4. RESULTS AND DISCUSSIONS

4.1. Body weight, weight gain and growth rate:

Results concerning the effect of dietary supplementation of garlic, ginger and their combinations and ginseng on live body weight of the weaned V-line rabbits are illustrated in Table 2.

Results presented in (Table 2) indicated that there were no significant differences in initial body weight among different treatments showing the random distribution of the experimental rabbits among treatments.

Dietary garlic supplementation did not significantly ($P \leq 0.05$) influence the final live weight and daily weight gain of the V-line growing rabbits. However, the results showed insignificant increase in final body weight due to addition of garlic, ginger and the combination of garlic plus ginger reached to 1.5, 1.2 and 2.4 and insignificant decrease reached to 0.7 % due to addition of ginseng in the diet as compared to the control group. This observation agrees with the results of Ademola *et al.* (2004) which showed no significant difference ($P \leq 0.05$) in average live weight of broiler chickens fed garlic at 5,000 mg/kg diet. Also, Onibi *et al.* (2009) reported that the final live weight and weight gain were numerically higher at high levels of inclusion garlic in the diets (5,000 mg compared with 500 mg/kg diet for both raw and boiled garlic).

The numerical improvement in body weight gain achieved with mixture of garlic and ginger than garlic and ginger as sole agent in rabbit diets suggest the positive beneficial growth enhancing synergetic effects of these herbs. It could be that a mixture of these herbs may have controlled and limited the growth and colonization of numerous pathogenic and non pathogenic species of bacteria in the gut leading to improved translation of feed to meat.

The results of Issa and Abo Omar (2012) reported that levels, 0.2 and 0.4 %, of garlic powder had no effect on body weight at different periods post feeding. Birds fed the control diet had similar weight gain compared to broilers fed the two levels of garlic powder. Perto (2007) indicated that ginseng had insignificant effect on body weight of broiler chicks from 1-38 d of age.

Concerning daily weight gain of rabbits, the results showed significant increase in daily weight gain through the period 8-10 weeks of age. Daily weight gain of rabbits in the group received 0.25 % garlic powder significantly ($P \leq 0.05$) increased by 27.1 % as compared to the control group, however, this significant increase in daily weight gain disappeared at 10 – 12 weeks of age and thereafter. Higher but insignificant increase in daily weight gain was recorded also in the groups given 0.25 % ginger, the mix of garlic plus ginger and 10 g ginseng / Kg diet and this increase reached to 23.7, 23.0 and 13.3 % as compared to the control group, with non-significant differences among different feed additives groups at 8 – 10 weeks of age.

The improvement in body weight gain achieved with garlic as sole agent in rabbit diets suggest the positive beneficial growth enhancing effects of the garlic. It could be that garlic may have controlled and limited the growth and colonization of numerous pathogenic and non pathogenic species of bacteria in the gut leading to improved translation of feed to meat. The enhanced body weight gain of the rabbits fed ginger and garlic supplemented diets indicates the positive nutritive effects of these natural feed additive. This improvement in growth rate of rabbits fed garlic supplemented diets compared to the control is in line with the findings of

Table (2): Effect of treatments on live body weight (g/week) of growing V- Line rabbit.

Treatments	Age of rabbits			
	W6	W8	W10	W12
Control	811.11±21.55	1332.20±21.57	1641.70±45.95	2043.90±29.65
Garlic 0.25 %	811.11±17.93	1337.20±32.88	1730.60±23.59	2073.90±26.81
Ginger 0.25 %	812.22±44.44	1338.30±48.71	1721.10±51.06	2067.80±40.79
Garlic 0.25 + Ginger 0.25 %	820.62±26.16	1381.20±36.72	1761.90±36.61	2093.80±44.77
10 g / 100Kg diet ginseng	806.50±12.04	1312.50±38.81	1663.00±32.70	2029.00±33.77
Significance	NS	NS	NS	NS

NS: Not Significant.

Table (3): Effect of treatments on live body weight gain (g/rabbit/day) of growing V- Line rabbit.

Treatments	Age of rabbits			
	W6- W8	W8- W10	W10- W12	W6- W12
Control	37.22±1.10	22.10±2.20[b]	28.73±2.92	29.35±0.64
Garlic 0.25 %	37.58±1.81	28.10±2.31[a]	24.52±1.05	30.07±0.84
Ginger 0.25 %	37.58±2.38	27.34±0.88[ab]	24.76±1.84	29.89±1.03
Garlic 0.25 + ginger 0.25 %	40.05±1.86	27.19±1.26[ab]	23.71±1.67	30.31±1.10
10 g / 100Kg diet ginseng	36.14±2.74	25.04±1.61[ab]	26.14±1.16	29.11±0.91
Significance	NS	*	NS	NS

[a - b] Means in the same column having different letters are significantly different.
*P≤0.05. NS: Not Significant.

Table (4): Effect of treatments on growth rate (%) of growing V- Line rabbit.

Treatments	Age of rabbits			
	W6- W8	W8- W10	W10- W12	W6- W12
Control	48.77±1.75	20.58±1.89	22.03±2.56	86.45±1.92
Garlic 0.25 %	48.90±1.90	25.78±2.29	18.05±0.74	87.54±2.29
Ginger 0.25 %	49.47±3.40	25.19±1.05	18.49±1.65	87.73±3.99
Garlic 0.25 + ginger 0.25 %	51.47±2.12	24.56±1.14	17.25±1.00	88.05±2.58
10 g / 100Kg diet ginseng	46.48±3.12	23.46±2.01	20.12±0.98	85.30±2.07
Significance	NS	NS	NS	NS

NS: Not Significant.

Ortserga *et al.* (2008) and Ademola *et al.* (2005) who reported increase in weight gain of rabbits and broilers fed garlic supplemented diets respectively. On the other hand, 13.3% increase recorded for rabbits fed ginger supplemented diets compared to the control suggests that ginger positively influenced the utilization of the feed. This observation is in agreement with the reports of Okoye *et al.* (2006). Also, Wang *et al.* (2011) reported that the average daily gain of pigs fed fermented garlic powder and antibiotic-supplemented diets was greater ($P \leq 0.05$) than negative control (free of feed additives) from d 14 to 35 and the overall phase, but no dosage-dependent effects were observed. At the end of the experiment, the fecal *E. coli* count was linearly reduced by the increasing amounts of fermented garlic powder at d 35 ($P = 0.01$).

4.2. Feed intake:

Data regarding the effect of inclusion of garlic, ginger and their combinations and ginseng in rabbit's diets on feed intake during the different growing periods are shown in (Tables 5).

Information of the effect of garlic, ginger and ginseng on feed intake of rabbits is lacking.

It could be noticed that diet containing 0.25 % dried garlic, 0.25 % ginger and 10 g ginseng / Kg diet insignificantly increased feed intake at the first period (6 – 8 week) of the experiment compared with control. However, the results showed that feeding rabbits on diet containing combination of garlic and ginger gave the least value of feed intake during the period 6 – 8 weeks of age compared with other experimental diets. The results demonstrated also that garlic diet alone showed significant ($P \leq 0.05$) increase in feed intake as compared to the group given the mixed supplementation (garlic plus ginger).

