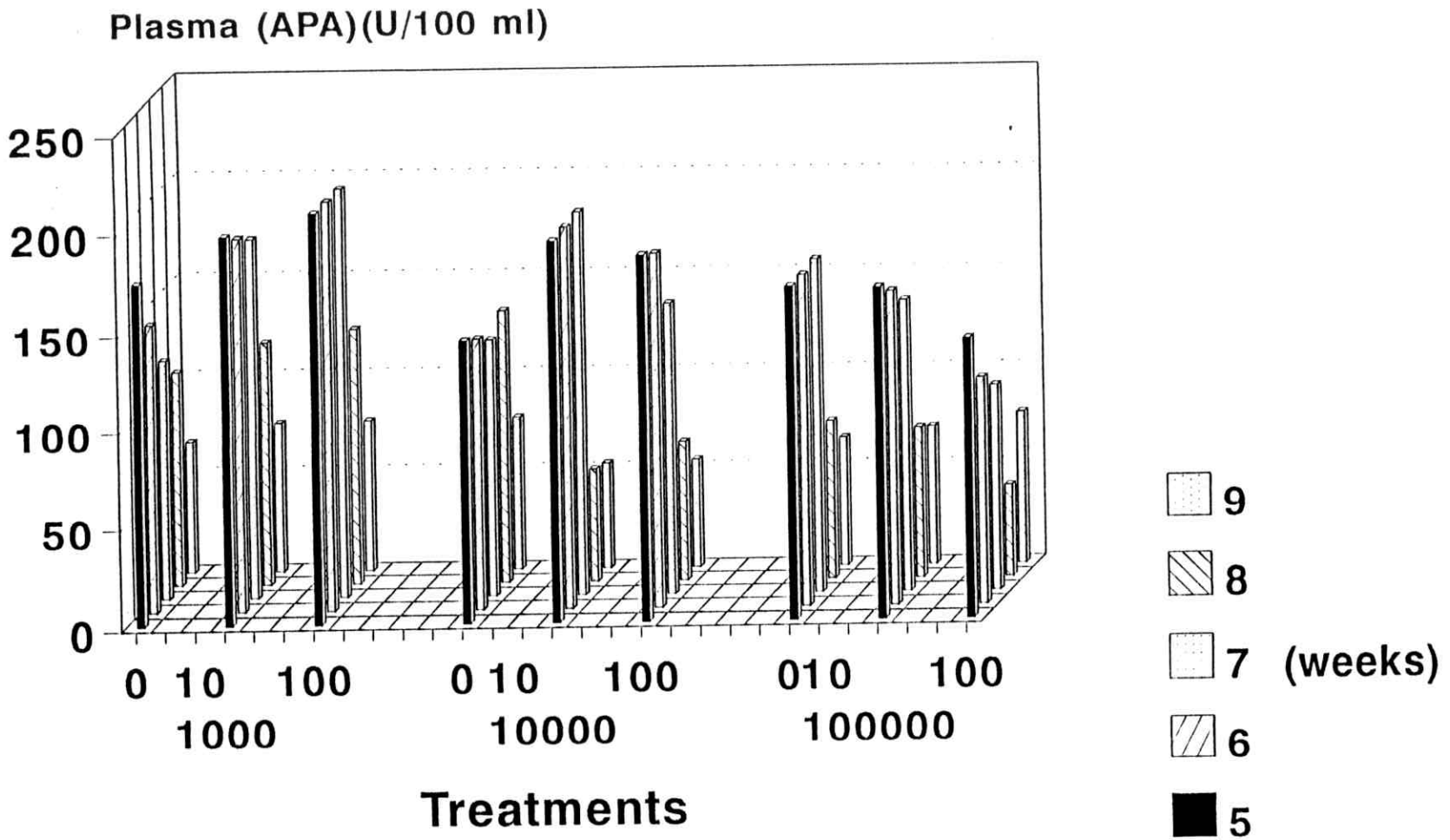


Fig.(11):Effect of dietary vitamin A and E levels on plasma (APA) of Hubbard broiler chicks

Table (13): ANOVA of plasma GOT, GPT and APA of Hubbard broiler chicks.

S.O.V.	d.f.	GOT (M.S.)	GPT (M.S.)	APA (M.S.)
Replication	3	2.376	3.742	1547.115
Vitamin A	2	2845.772**	1.097	14740.639**
Vitamin E	2	1492.356**	103.203**	2464.319*
A x E	4	51.972	5.353*	7854.696**
Age	4	13381.922**	351.771**	81473.383**
A x age	8	169.543**	2.919	1232.900
E x age	8	135.460**	8.359**	2011.013*
A x E x age	16	101.087**	1.034**	2216.371**
Error	132	45.884	1.866	770.531

* $P < 0.05$, ** $P < 0.01$.

Analysis of variance showed a significant effect ($P<0.01$) of age on plasma (APA) of Hubbard broiler chicks (ANOVA Table, 13). Results obtained in Table (12) showed a decrease in plasma (APA) with advancing age in all experimental groups. These results agreed with those reported by Veltmann *et al.* (1986).

Finally, it could be concluded from the previous results that the disturbance in liver function caused a certain increase and high levels of GOT and GPT in plasma of Hubbard broiler chicks which received high levels of vitamin A and E, respectively. The damage and/or disturbance in liver function might be attributed to some disturbances in the enzyme system as reported by Rivetz and Bogin (1982).

4.3. Effect of dietary vitamin E levels on the stability of broilers meat:

Results in Table (14) showed that, supplementation of vitamin E at a concentration of 10 IU/kg diet significantly ($P<0.01$) improved the stability of all tissues tested (ANOVA Table, 15). Increasing dietary vitamin E levels from 0 to 10 IU/kg showed a significant decrease in TBA numbers, from 0.36 ± 0.03 to 0.27 ± 0.05 and from 0.40 ± 0.04 to 0.36 ± 0.04 mg malon-aldehyde/kg in breast and thigh muscle, respectively at 9th week old broiler chicks after 3 months of storage. Increasing concentration of vitamin E from 10 to 100 IU/kg diet caused a

Table (14): Effect of dietary vitamin E concentration on meat stability (TBA) of Hubbard broiler chicks at 7, 8 and 9 weeks of age.

Age week	Vitamin E (IU/kg)	Meat type	Zero time	1st month	2nd month	3rd month
7	0	Breast	0.50±0.04	0.62±0.03	0.73±0.05	0.82±0.04
		Thigh	0.52±0.06	0.62±0.04	0.76±0.02	0.85±0.06
	10	Breast	0.29±0.02	0.35±0.03	0.44±0.03	0.69±0.04
		Thigh	0.35±0.03	0.38±0.04	0.48±0.05	0.71±0.05
	100	Breast	0.16±0.01	0.18±0.01	0.22±0.02	0.31±0.02
		Thigh	0.19±0.01	0.22±0.01	0.25±0.02	0.32±0.03
8	0	Breast	0.40±0.03	0.42±0.05	0.47±0.04	0.63±0.06
		Thigh	0.42±0.05	0.46±0.05	0.58±0.03	0.73±0.06
	10	Breast	0.27±0.03	0.30±0.03	0.32±0.03	0.37±0.04
		Thigh	0.30±0.03	0.35±0.03	0.37±0.05	0.44±0.04
	100	Breast	0.15±0.00	0.19±0.01	0.20±0.02	0.25±0.02
		Thigh	0.16±0.01	0.22±0.02	0.27±0.02	0.32±0.02
9	0	Breast	0.29±0.04	0.33±0.02	0.34±0.02	0.36±0.03
		Thigh	0.34±0.03	0.36±0.03	0.37±0.04	0.40±0.04
	10	Breast	0.17±0.01	0.19±0.00	0.21±0.02	0.27±0.05
		Thigh	0.20±0.02	0.22±0.01	0.24±0.02	0.36±0.04
	100	Breast	0.12±0.01	0.15±0.01	0.18±0.01	0.23±0.02
		Thigh	0.16±0.01	0.17±0.01	0.21±0.02	0.24±0.02

TBA numbers (mg malonaldehyde per 1000 g sample) Mean ± S.E.

Table (15): Analysis of variance of TBA numbers.

S.O.V.	d.f.	M.S.
Replication	2	0.023
Age (A)	2	0.736**
Vitamin E (B)	2	1.676**
A x B	4	0.123**
Meat type (C)	1	0.101**
A x C	2	0.006
B x C	2	0.000
A x B x C	4	0.001
Period (D)	3	0.320**
A x D	6	0.031**
E x D	6	0.016**
A x B x D	12	0.012**
C x D	3	0.003
A x C x D	6	0.002
B x C x D	6	0.000
A x B x C x D	12	0.001
Error	142	0.004

* $P < 0.05$, ** $P < 0.01$.

further improvement, i.e, a decrease TBA numbers of breast and thigh muscle from 0.27±0.05 to 0.23±0.02 and from 0.36±0.04 to 0.24±0.02, respectively with the same previous conditions. It can be concluded that, increasing vitamin E concentration of poultry diets resulted in an increase in the accumulation of α-tocopherol in the muscle and consequently increases the stability of the tissue to oxidative deterioration (Sheehy *et al.*, 1991).