The highest total feed intake during the whole experimental period (6 - 12 week) was observed in rabbits fed on different experimental diets as compared to the control group; however, the differences were insignificant.

The sense of taste (Baldwin, 1976) and Smell (Forbes, 1995) are important factors affecting feed intake. According to Schlolant (1983) the quantity of feed consumed by rabbits is dependent to a large extent on the palatability of the diet. Uno and Aja (2011) reported that the increased feed intake recorded for rabbits fed garlic or ginger supplemented diets may be due to improved flavour, palatability and taste of the feed. This may have enhanced the appetite of the rabbits thereby stimulating increased consumption. This observation implies that the level of inclusion of these herbs were within the tolerable limits of the rabbits. It also suggests that the odour of the diets were not extremely pungent to clamp down feed intakes. The increased feed intake observed in this study is in agreement (less or more) with the reports of Okoye *et al.* (2006); Omage *et al.* (2007) and Adeniyi and Balogun (2002). Issa and Abo Omar (2012) reported that levels, 0.2 and 0.4 %, of garlic powder had no effect on feed intake of broilers during the first three weeks of the feeding trial and this trend was maintained until the termination of the feeding trial at day 42. Perto (2007) indicated that ginseng had insignificant effect on feed consumption of broiler chicks from 1-38 d of age.

Another studies showed insignificant absence of garlic on feed intake. The absence of garlic on feed intake and then general performance was probably due to the intense smell of garlic, which required a period of adaptation of chickens to this kind of feed (Horton *et al.*, 1991).

Table (5): Effect of treatments on feed intake (g/rabbit/day) of growing V- Line rabbit.

Treatments	Age of rabbits			
	W6- W8	W8- W10	W10- W12	W6- W12
Control	63.45±0.83[ab]	93.57±1.24	115.84±1.06	90.95±1.04
Garlic 0.25 %	66.78±1.09[a]	92.03±0.83	113.69±0.78	90.83±0.56
Ginger 0.25 %	65.83±1.80[ab]	86.31±1.06	110.38±1.15	87.51±0.24
Garlic 0.25 + ginger 0.25 %	62.38±0.66[b]	87.86±4.36	115.83±1.31	88.69±1.85
10 g / 100Kg diet ginseng	66.78±1.09[a]	94.29±1.09	118.10±1.76	93.05±0.66
Significance	*	NS	NS	NS

[a - b] Means in the same column having different letters are significantly different.
*P≤0.05. NS: Not Significant.

4.3. Feed conversion ratio and performance index:

Data for the effect of treatments on feed conversion ratio and performance index of V-line rabbits are presented in Tables (6 and 7).

In terms of feed utilization of the diets by the rabbits, the groups fed supplemented diets recorded significantly ($P \leq 0.05$) superior feed conversion ratio than those fed the control diet through the period from 8 – 10 weeks of age and also through the whole experimental period, however, the differences were not significant.

Feed conversion ratio during 8 – 10 weeks of age was significantly improved by 24.0 % due to 0.25 % garlic supplementation treatment, compared to the control. However 0.25 % ginger had significantly the best value of improving feed conversion ratio as compared to the control group and the other experimental groups. It improved feed conversion ratio by 26.7 % than control one. The mixed supplementation of garlic and ginger also had significant effect on this trait and improved it by 25.8 % as compared to the control group. Non-significant improvements in feed conversion ratio due to addition of ginseng to the diet and this improvement reached to 10.1 % as compared to the control group fed diet without supplementation. Through the whole experimental period the results showed non-significant improvement in feed conversion ratio reached to 5.0, 7.9, 5.6 for the rabbits fed diets supplemented with garlic, ginger or the mixed supplementation of garlic plus ginger comparing with control group, respectively.

The improvement in feed conversion ratio of the rabbits fed supplemented diets may be due to the antibacterial and antifungal properties of these herbs which might have improved the microflora and gut environment of the rabbits resulting in improved feed utilization. For instance, Reeds *et al.* (1993) attributed the positive effect of garlic on feed conversion ratio to the fact that susceptibility of pathogenic gram-positive bacteria to the antibacterial components of garlic is higher than the physiological desirable intestinal bacteria. According to the authors, the beneficial bacteria are believed to be unaffected by the presence of garlic as they are less sensitive to the inhibitory effect of garlic. Furthermore, garlic may have a prebiotic effect due to its classification as a fructooligosaccharide (Gibson, 2001).

The results obtained by Singh *et al.*, 1998; Avato *et al.*, 2000; Lewis *et al.*, 2003; Carrijo *et al.*, 2005; Mahmood *et al.*, 2009) showed that garlic can be used as a feed additive in broiler diets as it able to improve weight gain and reduce feed conversion ratio. This performance improving property is attributed to the antibacterial properties of allicin and ajoene. Maluf *et al.* (2008) reported that ajoene (4,5,9-trithiadodeca-1,6,11-triene 9-oxide), an organic sulphur compound, has antimicrobial properties. Therefore, feeding diets containing ajoene may inhibit the growth of entero-pathogenic bacteria, thus contributing on the balance of gut microbial populations (Harris *et al.*, 2001) and resulting in a better growth performance (Lewis *et al.*, 2003; Adibmoradi *et al.*, 2006). Oladele et al. (2012) reported that garlic meal supplementation at 0.125% in the diet of commercial broilers improved feed conversion ratio of broilers by increasing villi length, villi width and cryptal depth.

Chrastinova *et al.* (2009) reported that the application of *Eleutherococcus senticosus* (30g/100kg diet) improved feed conversion ratio and average daily weight gain of fattening rabbits ($P \leq 0.05$). The antimicrobial effect of *Eleutherococcus* extract was observed against coagulase-positive staphylococci, *Staphylococcus aureus*, *Clostridium*-like species, similarly to results presented by Simonová *et al.* (2008). In addition, Perto (2007) indicated that ginseng

Table (6): Effect of treatments on feed conversion ratio (g feed/g gain) of growing V- Line rabbit.

Treatments	Age of rabbits			
	W6- W8	W8- W10	W10- W12	W6- W12
Control	1.71±0.02	4.34±0.47[a]	4.17±0.54	3.41±0.09
Garlic 0.25 %	1.79±0.08	3.30±0.18[b]	4.65±0.14	3.24±0.08
Ginger 0.25 %	1.78±0.17	3.18±0.18[b]	4.48±0.20	3.14±0.13
Garlic 0.25 + ginger 0.25 %	1.56±0.05	3.22±0.13[b]	4.88±0.06	3.22±0.08
10 g / 100Kg diet ginseng	1.96±0.32	3.90±0.37[ab]	4.49±0.17	3.45±0.10
Significance	NS	*	NS	NS

[a - b] Means in the same column having different letters are significantly different.
*P≤0.05. NS: Not Significant.

Table (7): Effect of treatments on performance index (final body weigh, Kg. / feed conversion ratio x 100) of growing V- Line rabbit.

Treatments	Performance index (6-12 Ws)
Control	60.15±2.51
Garlic 0.25 %	64.06±2.23
Ginger 0.25 %	66.19±4.65
Garlic 0.25 + ginger 0.25 %	65.08±2.82
10 g / 100Kg diet ginseng	58.78±2.60
Significance	NS

NS: Not Significant.

had insignificant improving effect on feed conversion ratio of broiler chicks from 1-38 d of age.

On the other hand, Issa and Abo Omar (2012) reported that levels, 0.2 and 0.4 %, of garlic powder had no effect feed conversion ratio of broilers during the first three weeks of the feeding trial and this trend was maintained until the termination of the feeding trial at day 42. Birds fed the control diet had similar feed conversion ratio compared to broilers fed the two levels of garlic powder. Also, Osfor (1995) fed Panax ginseng powder extract at 2 mg and 4 mg/ Japanese quail bird daily. His results found that Panax ginseng slightly improved the efficiency of feed utilization.

Concerning performance index, the results presented in Table 7 showed that rabbits fed garlic or ginger alone or mix of garlic and ginger recorded the best performance index, while those fed the control or ginseng containing diet had the worst values. The increase in performance index may be due to the improvements in feed conversion ratio.

4.4. Digestibility coefficients of nutrients of the experimental diets:

Data for the effect of treatments on digestibility of nutrients are shown in Table (8).

The different supplementations had significant ($P \leq 0.01$) effect on digestibility of crude protein, ether extract and nitrogen free extract. Generally, there was no significant effect of treatments on digestibility of crude fiber.

Clearly, there was significant improvement of 0.25 % garlic powder supplementation on digestibility coefficient of ether extract reached to 22.9 % and non-significant improvement on digestibility coefficient of crude protein and crude fiber reached to 6.2 and 6.9 %, respectively, as compared to the control group.

The 0.25 % ginger supplementation to rabbit diets significantly ($P \leq 0.01$) improved apparent digestibility of crude protein, ether extract and insignificantly crude fiber and nitrogen free extract as compared to the control group. The improvements surpassed the control one by 18.2, 26.4, 21.0 and 2.4 %, respectively.

Mixed supplementation of garlic and ginger powders significantly ($P \leq 0.01$) improved apparent digestibility of ether extract by 20.8 % and non-significantly improved apparent digestibility of crude protein by 10.1 % as compared to the control group.

Concerning ginseng supplementation to rabbit's diet; it was observed that supplementations had significant ($P \leq 0.01$) improvement effect on apparent digestibility coefficients of ether extract and nitrogen free extract reached to 29.6 and 7.3 %, respectively, however, it had non-significant improvements effect on digestibility coefficients of crude protein and crude fiber reached to 7.3 and 27.8 %, respectively, compared to the control group.

In this respect, Issa and Abo Omar (2012) found that the apparent digestibility of total tract DM, CP and EE was improved ($P < 0.05$) by the addition of the garlic powder compared to that in the control diet. These findings are in agreement with previous research of Hernandes *et al.* (2004) who showed that plant extract supplementation improved apparent whole tract digestibility of the nutrients. Issa and Abo Omar (2012) demonstrated that the improvement of total tract digestibility in broilers fed different levels of garlic powder was probably due to herbal effects in decreasing the microbial population especially the number of bacteria such as *E. coli*, *Clostridium* spp. and *Enterococci.* The efficacy of any dietary feed additives observed under less hygienic housing conditions, especially under the separate floor pens equipped with wood shaving litter stimulates the activity of the feed additives.

Table (8): Effect of treatments on digestibility coefficients of growing V- Line rabbit.

Treatments	Digestibility coefficients			
	CP	EE	CF	NFE
Control	66.43±0.63[b]	66.50±2.15[b]	17.03±3.33	77.07±1.47[b]
Garlic 0.25 %	70.53±0.45[b]	81.70±2.82[a]	18.20±1.08	74.67±1.51[b]
Ginger 0.25 %	78.53±0.25[a]	84.07±1.93[a]	20.60±0.90	78.90±1.01[ab]
Garlic 0.25 + ginger 0.25 %	73.13±1.97[ab]	80.30±2.00[a]	16.44±1.37	76.54±2.26[b]
10 g / 100Kg diet ginseng	71.26±4.09[b]	86.17±1.82[a]	21.77±0.47	82.67±0.64[a]
Significance	**	***	NS	**

[a - b] Means in the same column having different letters are significantly different.
**P≤0.01. ***P≤0.01. NS: Not Significant.

The isoprene derivatives, flavonoids, glucosinolates and other plant metabolites may affect the physiological and chemical function of the digestive tract. The stabilizing effect on intestinal microflora may be associated with intermediate nutrient metabolism (Bratta *et al.*, 1998 and Jamroz *et al.*, 2003). The active principles of essential oils act as a digestibility enhancer, balancing the gut microbial ecosystem and stimulating the secretion of endogenous digestive enzymes and thus improving growth performance in poultry (Lovkova *et al.*, 2001; Williams and Losa, 2001; Cross *et al.*, 2007).

In this regard, Adimoradi *et al.* (2006) evaluated the effect of garlic meal on the intestinal mucosal morphology of broiler chickens between 21 and 42 days of age. They reported that garlic meal as a feed additive significantly enhanced villi height and crypt depth and decreased epithelial thickness and goblet cell numbers in duodenum, jejunum and ileum of birds. They also concluded that such intestinall morphological changes in chickens due to dietary garlic meal supplement demonstrate that absorptive process could be activated by garlic meal as an antibiotics alternative growth promoter. In the same direction, Oladelr *et al.* (2012) investigated the effect of garlic on the absorptive surface of the small intestine of broiledr chicks, in order to elucidate the mechanism of garlic as a growth promoter.

4.5. Carcass characteristics:

Data concerning the effect of feeding V-line rabbits on diets containing 0.25 % garlic, 0.25 % ginger and their combinations and 10 g ginseng / Kg diet on their carcass characteristics are shown in Tables (9 - 13).

Information of the effect of garlic, ginger and ginseng on carcass traits of rabbits is lacking. The results showed that the different treatments had insignificant effect on pre slaughter weight of rabbits at 12 weeks of age .The percentage of dressing, liver, heart, lungs, head, intestine, kidney and fur of rabbits fed the experimental diets were insignificantly affected by different treatments, whereas, significant effect due to treatments was found in percentage weight of spleen and cecum.

The highest significant ($P \leq 0.01$) values of spleen percentage were recorded for rabbits fed 0.25 % garlic and 10 g ginseng / Kg diet, while insignificant increase in spleen percentage was recorded also in the group received 0.25 % ginger followed by the group received mixed garlic and ginger supplementation as compared to the control group. Perto (2007) showed that the relative weight of Bursa of Fabricius in broilers in both low and high dose of ginseng treated-groups were insignificantly higher (0.16 and 0.11% respectively) than the control (0.08%). This is in accordance with the immunostimulant effect of ginseng cited with other animals and in humans.