Age of broiler at slaughtering had significantly influenced ($P<0.01$) the oxidation rates with the greatest changes being noted between 7 and 9 weeks of age. Generally, TBA values were lower at 9th week than at earlier age i.e, a significant decrease in TBA number from 0.31±0.02 to 0.23±0.02 and from 0.32±0.03 to 0.24±0.02 in breast and thigh muscle, respectively of broiler fed 100 IU vitamin E/kg diet after 3 months storage. These results are corresponded with those of Marion (1969) who reported a significant decrease of TBA numbers with increasing age.

Breast meat had TBA numbers significantly ($P<0.01$) lower than thigh meat. The TBA numbers were 0.12±0.01 and 0.16±0.01 in fresh breast and thigh meat, respectively of broilers fed 100 IU vitamin E/kg diet at 9th week old. The above observation may be attributed to the amount of tocopherol in tissues. The breast meat had greater concentration of it per unit of fat than thigh tissue (Sheldon, 1984). The TBA numbers were significantly increased ($P<0.01$) with increasing time of storage

from 0.12±0.01 to 0.23±0.02 and from 0.16±0.01 to 0.24±0.02 in breast and thigh meat, respectively of broilers fed 100 IU vitamin E/kg diet at 9th week old with increasing storage to 3 months. These results are in agreement with those reported by Sheldon (1984).

It can be concluded that, significant effect ($P<0.01$) on TBA value was found due to vitamin E treatment and meat type (breast or thigh). Breast muscle was found to be more stable toward oxidation than the thigh. Such results agreed with that obtained by Marion (1969) and Bartov and Bornstein (1976). TBA numbers were significantly decreased ($P<0.01$) with increasing age of broiler after slaughter. TBA numbers increased with increasing time of storage.

4.4. Effect of dietary vitamin A and E on growth parameters:

4.4.1. Body weight, weight gain and rate of growth:

Data presented in Table (16) and illustrated graphically in Fig. (12) showed the weekly body weight average (in g) for the experimental Hubbard broiler groups during a period of 3 to 9 weeks of age.

Inspection of data showed that, the average body weight of chicks gradually and significantly increased ($P<0.01$) from 3rd week up to the end of experimental period. This was quite true in

Table (16): Effect of dietary vitamin A and E levels on body weight of Hubbard broiler chicks.

Treatment (IU/kg)		Average body weight (g) ± S.E.						
A	E	3rd wk	4th wk	5th wk	6th wk	7th wk	8th wk	9th wk
1,000	0	444.46± 7.11	679.00±20.29	871.66±20.28	1085.33±29.50	1441.33±41.37	1695.66±58.99	2176.66±59.52
	10	432.66±11.25	661.33±13.57	839.00±25.33	1050.66±32.16	1346.00±40.18	1640.00±38.66	1839.33±49.31
	100	435.66±11.42	704.00±29.61	907.66±27.18	1155.00±20.37	1580.00±32.45	1927.66±40.54	2327.33±42.78
10,000	0	434.66±10.29	727.00±10.07	922.33±19.87	1170.00±27.16	1644.00±26.93	1950.00±40.54	2371.33±62.48
	10	435.33±10.47	713.66±18.30	948.00±14.24	1192.33±18.88	1661.33±33.39	1979.33±31.69	2382.66±47.48
	100	436.66± 6.27	684.00±15.79	890.66±24.36	1113.66±17.22	1516.00±42.99	1904.33±44.44	2216.66±69.00
100,000	0	433.33±10.09	693.33±19.18	895.33±21.00	1155.00±20.37	1553.00±59.78	1787.33±47.23	2255.66±63.83
	10	435.33±10.40	709.33± 9.72	913.00±22.94	1158.66±31.17	1608.00±28.29	1933.00±52.23	2331.00±39.16
	100	438.00±10.37	676.00±13.25	897.00±18.21	1131.33±36.97	1563.00±25.87	1918.00±36.89	2303.33±52.18

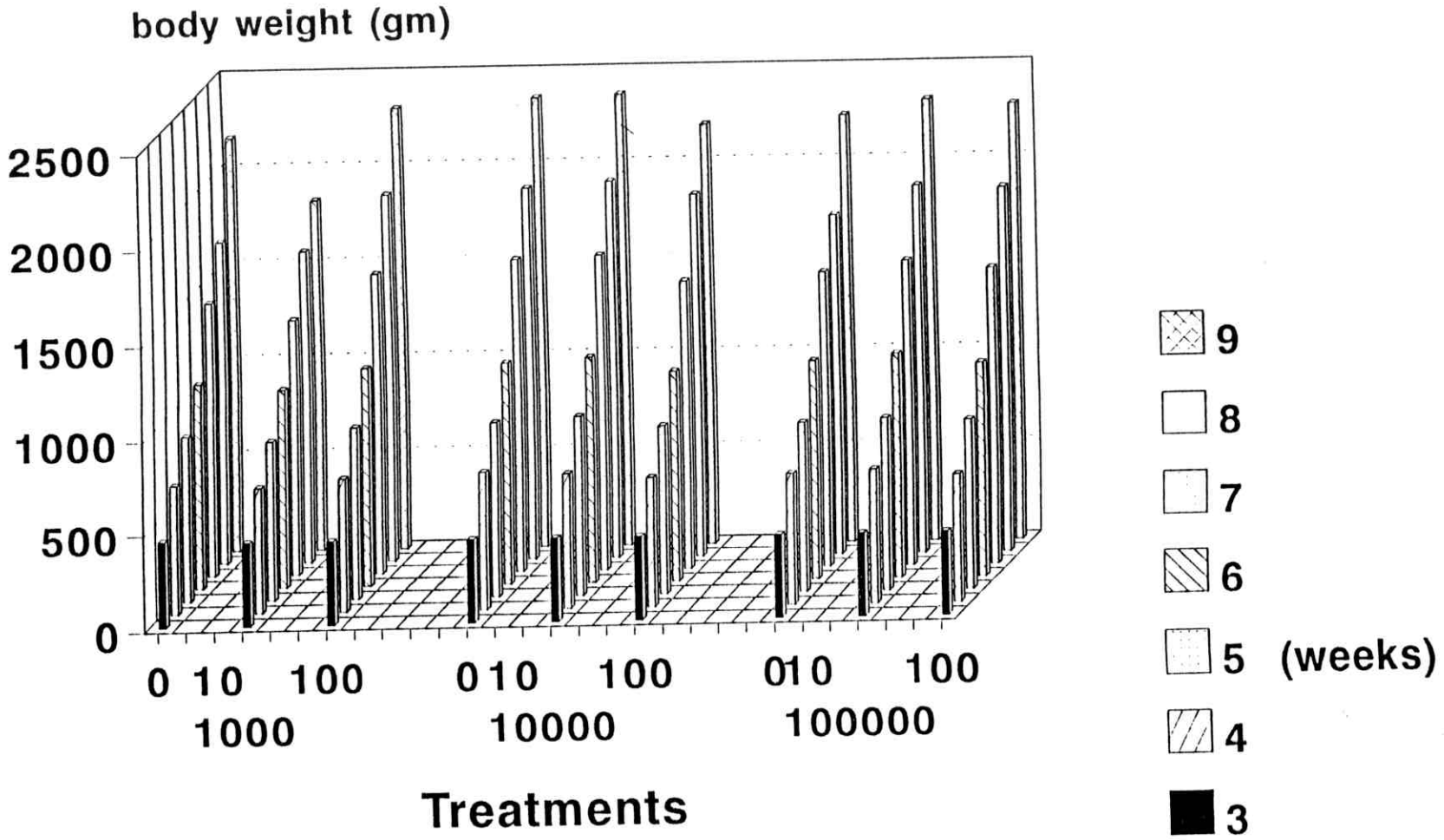


Fig.(12):Effect of dietary vitamin A and E levels on body weight of Hubbard broiler chicks

chicks of all experimental groups. These results agreed with those of El-Gendi (1989).

Analysis of variance showed a significant effect ($P<0.01$) of dietary vitamin A levels on average body weight of Hubbard broiler chicks (ANOVA Table, 20). Broiler chicks fed 10,000 or 100,000 IU/kg diet vitamin A with or without tocopherol was significantly greater ($P<0.01$) than that of corresponding broiler chicks fed only 1000 IU/kg of vitamin A. Increasing the level of vitamin A from 10,000 to 100,000 IU/kg with or without tocopherol had no effect on body weight of broiler chicks. These results are in correspondence with those of Stevens and Blair (1983). However, it can be concluded that 10,000 IU/kg of vitamin A is quite suitable for normal growth.

Dietary vitamin E levels had no significant effect ($P>0.05$) on body weight of broiler chicks. These results agreed with those of Sheehy *et al.* (1991). However, the interaction of vitamin A with E had a significant ($P<0.01$) effect on body weight. At deficient vitamin E chicks, body weight increased from 2176.66 ± 59.52 to 2371.33 ± 62.48 g with increasing vitamin A from 1000 to 10,000 IU/kg at 9th week old broiler (end of the experimental period). The moderate level of vitamin E (10 IU/kg) with the deficient level of vitamin A (1000 IU/kg) significantly reduced body weight from 2176.66 ± 59.52 to 1839.33 ± 49.31 g at the end of experimental period. Increasing vitamin E from 0 to

100 IU/kg at the moderate level of vitamin A reduced body weight from 2371.33±62.48 to 2216.66±69.0 g. However, increasing dietary vitamin E with the highest level of vitamin A significantly ($P<0.01$) increased body weight. The highest body weight reached in broiler chicks which were fed the moderate levels of each vitamin A and E (2382.66±47.48 g). The lowest body weight was found in chicks fed the moderate level of vitamin E with deficient level of vitamin A (1839±49.31 g). These results coincide with those of Abawi and Sullivan (1989) and Sheehy (1991). However, it could be concluded that the most suitable amount of vitamin E for Hubbard broiler chicks is about 10 IU/kg diet.

Data concerning the effect of dietary vitamin A and E levels on weekly body weight gain of Hubbard broiler chicks are presented in Table (17) and illustrated graphically in Fig. (13).

Analysis of variance showed significant effect of age on body weight gain of Hubbard broiler chicks all over the experimental period (ANOVA Table, 20). Results obtained, showed that, body weight gain increased in all experimental group by advancing age up to 7th week which a remarkable decrease in this trait was obviously found.

Analysis of variance showed significant effect ($P<0.01$) of vitamin A and the interaction of vitamin A with E on body weight

Table (17): Effect of dietary vitamin A and E levels on body weight gain of Hubbard broiler chicks.

Treatment (IU/kg)		Average body weight gain (g) ± S.E.					
A	E	3-4 wk	4-5 wk	5-6 wk	6-7 wk	7-8 wk	8-9 wk
1,000	0	234.53±14.91	192.66± 5.04	213.66±10.10	356.00±13.03	254.33±19.95	481.00±15.85
	10	228.66± 4.72	177.66±14.35	211.66±10.63	295.33±13.89	294.00±5.33	199.33±15.20
	100	268.33±18.42	203.66± 4.64	247.33± 9.14	425.00±13.52	347.66±15.19	399.66±21.16
10,000	0	292.33± 5.66	195.33±10.80	247.66±11.35	474.00±13.32	306.00±15.75	421.33±28.40
	10	278.33± 8.46	234.33± 7.43	244.33± 7.10	469.00±16.57	318.00±13.98	403.33±20.04
	100	247.34± 7.83	206.66±10.49	223.00±15.77	402.33±28.90	388.33±13.05	312.33±31.77
100,000	0	260.00± 9.60	202.00±12.93	259.66± 7.16	398.00±39.74	234.33±25.46	468.33±29.79
	10	274.00± 5.57	203.66±14.00	245.66±13.77	449.33±10.01	325.00±26.18	398.00±16.09
	100	238.00± 4.22	221.00± 7.58	234.33±24.14	431.66±13.95	355.00±11.62	385.33±21.47

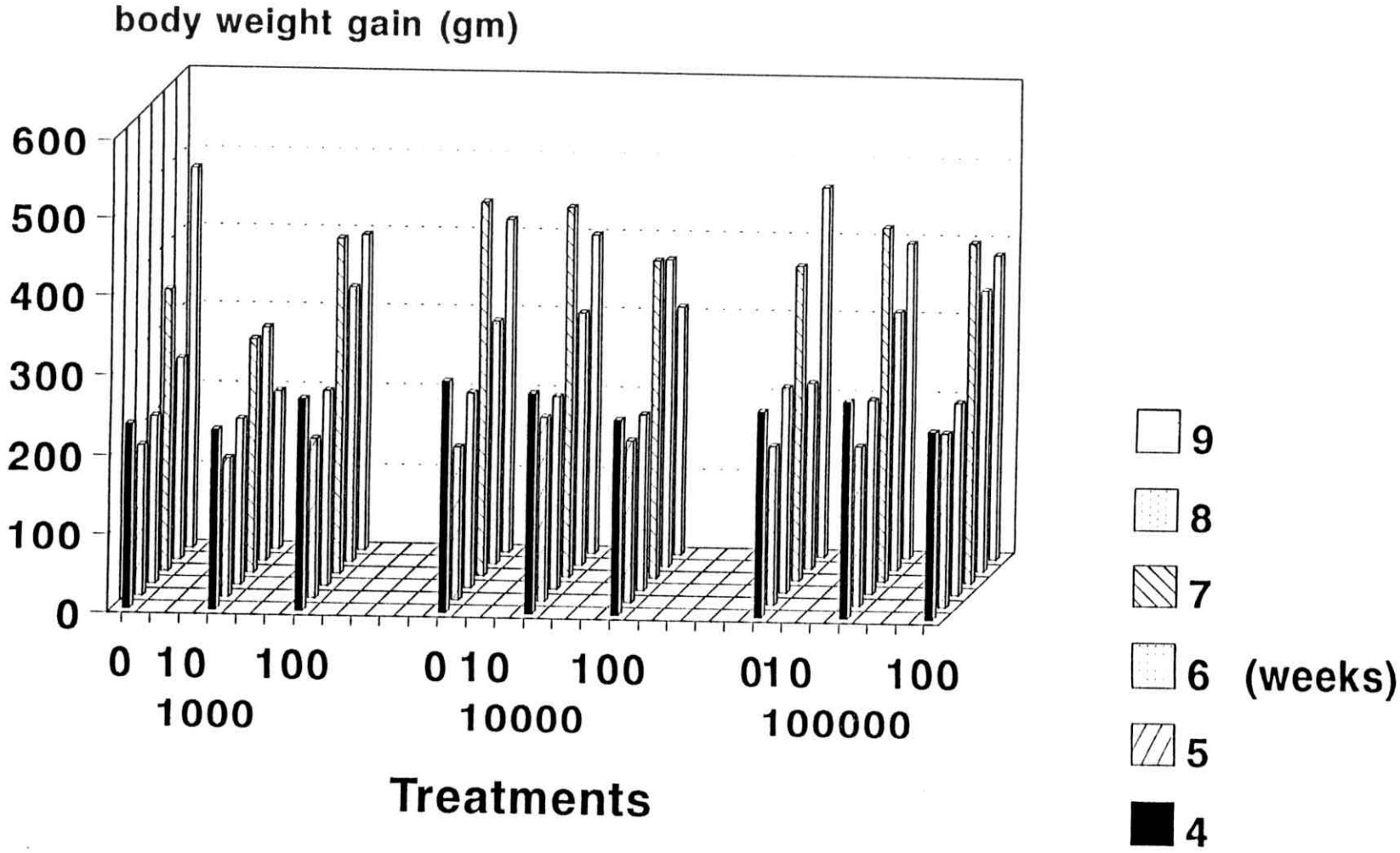


Fig.(13):Effect of dietary vitamin A and E levels on body weight gain of Hubbard broiler chicks

gain of broiler chicks. At the end of experimental period, body weight gain of broiler chicks fed vitamin A was significantly greater ($P<0.01$) than that of corresponding broiler chicks fed vitamin A with vitamin E. Increasing vitamin E reduced body weight gain of chicks at all levels of each vitamin A. Increasing dietary vitamin E from 0 to 100 IU/kg diet reduced body weight gain from 481.00±15.85 to 399.66±21.16 from 421.33±28.40 to 312.33±31.77 and from 468.33±29.79 to 385.33±21.47 in broiler fed deficient, optimum and excessive levels of dietary vitamin A, respectively at 9th old broiler. These results are in agreement with those reported by Abawi and Sullivan (1989).

Data in Table (18) and illustrated graphically in Fig. (14) showed the effect of dietary vitamin A and E levels on the rate of growth in Hubbard broiler chicks along the experimental period. Analysis of variance showed a significant effect ($P<0.01$) of age on growth rate of broiler chicks all over the experimental period. The average of growth rate of chicks gradually decreased along the experimental period except during 6-7 week old period. The rate of growth significantly affected ($P<0.01$) by dietary vitamin A levels. Rate of growth of broiler fed 10,000 or 100,000 IU/kg vitamin A had significantly greater than that of corresponding broiler fed 1000 IU/kg diet. Increasing dietary vitamin A from 10, 000 to 100,000 IU/kg had no effect on growth rate of chicks. These results are in agreement with those reported by Abawi and Sullivan (1989).

Table (18): Effect of dietary vitamin A and E levels on growth rate of Hubbard broiler chicks.