Small intestine length significantly ($P \leq 0.01$) decreased in the group of rabbits fed the different supplementation and the lowest values were recorded in the group fed ginseng, followed by those group fed mixed garlic and ginger as compared to the other experimental groups.

The lack of garlic powder effect on rabbits visceral organs observed in this experiment is similar to that reported by previous research. Issa and Abo Omar (2012) reported that dressing percentages and abdominal fat weight, relative weights of carcass cuts, liver, gizzard and heart were not affected by garlic powder. Raeesi *et al.* (2010) reported that garlic at levels of 1 and 3% had no significant effects on relative weights of carcass, fat pad, or digestive organs among different treatments, except for the small intestine. Similar trend was observed for small intestine and cecum relative weights. These findings are in agreement with the

Table (9): Effect of treatments on body weight (g), dressed weight (g& %) and heart weight (g& %) of growing V- Line rabbit.

Treatments	Pre-slaughter weight	Dressed weight		Heart	
	(g)	(g)	(%)	(g)	(%)
Control	1980.0±25.2	1178.0±22.3	59.49±0.64	6.30±0.4	0.31±0.02
Garlic 0.25 %	1976.0±48.0	1183.0±35.6	59.87±0.71	7.06±0.4	0.34±0.02
Ginger 0.25 %	2054.0±29.9	1214.0±23.1	59.10±0.63	6.76±0.6	0.32±0.03
Garlic 0.25 + ginger 0.25 %	2012.0±22.7	1186.0±12.9	58.95±0.20	6.72±0.5	0.32±0.02
10 g / 100Kg diet ginseng	1970.0±18.5	1169.0±14.6	59.35±0.68	6.70±0.2	0.33±0.01
Significance	NS	NS	NS	NS	NS

NS: Not Significant.

Table (10): Effect of treatments on liver weight (g& %) spleen weight (g& %) and lung weight (g& %) of growing V- Line rabbit.

Treatments	Liver		Spleen		Lungs	
	(g)	(%)	(g)	(%)	(g)	(%)
Control	49.22±2.79	2.40±0.13	1.06±0.12^{c}	0.05±0.01^{b}	17.24±0.98	0.84±0.05
Garlic 0.25 %	52.98±2.26	2.57±0.13	1.58±0.15^{a}	0.08±0.01^{a}	18.78±1.63	0.91±0.08
Ginger 0.25 %	51.48±5.19	2.40±0.20	1.50±0.15^{ab}	0.07±0.01^{ab}	14.54±0.83	0.68±0.04
Garlic 0.25 + Ginger 0.25 %	52.08±2.34	2.49±0.10	1.18±0.11^{bc}	0.06±0.00^{b}	17.12±2.00	0.82±0.09
10 g / 100Kg diet ginseng	46.24±3.02	2.26±0.13	1.60±0.06^{a}	0.08±0.00^{a}	17.82±2.80	0.88±0.14
Significance	NS	NS	**	**	NS	NS

$^{a-c}$ Means in the same column having different letters are significantly different.
**P≤0.01. NS: Not Significant.

Table (11): Effect of treatments on fur weight (g& %), head weight (g& %) and kidney weight (g& %) of growing V- Line rabbit.

Treatments	Fur		Head		Kidney	
	(g)	(%)	(g)	(%)	(g)	(%)
Control	238.00±19.2[b]	11.60±0.93	128.40±10.68	6.25±0.45	11.92±11.92	0.58±0.02
Garlic 0.25 %	254.00±5.79[ab]	12.32±0.21	112.00±2.55	5.44±0.16	13.22±13.22	0.64±0.03
Ginger 0.25 %	267.00±5.83[ab]	12.50±0.25	120.00±4.18	5.62±0.20	13.52±13.52	0.63±0.04
Garlic 0.25 + Ginger 0.25 %	276.00±5.79[a]	13.21±0.32	122.00±3.39	5.84±0.21	12.74±12.74	0.61±0.02
10 g / 100Kg diet ginseng	266.00±9.54[ab]	13.02±0.48	119.00±3.32	5.83±0.19	13.12±13.12	0.64±0.04
Significance	*	NS	NS	NS	NS	NS

[a - b] Means in the same column having different letters are significantly different.
*P≤0.05. NS: Not Significant.

Table (12): Effect of treatments on small intestine weight (g& %) and cecum weight (g %) of growing V- Line rabbit.

Treatments	Small Intestine		Cecum	
	(g)	(%)	(g)	(%)
Control	35.92±3.63	1.75±0.18	45.04±1.64[a]	2.20±0.08[a]
Garlic 0.25 %	37.14±1.42	1.80±0.07	42.94±2.71[ab]	2.09±0.15[ab]
Ginger 0.25 %	37.86±0.94	1.77±0.06	36.86±2.33[b]	1.73±0.12[b]
Garlic 0.25 + Ginger 0.25 %	38.36±2.24	1.84±0.11	38.86±1.91[ab]	1.86±0.09[ab]
10 g / 100Kg diet ginseng	40.06±1.40	1.96±0.07	43.56±2.88[ab]	2.13±0.14[a]
Significance	NS	NS	*	*

[a - b] Means in the same column having different letters are significantly different.
*P≤0.05. NS: Not Significant.

Table (13): Effect of treatments on small intestine length (cm) and cecum length (cm) of growing V- Line rabbit.

Treatments	Small Intestine length(cm)	Cecum length(cm)
Control	264.40±11.50[a]	32.60±0.40
Garlic 0.25 %	260.00±13.42[ab]	34.00±1.10
Ginger 0.25 %	245.80±3.62[b]	34.40±1.17
Garlic 0.25 + Ginger 0.25 %	233.80±8.48[bc]	34.40±1.47
10 g / 100Kg diet ginseng	220.20±3.40[c]	33.00±1.00
Significance	**	NS

[a - c] Means in the same column having different letters are significantly different.
**P≤0.01. NS: Not Significant.

findings of Hashish *et al.* (1995) and Ceylan *et al.* (1998). This result is in disagreement with previous research where supplementation of 1% garlic powder caused higher thigh yield while the poorest thigh yield belonged to 3% garlic powder group. Groups received 1% garlic powder significantly had higher breast yield than others (Raeesi *et al.,* 2010). On the other hand, Cullen *et al.* (2005) reported that pigs offered the garlic diets had a better ($P \leq 0.05$) carcass values than the pigs offered the control diet. The results of Perto (2007) indicated that ginseng had insignificant effect on carcass traits of broiler chicks at 38 d of age.

4.6. Blood hematology:

Hematological constituents reflect the physiological responsiveness of animal to its internal and external environment, which includes feed and feeding (Esonu *et al.*, 2001).

The paked cell volume (PCV), haemoglobin (Hb), red blood cells (RBCs) and white blood cells (WBCs) (haematological characteristics) of the weaned rabbits fed 0.25 % garlic, 0.25 % ginger and their combinations and 10 g ginseng / Kg diet supplemented diets are as presented in Table 14.