Treatment (IU/kg)		Growth rate average (%)					
A	E	3-4 wk	4-5 wk	5-6 wk	6-7 wk	7-8 wk	8-9 wk
1,000	0	41.75	24.85	21.84	28.18	16.21	24.84
	10	41.80	23.68	22.40	24.65	19.69	11.46
	100	47.09	25.27	23.98	31.07	19.82	18.79
10,000	0	50.33	23.69	23.67	33.68	17.03	19.50
	10	48.45	28.20	22.83	32.87	17.47	18.49
	100	44.14	26.25	22.25	30.60	22.71	15.16
100,000	0	46.15	25.43	25.33	29.39	14.03	23.17
	10	47.87	25.11	23.72	32.48	18.36	18.67
	100	42.73	28.10	23.11	32.04	20.40	18.26

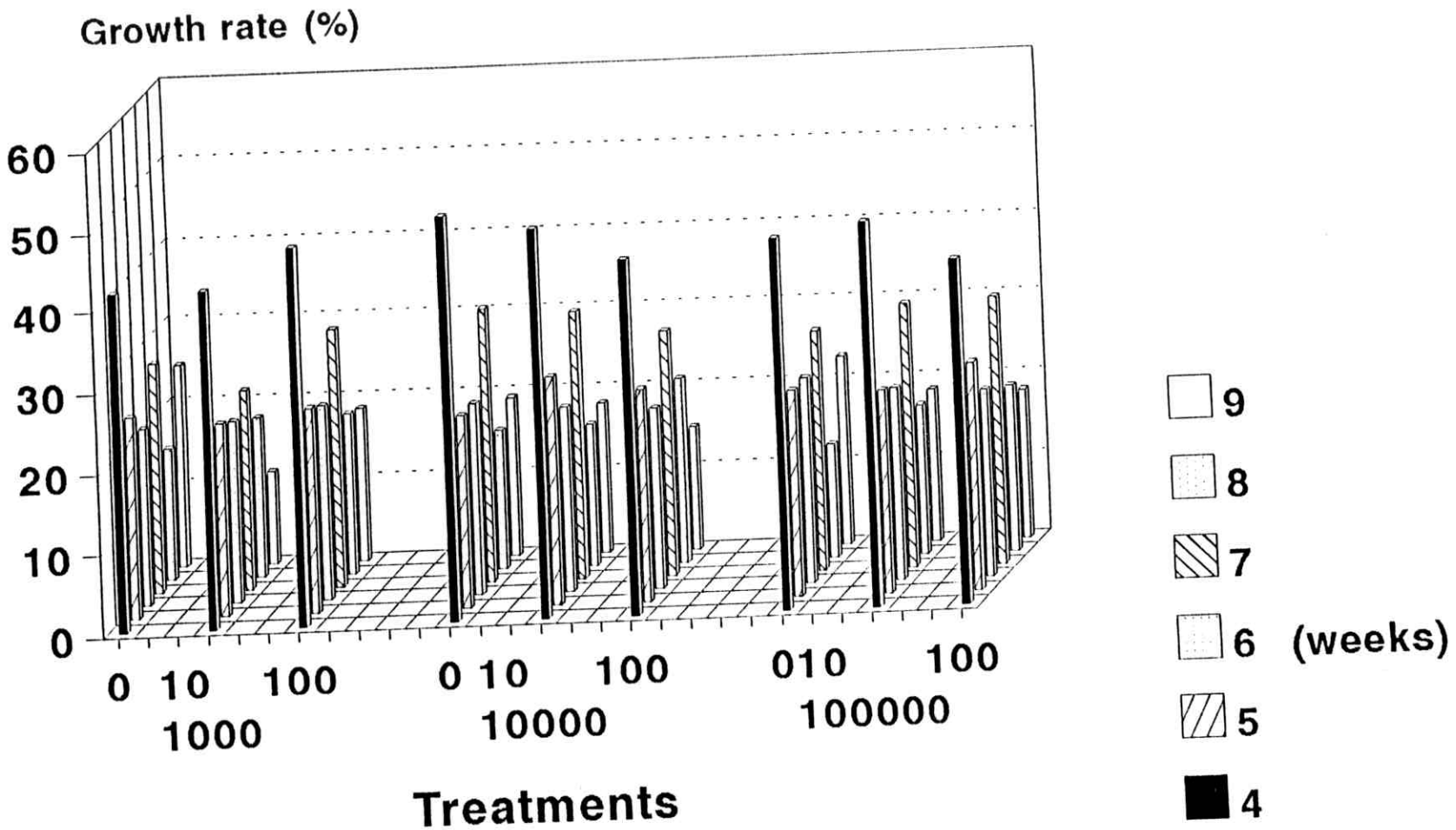


Fig.(14):Effect of dietary vitamin A and E levels on growth rate of Hubbard broiler chicks

4.4.2. Feed consumption, efficiency and mortality:

Weekly average feed consumption in grams for each individual bird of Hubbard broiler chicks are listed in Table (19) and illustrated graphically in Fig. (15). Results obtained showed that, the feed consumption per chick significantly ($P<0.01$) and gradually increased consistently from the 3rd week up to the end of experimental period. This was quite true in all experimental groups. However, the rate of consumption increment differed according to the applied treatments. These results agreed with those reported by El-Gendi (1989).

Analysis of variance showed that variation in feed consumption due to dietary level of each vitamin was significant ($P<0.01$) along the experimental period (ANOVA Table, 20). Generally, feed consumption of broiler fed 10,000 or 100,000 IU/kg vitamin A was significantly ($P<0.01$) greater than that of corresponding broiler fed 1000 IU/kg. Increasing vitamin A levels from 10,000 to 100,000 IU/kg had no effect on feed consumption. On the other hand, feed consumption of broilers fed on the moderate level of vitamin E was significantly lower ($P<0.01$) than that of corresponding broiler fed deficient and high levels.

The interaction of vitamin A with E had significant effect ($P<0.01$) on feed consumption along the experimental period. Increasing level of vitamin E from 0 to 10 IU/kg with deficient

Table (19): Effect of dietary vitamin A and E levels on feed consumption of Hubbard broiler chicks.

Treatment (IU/kg)		Average feed consumption (g/chick/wk) ± S.E.					
A	E	4rd wk	5th wk	6th wk	7th wk	8th wk	9th wk
1,000	0	322.00±4.53	468.83±5.84	488.66±10.30	552.00±10.16	613.66± 8.95	697.00±14.41
	10	236.16±8.74	309.83±5.64	357.83± 7.23	408.66± 7.13	430.00± 5.78	498.50± 7.11
	100	325.16±5.63	464.66±7.41	480.50±11.56	552.00± 7.28	608.66± 6.13	690.16±11.70
10,000	0	322.50±6.62	448.50±6.93	510.66± 5.64	561.83± 6.36	635.33± 8.67	720.33±11.56
	10	422.66±6.78	489.33±5.95	583.50± 2.75	593.66±23.23	702.66±11.75	778.66±10.01
	100	332.00±7.11	472.66±7.08	497.00± 8.79	580.50±25.19	618.83± 6.01	710.33±11.41
100,000	0	374.00±9.26	456.83±7.54	534.33± 8.37	570.16±11.70	635.66± 9.31	733.33±12.90
	10	335.33±6.71	468.66±6.64	492.66±11.66	553.83±12.02	627.00±14.52	734.66±25.72
	100	381.66±6.65	473.16±9.14	543.50± 7.11	580.33± 8.67	651.83± 7.13	750.83±10.11

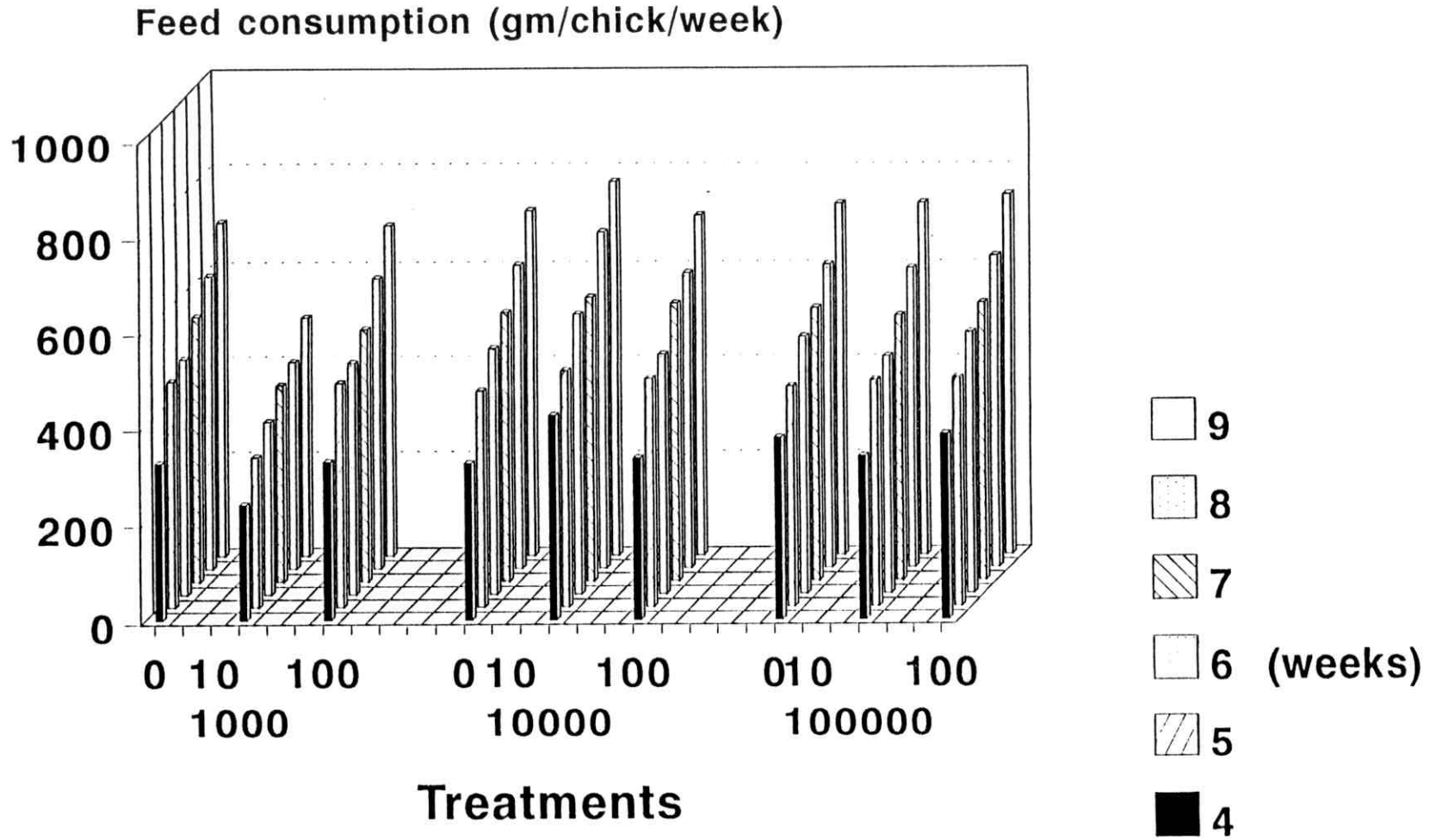


Fig.(15):Effect of dietary vitamin A and E levels on feed consumption of Hubbard broiler chicks

Table (20): ANOVA of body weight, weight gain, growth rate and feed consumption of Hubbard broiler chicks.

S.O.V.	d.f.	Body weight (M.S.)	Weight gain (M.S.)	Growth rate (M.S.)	Feed consumption (M.S.)
Replication	2	1021092.321	50629.660	1.205	4837.358
Vitamin A	2	200285.932**	18650.345**	45.179**	114676.298**
Vitamin E	2	11816.303	4737.157	12.020	24095.094**
A x E	4	117777.849**	15603.412**	28.988	66982.462**
Age	5	9536128.821**	187312.519**	2767.262**	434886.680**
A x age	10	16335.473**	2740.768	12.368	1367.961**
E x age	10	7800.310	12136.721**	39.534**	646.902**
A x E x age	20	10890.445**	3844.397	18.139	1177.581**
Error	106	4671.308	2548.402	14.617	234.710

* $P < 0.05$, ** $P < 0.01$.

level of vitamin A (1000 IU/kg) led to a significant ($P<0.01$) decrease on feed consumption from 697.00±14.41 to 498.50±7.11 g at 9th week (end of the experimental period). Such reduction in feed consumption was paralleled with the noticed decrease in body weight and weight gain. These results are in agreement with those of Plavink and Hurwitz (1985). Conversely, increasing dietary levels of vitamin E led to an increase in feed consumption of broiler fed moderate and high levels of vitamin A The lowest feed consumption found with broiler fed on the moderate level of vitamin E and the deficient level of vitamin A, but the highest feed consumption found with broiler fed on the moderate levels of each vitamins. These results are mostly in accordance with decreasing or increasing body weight and weight gain and almost in linearly pattern. Such results are in correspondence with those reported by Nir *et al.* (1974).

Data presented in Table (21) showed the average feed efficiency for experimental groups of Hubbard broiler chicks calculated as a ratio between total feed consumption to total weight gain all over the experimental period. It is clearly observed that chicks fed diet containing the lowest and highest level of vitamin A without vitamin E had greater feed efficiency than those of the corresponding broilers fed on the moderate level. Increasing levels of vitamin E reduced feed efficiency with the lowest level of vitamin A. However, increasing dietary vitamin E level with the

Table (21): Effect of dietary vitamin A and E levels on feed efficiency and mortality rate of Hubbard broiler chicks.

Treatment (IU/kg) A	E	Feed efficiency (feed/gain)	Mortality (%)
1,000	0	1.81±0.04	13.16
	10	1.66±0.03	18.43
	100	1.65±0.17	10.53
10,000	0	1.65±0.15	15.79
	10	1.83±0.21	18.43
	100	1.80±0.15	13.16
100,000	0	1.81±0.18	21.05
	10	1.69±0.19	5.26
	100	1.81±0.05	2.63

moderate level of vitamin A increased feed efficiency. These results are in agreement with those reported by Abawi and Sullivan (1989).

The mortality rate is also shown in Table (21). Increasing level of dietary vitamin A resulted in greater mortality at low levels of dietary vitamin E. High levels of dietary vitamin A can be toxic at the lowest level of vitamin E as observed by increasing mortality rate to (21.05%). Also, high levels of vitamin E can be toxic in the presence of low vitamin A. Toxic level of vitamin A can be alleviated by increasing vitamin E levels. Also, toxic effect of vitamin E can be alleviated by similar increase in vitamin A. The lowest mortality rate found from groups of chicks fed the highest level of each vitamin (2.63%). These results agreed with the results of Abawi and Sullivan (1989). Furthermore, Edwin *et al.* (1962) reported that animals deficient in both vitamin A and E lived longer than those fed on tocopherol without vitamin A.

4.5. Storage of mixed feeds and premixes:

4.5.1. Effect of storage on chemical properties of fat in mixed feeds and premixes:

Eight different mixed feeds were subjected to different periods of storage i.e. El-Kahera, Valagi, Walid and El-Morsheidy, broiler starter and finishing feeds, and 2 different broiler premixes i.e. Hendrix and Preconex.

The changes occurred in the chemical properties of fat in these mixed feeds and premixes during storage process were pointed out and the obtained results are illustrated in Tables (22, 23 and 24).

Free fatty acid (FFA) and iodine value (I.V.) in the various mixed feeds and premixes are presented in Table (22). The FFA of premixes were significant lower ($P<0.01$) than that of mixed feeds, i.e. free fatty acids of fresh Hendrix and Preconex broiler premixes were 35.2 ± 0.5 and 34.2 ± 0.6 whereas in different mixed feeds ranged from 51.1 ± 0.6 to 117.7 ± 0.3.

Free fatty acid levels of the various feeds and premixes were significantly increased ($P<0.01$) from an initial level prior to the end of storage period, i.e., it increased from 117.7 ± 0.3 at zero time to 120.4 ± 0.5 at the end of the storage period in El-Kahera broiler starter. Whereas it increased from 35.2 ± 0.5 and 34.2 ± 0.6 to 40.3 ± 0.6 and 41.9 ± 0.9 by the end of 4th month storage in Hendrix and Preconex broiler premixes, respectively.

This significant increase in FFA values of the mixed feeds and premixes during storage was mostly due to the hydrolysis of the ester linkages of their glyceride content leading to the formation of more carboxylic groups. Consequently prolonging time of storage was accompanied by an increase in the degree of

Table (22): Effect of storage on acid value and iodine value of mixed feeds and permixes.

Feeds and premixes	Acid value					Iodine value				
	Zero time	1st month	2nd month	3rd month	4th month	Zero time	1st month	2nd month	3rd month	4th month
El-Kahera starter	117.7±0.3	118.1±0.7	119.3±0.4	119.9±0.8	120.4±0.5	124.9±1.4	124.6±0.8	122.8±2.3	121.3±1.0	119.4±3.6
El-Kahera finishing	96.8±0.6	100.0±0.8	100.2±0.6	101.8±0.6	102.6±0.7	116.5±1.6	116.4±1.2	116.1±1.4	114.8±0.9	111.0±1.5
Valagi starter	101.7±0.4	104.9±0.6	104.9±0.7	106.7±0.9	108.2±0.6	117.7±1.8	110.7±1.4	106.4±3.3	100.6±1.0	95.5±2.3
Valagi finishing	104.0±0.9	106.4±0.7	107.5±0.7	107.6±0.9	109.4±0.9	121.3±2.3	118.3±0.7	115.7±2.6	110.7±1.0	106.7±1.3
Walid starter	57.1±0.6	58.0±0.7	60.7±0.8	62.0±0.8	62.9±1.1	118.6±1.9	116.6±1.1	117.7±1.6	111.0±1.7	98.5±1.8
Walid finishing	71.9±1.1	72.3±0.8	74.0±0.6	76.4±0.4	77.8±0.8	124.9±1.9	120.7±1.6	116.2±2.4	110.5±0.9	117.2±2.2
El-Morshidy starter	70.5±0.7	71.7±1.1	74.8±0.7	75.6±0.4	77.2±0.6	121.8±4.2	120.5±1.2	118.0±1.7	110.8±1.0	92.2±1.4
El-Morshidy finishing	88.4±0.5	90.0±0.6	95.2±0.9	97.5±0.8	99.6±0.9	124.8±1.2	120.1±1.5	116.6±1.3	116.6±1.0	116.3±0.7
Hendrix premix	35.2±0.5	36.2±0.6	37.4±0.4	39.3±0.6	40.3±0.6	77.8±1.3	73.8±0.7	68.0±0.9	66.7±1.4	65.1±0.9
Preconex premix	34.2±0.6	36.2±0.6	37.6±1.4	39.5±0.9	41.9±0.9	78.1±2.0	74.8±1.2	68.1±1.9	65.7±0.7	62.3±2.2

hydrolysis. Also, the oxidation of aldehydes and ketones which formed during storage, leading to the formation of mono and dicaboxylic short chain organic acids which finally lead to an increase in the acid value (Wishner and Keeney, 1965).