Results on haematological parameters of the rabbits show a general increase ($P \leq 0.05$) in PCV and RBC and insignificant increase in WBC, and Hb of rabbits fed garlic, ginger and their mix or ginseng supplemented diets. Plat lets was not differ significantly due to different treatments. The general increase in PCV and RBC of rabbits fed garlic, ginger or their mix and ginseng supplemented diets indicates that these feed additives may contain blood forming factors that may have stimulated more blood production by the rabbits fed supplemented diets than those fed un-supplemented diets. This also suggests that these herbs may have helped in boosting the immune system of the rabbits. The percentage of lymphocytes, basophils, eosinophils and neutrophils were not affected by different feed additives, however, monocytes significantly ($P \leq 0.01$) increased in the groups received mixed of garlic and ginger or ginseng containing diets.

The RBC, PCV and Hb values were nearly similar ($P \leq 0.05$) among the treatment groups and also fall within the normal range of 3.7 - 8.0 10^6 μ / l, 25 – 50% and 8.9 – 17.5 g/dl reported for healthy rabbits by Mitruka and Rawnsley (1977). The normal PCV indicates the absence of normocytic anaemia which is reportedly characterized by normal MCV and MCH and only detected by a decreased number of RBC or PCV (Coles, 1986). The result is corroborated by the normal RBCs which further elucidated the absence of hemolytic anaemia and depression of erythrogenesis. The normal hemoglobin concentration for all the experimental rabbits is probably an indication that ginger rhizome powder supplement supported hemoglobin synthesis, which according to Sirosis (1995) is among other factors, primarily affected by protein intake. The result suggests absence of microcytic hypochromic anaemia, which is due to iron deficiency and its improper utilization for the formation of haemoglobin. Njidda *et al.* (2006) reported that normal range of values for Hb indicated that the vital physiological relationship of haemoglobin with oxygen in the transport of gases (oxygen and carbon dioxide) to and from the tissues of the body has been maintained and was normal.

Kyo (2001) suggest that aged garlic extract could be a promising candidate as an immune modifier, which maintains the homeostasis of immune functions.

Table (14): Effect of treatments on red blood cells (10^6/mm3), white blood cells (10^3/mm3), hemoglobin (g/dl), packed cell volume (%), and plat lets of growing V- Line rabbit.

Treatments	Blood hematology				
	Red blood cells	White blood cells	Hemoglobin	Packed cell volume	plat lets
Control	4.44±0.70^{b}	3.73±0.34	11.32±0.94	27.40±1.29^{b}	220.80±28.43
Garlic 0.25 %	5.56±0.63^{ab}	4.14±0.34	12.22±1.08	31.40±0.81^{a}	211.42±24.33
Ginger 0.25 %	5.30±0.63^{ab}	4.67±0.31	13.80±0.96	28.20±1.59^{ab}	215.60±24.11
Garlic 0.25 % + ginger 0.25 %	6.44±0.63^{ab}	4.37±0.45	12.64±1.45	30.40±0.98^{ab}	216.24±26.27
10 g ginseng / 100Kg diet	6.84±0.81^{a}	4.60±0.11	13.02±0.24	31.60±0.81^{a}	234.40±29.69
Significance	*	NS	NS	*	NS

$^{a-b}$ Means in the same column having different letters are significantly different.
*P≤0.05. NS: Not Significant.

Table (15): Effect of treatments on non-granular leucocytes (%) and granular leucocytes (%) of growing V- Line rabbit.

Treatments	Blood hematology				
	Lymphocytes	Monocytes	Basophils	Eosinophils	Nuterophils
Control	38.60±2.16	3.60±0.24^{bc}	0.60±0.24	2.80±0.37	54.40±2.01
Garlic 0.25 %	41.60±1.36	3.40±0.2^{4c}	0.60±0.40	2.40±0.24	52.00±1.48
Ginger 0.25 %	39.40±1.36	3.60±0.24^{bc}	0.60±0.24	3.00±0.00	53.60±1.60
Garlic 0.25 +Ginger 0.25 %	38.40±2.25	4.40±0.24^{a}	0.20±0.20	2.60±0.24	54.40±2.66
10 g / 100Kg diet ginseng	35.40±2.75	4.20±0.20^{ab}	0.20±0.20	3.00±0.00	57.20±2.96
Significance	NS	**	NS	NS	NS

$^{a-b}$ Means in the same column having different letters are significantly different.
**P≤0.01. NS: Not Significant.

4.7. Blood serum parameters:

Data for blood serum parameters for the 12-week old weaned rabbits are summarized in Tables 16-19.

The results in Table 16 showed that the different treatments induced insignificant changes in blood serum total protein and globulin, however, blood serum albumin was significantly affected by the different treatments. It could be observed that adding the different feed additives resulted in non-significant increase in serum content of total protein in comparison with the control group. With regard to albumin (g/dl), it could be noticed that the different treatments had significant effect ($P \leq 0.05$) among different experimental groups. Looking at the results of serum globulin, it could be observed that adding garlic, ginger and their mix or ginseng to rabbits feed resulted in non-significantly higher globulin than the value obtained in control group. These groups surpassed the control one by about 44.8, 54.6, 6.2 and 39.7 %, respectively. The groups fed ginger, garlic and ginseng recorded the highest values of serum globulin content as compared to the control and the combination of garlic plus ginger. This implies that ginger, garlic or ginseng at these levels used in the present study did not impair the synthesis and concentration of serum protein and albumin. All treatments in this study insignificantly or significantly increased the values of total protein, albumin and globulin when compared to control group. The increase of total protein and globulin may be attributed to the increase in the level of metabolic processes.

Also, the different supplementations caused insignificant effect on uric acid and blood urea concentrations as compared to the control group; however, creatinine concentration was reduced due to different supplementations and reached significant effect only with ginceng supplementation when compared with the control group.

Serum GOT was insignificantly and serum alkaline phosphatase was significantly decreased by addition of different feed additives.

The insignificant effect on GOT or the decrease in the concentration of alkaline phosphatase with all feed additives supplemented reflects better liver function (Abou-Egla *et al.,* 2001). Abdel-Azeem (2002) and Soliman *et al.* (2003) found decreases in creatinine kinase, GOT and GPT and these decreases are correlated with significantly increased values of total protein and globulin.

As presented in Table 18, the results indicated that glucose concentration was insignificantly affected by different feed additives.

Concerning lipid profile in the serum, Tables 18 and 19 represents the results of the effects of garlic, ginger and their mix or ginseng powders on rabbit's serum total lipids, triglycerides, total cholesterol, LDL and HDL concentrations.

Results in Table 18 indicated that serum total lipids significantly ($P \leq 0.05$) decreased due to addition of different feed additives, however, the results in Table 19 and figure 1 showed that low density lipoprotein significantly ($P \leq 0.05$) decreased by adding garlic in rabbits diet as compared to control and the other experimental groups. Total cholesterol insignificantly decreased by feeding diets containing different feed additives as compared with the control group, however, high density lipoprotein concentration insignificantly increased by addition of different feed additives (Table 19 and figure 1).

In fact, the mechanisms by wich garlic preparations reduce blood plasma lipids in human and animals are not completely confirmed yet. But it is generally accepted that dietary garlic supplementation inhibits the hepatic activities of lipogenic and cholestrogenic enzymes

in chickens (Qureshi *et al.*, 1983), pigs (Qureshi *et al.*, 1987) and rats (Mathew *et al.*, 2004). In agreement with the present results, Tollba and Hassan (2003) studied the effect of feeding garlic-containing diets on the physiological parameters of broiler chicks and observed significant increases on plasma total protein and albumin in response to feeding the garlic-containing diets. Similarly, significant reductions in blood plasma concentrations of triglycerides were observed in broilers (Al-Homidan, 2005). And Japanese quail (Khalil *et al.*, 2007) in response to feeding garlic-supplemented diets compared with control birds. The present results are in accordance also with the findings obtained by Prasad *et al.* (2009), who found that blood plasma total cholesterol; triglycerides, low density lipoprotein and very lowdensity lipoprotein were significantly decreased, while high density lipoprotein was significantly increased by garlic supplementation in broiler chickens in comparison to thecontrol group. In addition, Choi *et al.* (2010) indicated that dietary garlic powder significantly decreased total and low-density lipoprotein cholesterol and increased high-density lipoprotein cholesterol in broiler blood. This may probably be due to the possible mechanism of hypocholesterolaemic and hypolipidemic action of garlic products which depresses the hepatic activities of lipogenic and cholesterogenic enzymes such as malic enzyme, fatty acid synthase, glucose-6-phosphatase dehydrogenase (Chi *et al.*, 1982; Qureshi *et al.*, 1983a) and 3-hydroxyl-3-methyl-glutaryl-CoA (HMG-CoA) reductase (Qureshi *et al.*, 1983b, 1987). Afzal *et al.* (1985) reported that polyunsaturated fatty acids prevent atherosclerosis through the formation of cholesterol esters. They further reported the presence of higher polyunsaturated fatty acids like arachidonate and eicosapentenoate in garlic which could well be responsible for preventing atherosclerosis. Furthermore, garlic powder can facilitate activity of enzymes which are involved in the conversion of cholesterol to bilious acids and subsequently, there will be less cholesterol in the carcass (Bordia *et al.*, 1975; Raeesi *et al.*, 2010).

Ginger was found to have hypocholesterolemia and caused a decrease in blood glucose and alkaline phosphatase in adult male rat (Bhandari *et al.*, 2005). Also, Onu and Aja (2011) reported that the hypocholesterolemic effect of ginger could have possibly resulted from the inhibition of cellular cholesterol biosynthesis. The results of Dias *et al.* (2006) and Malekizadeh *et al.* (2012) reported that the total cholesterol level were significantly decreased by dietary supplementation of 1% ginger extract meal in rats . They stated that ginger treatment can reduce total serum cholesterol by enhancing the activity of liver cholesterol -7-a- hydrolase or inhibition of hydroxy- methyl- glutaryl- Co- enzyme – A (HMG- CoA) reductase , either by bile – acid conversion or fecal excretion of cholesterol (Bhandari *et al.*, 1998). The adding ginger rhizome powder to the food could be useful in the management of cardiovascular disease in which atherosclerosis is the most important factor may be due to the presence poly- phenolic and flavonoids may prevent coronary artery disease by reducing plasma cholesterol level or by inhibiting LDL oxidation, a process which is through to play a key role in the pathogenesis of atherosclerosis (Bordia et al., 1997; Fuhrman *et al.*, 2000 and Nicoll and Henein, 2009).

Generally, the results of hypolipidemic action of the supplements showed that they could be used to lower some of the risk factors associated with the development of cardiovascular diseases and cancer whether in animals or human beings. It has been reported that lowering blood levels of cholesterol and fats may help to prevent heart disease, angina,

Table (16): Effect of treatments on blood serum total protein (g/L), albumin (g/L) and globulin (g/L) of growing V Line rabbit.

Treatments	Blood biochemical parameters		
	Total protein	Albumin	Globulin
Control	4.82±0.43	2.88±0.15[b]	1.94±0.30
Garlic 0.25 %	6.50±0.18	3.68±0.03[a]	2.81±0.21
Ginger 0.25 %	6.54±0.48	3.54±0.24[ab]	3.00±0.36
Garlic 0.25 + Ginger 0.25 %	5.23±0.83	3.16±0.39[ab]	2.06±0.51
10 g / 100Kg diet ginseng	6.14±0.48	3.43±0.19[ab]	2.71±0.31
Significance	NS	*	NS

[a - b] Means in the same column having different letters are significantly different.
*P≤0.05. NS: Not Significant.

Table (17): Effect of treatments on blood serum creatinine (mg/L), serum uric acid (mg/L), Glutamic- oxaloacetic transaminase (GOTu/l) and urea (g/L) of growing V-Line rabbit.

Treatments	Blood biochemical parameters			
	Creatinine	Uric acid	GOT	Urea
Control	0.58±0.08^{a}	0.66±.09^{ab}	6.67±0.33	7.59±0.59^{ab}
Garlic 0.25 %	0.46±0.02^{ab}	0.87±0.16^{a}	6.17±1.01	8.46±0.17^{a}
Ginger 0.25 %	0.48±0.02^{ab}	0.53±0.03^{b}	7.83±1.17	5.90±0.14^{b}
Garlic 0.25 + Ginger 0.25 %	0.48±0.02^{ab}	0.81±0.02^{ab}	6.67±0.17	5.63±1.23^{b}
10 g / 100Kg diet ginseng	0.41±0.01^{b}	0.65±0.02^{ab}	7.17±0.17	8.32±0.42^{a}
Significance	*	*	NS	**

$^{a-b}$ Means in the same column having different letters are significantly different.
*P≤0.05. **P≤0.01. NS: Not Significant.

Table (18): Effect of treatments on blood serum total lipids (mg/L), serum alkaline phosphatase and serum Glucose (g/L) of growing V- Line rabbit.

Treatments	Blood biochemical parameters		
	Total lipids	Alkaline phosphatase	Glucose
Control	351.63±50.88[a]	266.18±2.79[a]	53.01±3.66
Garlic 0.25 %	212.73±5.89[b]	167.25±13.28[c]	50.73±5.34
Ginger 0.25 %	254.67±6.82[b]	197.48±3.47[bc]	47.80±3.80
Garlic 0.25 + Ginger 0.25 %	236.60±38.40[b]	172.00±3.21[c]	51.88±1.79
10 g / 100Kg diet ginseng	228.00±12.74[b]	207.75±19.06[b]	50.41±5.65
Significance	*	***	NS

[a - c] Means in the same column having different letters are significantly different.
*P≤0.05. ***P≤0.001. NS: Not Significant.

Table (19): Effect of treatments on blood serum total cholesterol (mg/dL), low density lipoprotein (mg/dL), high density lipoprotein (mg/dL) and triglycerides (mg/dl) of growing V- Line rabbit.