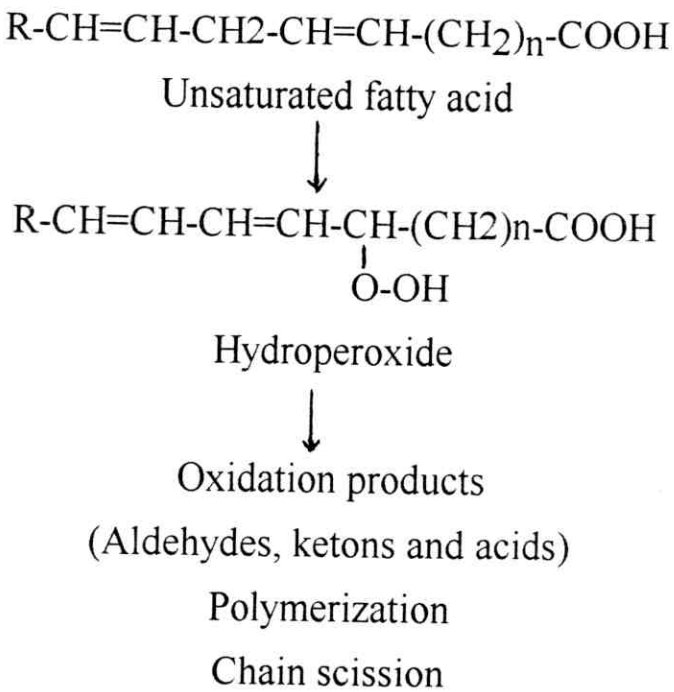
The iodine (I.V.) value in general reflects the degree of unsaturation, i.e., the amount of monoenoic and dienoic acids in mixed feeds and premixes during storage. I.V. of mixed feeds were significantly ($P<0.01$) higher than those of broiler premixes. Such results indicate the presence of a high concentration of unsaturated fatty acids in mixed feeds.

The various I.V. of the mixed feeds and premixes were significantly decreased ($P<0.01$) from an initial level prior to the end of storage period. For instance, I.V. of Valagi broiler starter decreased from 117.7 ± 1.8 to 95.5 ± 2.3 after 4th month storage period. I.V. of fresh Hendrix and Preconex broiler premixes were 77.8 ± 1.3 and 78.1 ± 2.0 and decreased to 65.1 ± 0.9 and 62.3 ± 2.2, respectively, after 4th month storage. The I.V. of different mixed feeds ranged from 116.5 ± 1.6 to 124.9 ± 1.4 and were decreased to 92.2 ± 1.4 and 119.4 ± 3.6, respectively, after 4th month storage. These results are in agreement with those reported by Thafvelin and Oksanen (1966).

The noticed decrease in I.V. was corresponded fairly well with the decrease in the dienoic acids, owing to its saturation,

mostly regarded to the oxidation of these double bonds (Waltking and Zmachinski, 1970).

The above mentioned results can be interpreted as shown in the following steps;



General scheme for the oxidation and possible reactions of unsaturated fatty acids. Fishwick and Swoboda (1977).

The above mechanism involves migration of the double bond at the point of oxygen addition. In linoleic or linolenic acid the reaction will leds to the formation of conjugated double bonds which are less susceptible to iodine atoms. The formed peroxides appeared to be relatively stable, so that the increase in its content,

more or less was paralleled with the oxygen adsorption in the fat. In the later stages, however, they being to decompose or react with one another or with other oxidation products to produce the compounds actually responsible for rancid flavor and odor (Fishwick and Swoboda, 1977).

Peroxide value (PV) and thiobarbituric acid (TBA) number in the various feeds and premixes are presented in Table (23). The results obtained for mixed feeds indicated that the peroxide values were in the range of 3.6±0.4 to 16.5±0.5 . On the other hand, the results obtained for broiler premixes had very low PV ranged from 1.3±0.3 to 5.4±0.5. It was also noticed that the PV of mixed feeds were significantly higher ($P<0.01$) than those of broiler premixes. This variation is probably due to the presence of more amount of unsaturated fatty acids in mixed feeds which has more ability for oxidation and caused high peroxide value than that of premixes.

The PV of the various feeds and premixes were gradually and significantly increased ($P<0.01$) from the initial level till the end of the storage period. The PV of El-Kahera broiler starter increased from 3.6±0.4 to 27.2±0.7 after 4th month storage. The PV of Hendrix and Preconex broiler premixes were significantly increased ($P<0.01$) from 5.4±0.5 and 1.3±0.9 to 10.2±0.9 and 12.0±0.6, respectively by the end of storage period. These results are in agreement with those reported by Young *et al.*, (1975).

Table (23): Effect of storage on peroxide value and thiobarbituric acid (TBA) number of mixed feeds and permixes.

Feeds and premixes	Peroxide value					TBA number				
	Zero time	1st month	2nd month	3rd month	4th month	Zero time	1st month	2nd month	3rd month	4th month
El-Kahera starter	3.6±0.4	8.8±0.6	15.3±0.6	21.6±0.5	27.2±0.7	0.98±0.22	1.61±0.26	4.58±0.36	6.23±0.24	7.38±0.46
El-Kahera finishing	5.6±0.5	9.5±0.6	15.3±0.5	20.3±06	25.1±0.8	1.15±0.16	1.60±0.29	2.74±0.24	3.65±0.34	4.37±0.33
Valagi starter	16.5±0.5	17.1±0.6	22.8±0.7	23.9±0.7	28.4±0.9	1.32±0.19	1.59±0.18	4.73±0.30	6.49±0.47	7.30±0.31
Valagi finishing	8.9±0.7	15.0±0.5	23.4±0.5	29.6±1.2	39.5±1.5	1.12±.012	2.59±0.24	3.40±0.40	5.28±0.29	7.12±0.34
Walid starter	3.6±0.5	6.4±0.4	11.2±0.8	13.2±0.7	18.1±0.9	2.68±0.21	3.22±0.22	7.40±0.42	9.82±0.76	11.33±0.58
Walid finishing	11.5±0.5	12.2±0.7	15.1±0.8	17.2±0.7	19.9±0.3	3.46±0.13	6.24±0.24	8.69±0.35	9.40±0.40	10.42±0.45
El-Morshidy starter	14.7±0.6	15.7±0.7	18.4±0.5	19.9±0.7	22.2±0.9	2.24±0.25	4.07±0.16	4.33±0.31	5.36±0.40	7.24±0.39
El-Morshidy finishing	15.6±0.6	16.1±0.8	20.2±0.8	23.8±0.6	26.4±0.9	4.34±0.35	5.22±0.22	6.25±0.24	6.82±0.42	8.72±0.42
Hendrix premix	5.4±0.5	6.5±0.4	7.8±0.7	8.6±0.7	10.2±0.9	4.42±0.28	10.09±0.21	11.46±0.44	13.42±0.50	18.13±0.46
Preconex premix	1.3±0.3	3.4±0.5	6.6±0.5	8.8±0.4	12.0±0.6	11.58±0.38	16.21±0.21	18.74±0.74	21.42±0.47	25.57±0.57

Table (24): ANOVA of effect of storage on acid value, iodine value, peroxide value and thiobarbituric acid (TBA) number of mixed feeds and permixes.

S.O.V.	d.f.	Acid value (M.S.)	Iodine value (M.S.)	Peroxide value (M.S.)	TBA number (M.S.)
Replication	2	4.358	15.991	0.529	0.147
Feeds	9	12513.173**	5607.435**	499.756**	346.328**
Peroids	4	191.903**	1059.517**	979.804**	254.717**
Feeds X periods	36	3.429**	40.917**	30.801**	6.525**
Error	98	1.460	2.792	0.492	0.138

* $P < 0.05$, ** $P < 0.01$.

The thiobarbituric acid (TBA) reacts with volatile aldehyde which arised during autoxidation of mixed feeds and premixes and were determined along the storage period. The level of (TBA) number of the various feeds and premixes are presented in Table (23). The TBA number of different samples were generally and significantly ($P<0.01$) increased from an initial level prior to the end of the storage period. For example, TBA number of El-Kahera broiler starter was increased from 0.98 ± 0.22 to 7.38 ± 0.46 after 4th month storage. The TBA numbers of fresh Hendrix and Preconex broiler premixes were 4.42 ± 0.28 and 11.58 ± 0.38 which were significantly increased ($P<0.01$) to 18.13 ± 0.46 and 25.57 ± 0.57, respectively at the end of storage period. The obtained data (Table (23) showed that, Hendrix and Preconex broiler premixes gave highest TBA numbers, i.e., 18.13 ± 0.46 and 25.57 ± 0.57 by the end of storage period with a relatively low peroxide values 10.2 ± 0.9 and 12.0 ± 0.6. This may be due to their short induction period which leads to the transformation of the primary oxidation products i.e. hydroperoxides to the secondary oxidation products which react with TBA reagent.