Treatments	Blood biochemical parameters			
	Total Cholesterol	Low density lipoprotein	High density lipoprotein	Triglycerides
Control	70.01±10.07	22.44±0.70[a]	27.25±4.08	108.52±0.33
Garlic 0.25 %	61.03± 11.98	17.20±1.17[b]	36.96±3.21	106.09±2.50
Ginger 0.25 %	68.04±10.13	22.07±0.52[a]	41.51±2.33	108.08±2.07
Garlic 0.25 + Ginger 0.25 %	64.84± 9.41	19.27±2.06[ab]	36.853.37	106.91±1.08
10 g / 100Kg diet ginseng	61.64±3.66	22.69 ±1.47	34.00±9.24	107.01±1.50
Significance	NS	*	NS	NS

[a - b] Means in the same column having different letters are significantly different.
*P≤0.05. NS: Not Significant.

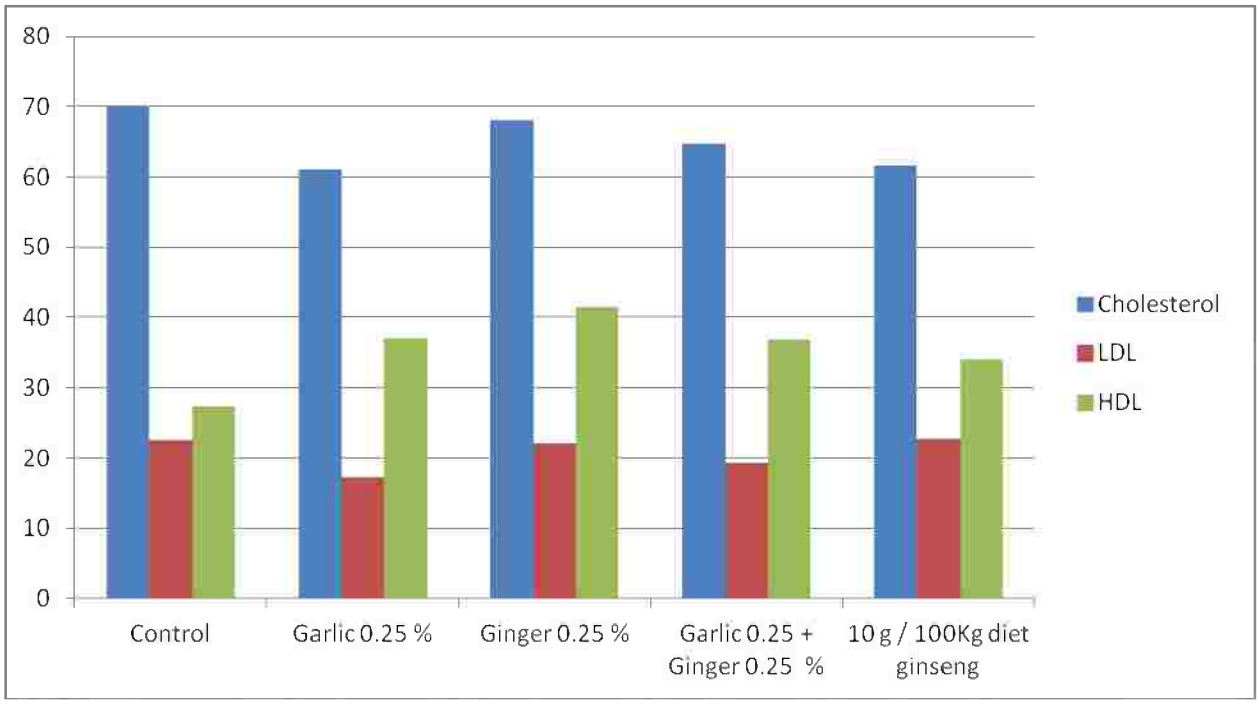

Figure 1: effect of different supplementation on cholesterol, LDL and HDL

stokes and heart attacks (Anonymous, 2008). Furthermore, it has been reported that increasing HDL and lowering LDL cholesterol and triacylglycerol levels by dietary or pharmacological means remain the most important goals to reach in dyslipidemic patients (NCEP, 2001; Ademola *et al.*, 2009).

4.8. Serum total antioxidant capacity, malondialdehyde and glutathione peroxidase:

Table 20 and figure 2 and 3 presents the results on the effects of differentfeed additives on serum total antioxidant capacity, malondialdehyde and glutathione peroxidase of growing rabbits at 12 weeks of age.

Exposing weaning rabbits to high temperature conditions during summer season resulted in significant decrease ($P \leq 0.001$) in serum total antioxidant capacity which was obtained in the control group, however, supplementation of garlic, ginger, and their combination or ginseng appeared to antagonize the effect of high temperature during summer. These feed additives increased total antioxidant capacity in blood serum as increased its value by about 100.4, 147.6, 152.4 and 166.6 %, respectively, as compared to the control group.

Heat stress causes increased free radical production (Halliwell and Gutteridge, 1989) and lowers the concentrations of antioxidant vitamins and minerals such as E, C, A and Zn in serum and tissues (Sahin and Kucuk, 2003a). Free radicals trigger the metabolic disorder, cell death and growth retardation (Okada, 1996).

By using malondiaidehyde (MDA) as a marker of the oxidative stress, we studied the effect of high temperature during summer conditions and supplemental garlic, ginger and their combination or ginseng on lipid peroxidation in serum. Exposing weaning rabbits to high temperature conditions during summer season resulted in elevated ($P \leq 0.05$) serum MDA as presented in the control group, however, supplementation of garlic, ginger and their combination or ginseng appeared to antagonize this effect of high temperature. These treatments reduced lipid peroxidation in serum expressed as serum malondialdehyde (MDA) by 4.9, 7.4, 26.4 and 18.3 %, respectively.

Stress leads to a generation of free radicals which can damage cell membranes by inducing lipid peroxidation of polyunsaturated fatty acids in the cell membrane (Luadicina and Marnett, 1990), destroying membrane integrity during stress. Similar to results of the present study, Morrissey *et al.* (1997) reported that dietary supplementation of chicken diets with α-tocopherol increased tissues α-tocopherol concentrations, while markedly decreasing MDA concentration. Supplementation with tocopherols will increase the α-tocopherol content of chicken tissues (Cherian *et al.*, 1996) and enriched poultry meat could be considered a useful source of this vitamin in the human diet. Moreover, the antioxidant function of tocopherols in poultry meat prevents the formation of primary (Grau *et al.*, 2001) and secondary (Cherian *et al.*, 1996) oxidation products (Ajuyah *et al.*, 1993). Garlic, ginger and ginseng have been defined as an important component of an antioxidant network that prevents membrane damage from oxidation (Hui, 1996, Akhani *et al.*, 2004 and Liu *et al.*, 2003).

Therefore, it may be concluded that supplementing garlic, ginger and their mixture to growing rabbit diets improve feed conversion ratio, performance index (except, ginceng supplementation) and reduced blood total lipids, triglycerides, LDL and MDA, however, it increased TAC and HDL under environmental Egyptian summer conditions. Ginceng supplementation had insignificant effect on performance traits of V-line rabbits, however, it had significant effect on reducing MDA and increasing TAC in the serum blood of growing rabbits.

Table (20): Effect of treatments on blood serum lipid peroxid (mg/L), serum glutatbione peroxieia (nmol/ml) and Total antioxidant capacity (mmol/L) of growing V- Line rabbit.

Treatments	Blood biochemical parameters		
	Lipid peroxide	Glutathione peroxidase	Total antioxidant capacity
Control	6.83±0.28[a]	55.43±0.45[c]	1.409±0.023[c]
Garlic 0.25 %	2.47±0.08[b]	65.27±7.41[bc]	2.833±0.037[b]
Ginger 0.25 %	2.46±0.12[b]	76.27±0.55[ab]	3.467±0.069[a]
Garlic 0.25 + Ginger 0.25 %	2.48±0.22[b]	81.03±5.18[a]	3.533±0.047[a]
10 g / 100Kg diet ginseng	2.45±0.05[b]	77.73±5.03[ab]	3.733±0.041[a]
Significance	*	**	*

[a - c] Means in the same column having different letters are significantly different.
*P≤0.05. **P≤0.01.

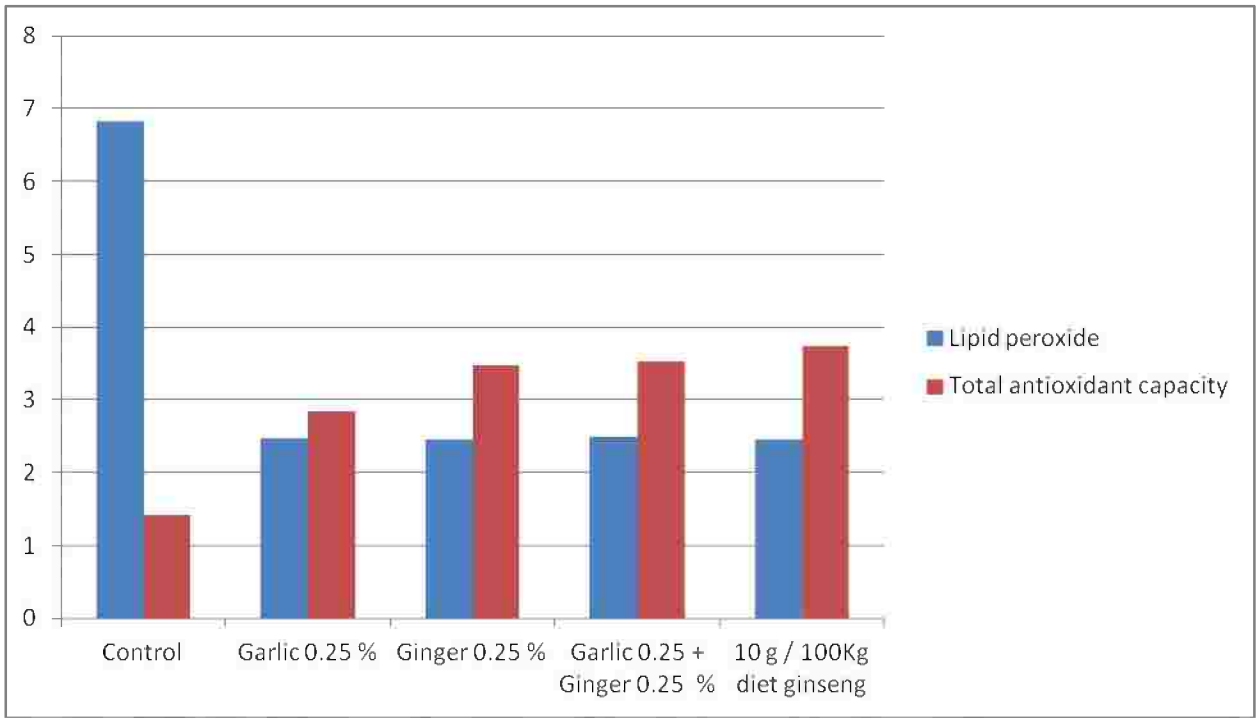

Figure 2: effect of different supplementation on lipid peroxide and total antioxidant capacity

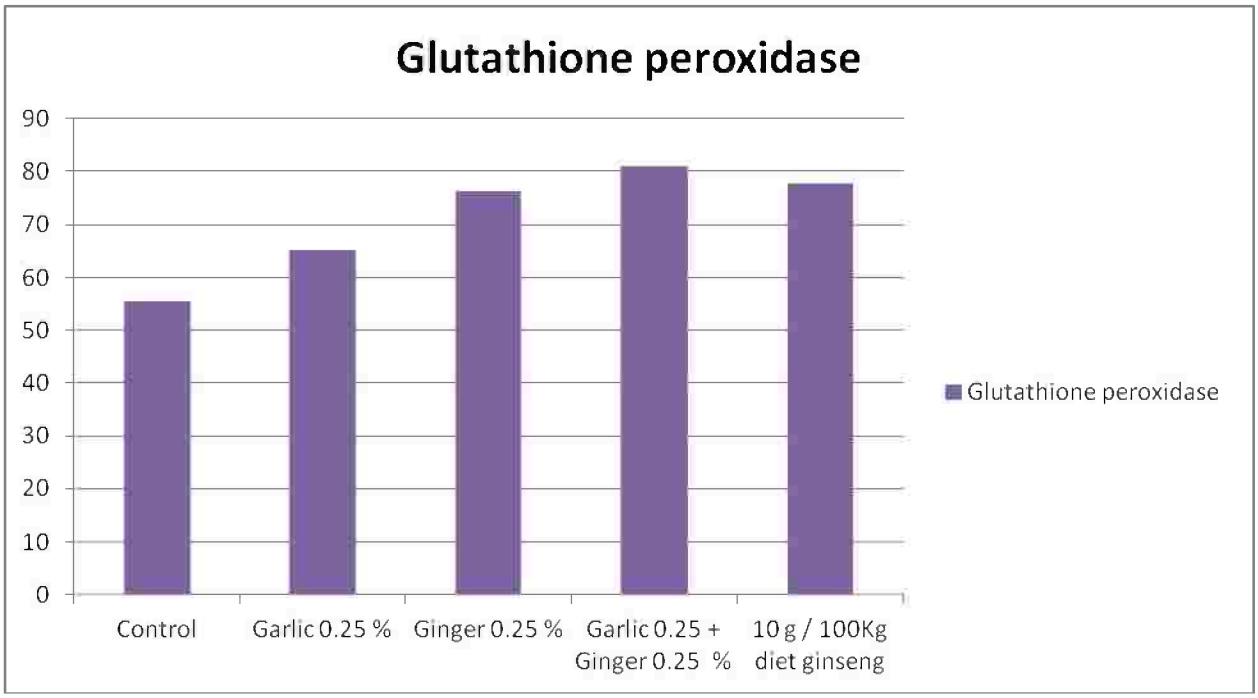

Figure 3: effect of different supplementation on glutathione peroxidase