4.5.2. Effect of storage on fatty acid composition of mixed feeds and premixes:

The fatty acid compositions in the various mixed feeds and premixes are presented in Tables (25, 26 and 27). The GLC of the methyl esters of the fatty acids of mixed feeds and premixes showed that, palmitic acid constitutes the major component of

saturated fatty acids. On the other hand, 4 unsaturated fatty acids were identified, palmitoleic, oleic, linoleic and linolenic. The major fatty acids in mixed feed and premixes are oleic and linoleic which constitute about 80% of the total fatty acids in most samples under investigation.

The total saturated fatty acids in mixed feeds ranged from 15.38±0.63 to 18.15±1.27 and were significantly increased ($P<0.01$) by the end of 2nd month of storage followed by further increase after 4th month of storage. The total saturated fatty acids of fresh Hendrix and Preconex broiler premixes were 29.64±0.32 and 28.80±1.54 at zero time and were significantly increased ($P<0.01$) to 34.42±0.74 and 34.00±1.50, respectively by the end of 2nd month. However, storage till the 4th month was accompanied by further increment to 38.43±0.12 and 38.94±1.42 for the first and the latter, respectively. On the other hand, the total unsaturated fatty acids significantly decreased ($P<0.01$) with storage. It decreased from 70.25±0.32 and 71.16±1.46 to 65.56±0.74 and 65.92±2.21 by the end of 2nd month of storage, a further decrease to 61.55±0.12 and 60.99±1.44 after 4th month storage in Hendrix and Preconex broiler premixe, respectively.

Palmitic and stearic acids were gradually and significantly ($P<0.01$) increased after 2nd and 4th months of storage. Palmitic acid was increased from 20.54±1.00 and 22.41±0.05 to

Table (25): Effect of storage on fatty acid compositions of El-Kahera and Valagi broiler starter and finishing feeds.

Feeds	Storage period	Fatty acid percentage								Total saturated	Total Un-saturated
		$C_{12:0}$	$C_{14:0}$	$C_{16:0}$	$C_{16:1}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$		
El-Kahera starter	**Zero time**	0.00±0.00	0.56±0.08	15.05±0.12	0.00±0.00	0.17±0.01	20.04±1.96	63.44±1.32	0.71±0.02	15.78±0.55	84.19±0.55
	2nd month	0.00±0.00	0.38±0.01	15.63±0.79	0.00±0.00	0.28±0.02	22.01±1.75	61.29±2.60	0.40±0.16	16.29±0.76	83.70±0.76
	4th month	0.00±0.00	0.22±0.11	16.03±2.04	0.00±0.00	0.31±0.06	24.06±1.53	59.05±3.75	0.30±0.12	16.56±2.09	83.41±2.09
El-Kahera finishing	**Zero time**	0.00±0.00	0.00±0.00	17.12±0.24	0.59±0.14	0.58±0.13	25.54±0.00	55.22±0.35	0.94±0.34	17.70±0.26	82.29±0.26
	2nd month	0.00±0.00	0.00±0.00	17.40±0.24	2.33±1.42	0.55±0.20	26.37±1.12	52.61±4.59	0.71±0.11	17.95±1.47	82.02±1.47
	4th month	0.00±0.00	0.00±0.00	17.23±0.01	3.27±0.22	0.50±0.01	30.01±1.25	48.28±0.78	0.61±0.12	17.73±1.10	82.17±1.10
Valagi starter	**Zero time**	0.62±0.08	0.19±0.01	15.46±1.78	0.00±0.00	0.57±0.00	27.01±1.61	55.35±0.10	0.79±0.02	16.84±1.68	83.15±1.69
	2nd month	0.58±0.19	0.29±0.04	18.91±1.05	0.00±0.00	0.72±0.06	30.11±2.14	48.71±4.00	0.65±0.31	20.50±1.67	79.47±1.67
	4th month	0.53±0.04	0.44±0.04	20.42±1.44	0.00±0.00	0.95±0.19	35.75±1.35	38.44±0.56	0.41±0.26	22.34±1.70	77.63±1.69
Valagi finishing	**Zero time**	0.32±0.00	0.25±0.00	16.79±0.42	0.00±0.00	0.23±0.05	20.76±1.66	60.74±1.25	0.91±0.07	17.59±0.49	82.41±0.48
	2nd month	0.29±0.07	0.30±0.03	18.90±1.05	0.00±0.00	0.32±0.24	29.26±1.95	55.12±2.80	0.76±0.11	19.81±0.92	80.14±0.92
	4th month	0.07±0.00	0.28±0.02	20.65±1.12	0.00±0.00	0.42±0.04	29.64±2.36	48.58±0.5	0.34±0.08	21.42±1.18	78.56±1.18

Table (26): Effect of storage on fatty acid compositions of Walid and El-Morshidy broiler starter and finishing feeds.

Feeds	Storage period	Fatty acid percentage							Total saturated	Total Un-saturated
		$C_{12:0}$	$C_{14:0}$	$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$		
Walid starter	**Zero time**	0.09±0.00	0.25±0.02	16.45±0.00	0.44±0.00	25.55±0.18	56.22±0.33	0.99±0.14	17.23±0.05	82.76±0.05
	2nd month	0.30±0.02	0.24±0.02	18.53±0.16	0.63±0.01	29.66±0.16	50.00±0.10	0.62±0.10	19.70±0.17	80.28±0.16
	4th month	0.52±0.03	0.23±0.04	20.62±0.33	0.82±0.02	33.77±0.15	43.78±0.13	0.25±0.07	22.19±0.36	77.80±0.36
Walid finishing	**Zero time**	0.00±0.00	0.17±0.01	14.70±0.52	0.51±0.09	21.92±2.58	61.66±1.96	0.98±0.16	15.38±0.63	84.56±0.64
	2nd month	0.11±0.03	0.15±0.04	17.01±0.59	0.73±0.02	26.42±0.97	54.90±1.61	0.67±0.07	18.00±0.70	81.99±0.70
	4th month	0.39±0.07	0.40±0.04	19.72±0.95	0.91±0.28	30.08±0.20	48.10±0.79	0.37±0.09	21.42±0.70	78.55±0.69
El-Morshidy starter	**Zero time**	0.30±0.12	0.38±0.04	17.07±0.78	0.40±0.06	21.91±2.12	57.94±3.31	1.92±0.03	18.15±1.27	81.77±1.27
	2nd month	0.22±0.04	0.32±0.09	17.31±0.14	0.44±0.04	24.60±0.50	55.54±0.41	1.55±0.04	18.29±0.07	81.69±0.06
	4th month	0.20±0.04	0.31±0.01	18.15±0.21	0.52±0.03	28.24±0.21	51.49±0.17	1.07±0.24	19.18±0.14	80.80±0.14
El-Morshidy finishing	**Zero time**	0.00±0.00	0.34±0.01	14.52±1.00	0.63±0.09	21.65±1.73	62.11±0.81	0.74±0.05	15.49±0.92	84.50±0.90
	2nd month	0.00±0.00	0.45±0.06	15.58±0.79	0.68±0.32	25.95±1.35	56.82±0.99	0.48±0.03	16.74±0.40	83.25±0.39
	4th month	0.00±0.00	0.56±0.08	16.13±0.05	0.94±0.60	27.00±0.24	55.02±0.43	0.34±0.05	17.63±0.62	82.36±0.62

Table (27): Effect of storage on fatty acid compositions of Hendrix and Preconex broiler premixes.

Feeds	Storage period	Fatty acid percentage							Total saturated	Total un-saturated
		$C_{12:0}$	$C_{14:0}$	$C_{16:0}$	$C_{16:1}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$		
Hendrix premix	**Zero time**	0.21±0.03	1.74±0.02	20.54±1.00	4.09±0.79	7.15±1.38	46.15±1.85	20.01±0.73	29.64±0.32	70.25±0.32
	2nd month	0.22±0.05	1.87±0.25	22.19±0.12	4.59±0.70	10.14±0.42	46.73±0.75	14.24±0.91	34.42±0.74	65.56±0.74
	4th month	0.20±0.02	2.42±0.04	25.76±0.18	2.89±0.13	10.05±0.07	43.84±0.20	14.82±0.21	38.43±0.12	61.55±0.12
Preconex premix	**Zero time**	0.33±0.07	1.59±0.04	22.41±0.05	3.19±0.09	4.47±1.02	48.44±1.13	19.53±0.22	28.80±1.46	71.16±1.46
	2nd month	0.21±0.11	1.68±0.53	22.50±0.32	5.75±1.63	9.11±1.61	47.00±1.07	13.17±0.49	33.50±1.50	65.98±1.50
	4th month	0.14±0.01	1.79±0.09	25.08±1.03	3.01±1.01	11.93±0.49	45.89±0.12	12.09±0.30	38.94±1.44	60.99±1.44

Table (28): ANOVA of the effect of storage on fatty acid compositions of mixed feeds and permixes.

S.O.V	d.f.	$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	Total saturated	Total Unsaturated
Replication	2	0.120	0.105	1.390	1.804	1.274	0.083
Feeds	9	63.879**	108.105*	699.905**	2507.967**	376.911**	402.749**
Periods	2	70.865**	11.903*	205.726**	669.555**	144.036**	140.264**
Feeds X period	18	5.118**	4.563	18.066**	17.322**	10.807**	10.565**
Error	58	0.362	0.154	0.954	1.522	1.329	0.627

* P<0.05 ** P<0.01

25.76±0.18 and 25.08±1.03 after 4th month storage in Hendrix and Preconix broiler premixes, respectively. Also, stearic acid was increased from 7.15±1.38 and 4.47±1.02 to 10.05±0.07 and 11.93±0.49 after 4th month storage in Hendrix and Preconex, respectively. However, the significant increase in palmitic and stearic acids by storage in feeds and premixes might be attributed to the direct saturation of the unsaturated $C_{18:1}$ and $C_{18:2}$ by oxidation and consequently stearic acid increased. Also, the increase in palmitic acid C_{16} might be explained on the basis of migration of double bonds in both mono and diethanoid acid to β-position followed by oxidative degradation at this position to produce an acid lower by two carbon atoms than the parent acid. Therefore, fatty acids with C_{18} ($C_{18:1}$ and $C_{18:2}$) were converted to $C_{16:0}$ and such oxidation will leads to an increase in palmitic acid (Farag *et al.*, 1981).

On the other hand, oleic and linoleic acids as two major unsaturated fatty acids in mixed feeds and premixes were gradually and significantly ($P<0.01$) decreased with storage as shown in Tables (25, 26 and 27). Oleic acid decreased from 46.15±1.85 and 48.44±1.13 at zero time to 43.84±0.20 and 45.89±0.12 by the end of 4th month storage in Hendrix and Preconix broiler premixes respectively. Also, linoleic acid decreased from 20.01±0.73 and 19.53±0.22 to 14.82±0.21 and 12.09±0.30 by the end of 4th month storage in the first and the latter, respectively. Linolenic acid ($C_{18:3}$) which is found only in

mixed feeds was also significantly decreased ($P<0.01$) by propagation of storage period i.e. it decreased from 0.77 ± 0.02 to 0.30 ± 0.12 in El-Kahera broiler starter by the end of 4th month storage. These results are in agreement with those reported by Thafvelin and Oksanen (1966).

However, the significant decrease in the amount of linoleic and linolenic acids in mixed feeds and premixes with prolonged storage might be interpreted as a result of air oxidation. The single methylene group ($-CH_2$) between two ethylenic groups in the polyunsaturated fatty acids ($C_{18:2}$ and $C_{18:3}$) constitues a very active center for oxidation. The high reactivity of the isolated methylene group in normal 9:10, 12:13 linoleic acid is responsible for the fact that this acid and its esters oxidize approximately 10 times as rapidly as those of oleic acid, which lack such group. Such phenomenon was mostly accompanied with an increase in the free acidity of fats, from splitting at the double bonds to yield short chain mono and dicarboxylic acids (Bailey, 1964).

4.5.3. Effect of storage on vitamin A and E concentration of mixed feeds and premixes:

The distribution of vitamins A and E in mixed feeds and premixes samples during different storage periods are shown in Table (29). Results obtained showed significant differences ($P<0.01$) in vitamin A and E content between different feeds and

Table (29): Effect of storage on vitamin A and E concentrations of mixed feeds and permixes.

Feeds and premixes	Vitamin A (µg/g)					Vitamin E (µg/g)				
	Zero time	1st month	2nd month	3rd month	4th month	Zero time	1st month	2nd month	3rd month	4th month
El-Kahera starter	0.74±0.16	0.68±0.37	0.61±0.30	0.61±0.06	0.58±0.24	4.57±0.54	4.36±0.36	4.13±0.65	3.71±0.56	3.48±0.70
El-Kahera finishing	0.65±0.19	0.61±0.06	0.57±0.11	0.53±0.17	0.48±0.29	4.03±0.67	3.65±0.77	3.46±0.39	3.19±0.58	2.74±1.04
Valagi starter	1.33±0.33	1.26±0.18	1.24±0.12	1.19±0.08	1.19±0.16	8.26±0.78	7.91±0.45	7.74±0.37	7.43±0.26	7.25±0.63
Valagi finishing	1.39±0.26	1.33±0.14	1.29±0.14	1.23±0.19	1.15±0.19	8.56±0.76	8.17±0.59	7.58±0.30	7.35±0.57	7.09±0.46
Walid starter	2.65±0.21	2.57±0.14	2.57±0.10	2.50±0.11	2.43±0.19	16.43±0.80	16.08±0.52	15.68±0.49	15.31±0.63	14.94±0.64
Walid finishing	1.07±0.16	1.02±0.14	0.97±0.08	0.92±0.15	0.91±0.36	6.63±0.61	6.33±0.51	6.09±0.50	5.87±0.63	5.53±0.79
El-Morshidy starter	2.07±0.12	2.03±0.16	1.96±0.19	1.88±0.11	1.78±0.12	12.84±0.66	12.50±0.43	12.37±0.51	12.15±0.78	10.87±0.88
El-Morshidy finishing	2.19±0.28	2.15±0.26	2.06±0.20	1.93±0.22	1.77±0.30	13.57±0.59	13.09±0.57	12.66±0.60	11.76±0.72	10.84±0.64
Hendrix premix	5.82±0.36	5.60±0.23	5.29±0.20	5.13±0.29	4.85±0.44	36.12±0.65	35.48±0.57	33.74±0.78	32.62±0.63	29.78±1.32
Preconex premix	6.15±0.87	6.16±0.21	5.48±0.32	5.50±0.31	5.31±0.26	38.13±0.58	36.45±0.78	33.42±0.99	31.84±1.00	30.62±1.04

Table (30): ANOVA of effect of storage on vitamin A and E concentrations of mixed feeds and premixes.

S.O.V.	d.f.	Vitamin A (M.S.)	Vitamin E (M.S.)
Replication	2	0.008	0.024
Feeds	9	52.158**	1909.928**
Periods	4	0.641**	31.129**
Feeds X period	36	0.051**	2.996**
Error	98	0.002	0.019

* $P < 0.05$, ** $P < 0.01$.

premixes (ANOVA Table, 30). El-Kahera broiler starter and finishing mixed feeds found to contain a lower levels of vitamin A and E than other different mixed feeds. Walid starter feed contained the highest amount of vitamin A and E at zero time. However, Table (29) shows that there is no specific standard rules to govern the vitamin contents of different feeds since the difference between vitamin contents of these different sources was relatively huge. On the other hand, Preconix broiler premix contains a significant ($P<0.01$) higher concentration of vitamin A and E than Hendrix broiler premix.

Data in Table (29) showed gradual and significant decreases ($P<0.01$) in vitamin A and E contents with prolonging storage time. Vitamin A significantly decreased by 21.62 and 14.28% within 120 days storage in El-Kahera broiler starter and finishing mixed feeds, respectively. Also, vitamin A in Hendrix and Preconex broiler premixes significantly decreased ($P<0.01$) by 16.66 and 13.65%, respectively within 120 days storage. The significant decrease in the amount of vitamin A with storage might be interprted as a result of the oxidation and destruction of carotene and vitamin A. Feeds mostly contain soybeans as protein source which contain an enzyme known as carotene oxidase. It readily destroys the carotenes and vitamin A (Ewing, 1963). However, early before Wall and Kelley (1951) reported that temperature, concentration, type of carrier and the source of

vitamin A had a marked effect on the stability of a number of carotene and vitamin A concentrates.

Vitamin E significantly decreased ($P<0.01$) by 23.85 and 32.00% in El-Kahera broiler starter and finishing feeds, respectively within 120 days of storage. Also, in Hendrix and Preconex broiler premixes vitamin E significantly ($P<0.01$) decreased by 17.55 and 19.69%, respectively within 120 days of storage. The significant decrease in the amount of vitamin E with prolonged storage might be interpreted as a result of its role in protecting lipid from oxidation. Vitamin E mostly destroyed by reaction with the reactive hydroperoxide and free radicals formed during the oxidation of linoleic acid or more highly unsaturated fatty acids.

The above mentioned results can be interpreted in the following steps, as reported by Witting (1975).

$RH \longrightarrow R^{\bullet}$ initiation

$R^{\bullet} + O_2 \longrightarrow RO_2^{\bullet}$ propagation

$RO_2^{\bullet} + RH \longrightarrow ROOH + R^{\bullet}$

$RO_2^{\bullet} + AH \longrightarrow ROOH + A^{\bullet}$

A fatty acid free radical ($R^{\bullet}$) is formed in the initiation reaction, which reacts with oxygen to form a peroxy free- radical ($RO_2^{\bullet}$), which in turn, reacts with another molecule of fatty acid

(RH) to form a hydroperoxide (ROOH) and a new free radical ($R^{\bullet}$). Vitamin E (AH) reacts with a peroxy free-radical to form tocopherol quinone (Witting, 1975). Moreover, vitamin E spontaneously destroyed by atmospheric oxygen or corresive metals.

SUMMARY