

Ameliorating Effect of β -Carotene on Haemato-Biochemical Parameters and Oxidative Stress Status during Gestational Stages in Goats

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Abstract

The possible effects of β -carotene orally supplementation upon gestational stages changes in serum concentrations across time for total protein (TP), albumin (ALB), globulin (GLB), total cholesterol (TC), triglyceride (TG) and alanine transaminase (ALT) and aspartate transaminase (AST), Haemoglobin (Hb), Red blood cells count (RBCs), packed cell volume (PCV) malondialdehyde (MDA), reduced glutathione (GSH), total antioxidant capacity (TAC) and progesterone (P4) were evaluated. Experiments were carried out from May to October and were constructed into two groups of gestational goats (20 does each) with 2-3 years (body weight 26 ± 2 kg) crossbred does 50% Zaraibi x 50% Baladi. The first group was considered as control (C) while the other one was β -carotene (BC) group in which 50 mg BC was oral supplemented/day/goat. Serum blood samples were collected in order to quantify progesterone concentrations (P4) through radioimmunoassay. TP, ALB, GLB, TC, and TG were analyzed spectrophotometrically. Oral supplementation with β -carotene significantly increased ($p \leq 0.05$) the concentrations of TP, ALB, GLB, GSH, TAC and P4 with the associated significant decrease in TC, TG and MDA concentrations, compared with the control. Gestation stages showed significant differences ($p \leq 0.002$ and $p \leq 0.05$) in all biochemical parameters, haematological, oxidative stress parameters and P4 level. However, a treatment \times gestation stages interaction occurred between treatments for TP, ALT, AST, Hb, RBCs, PCV, MDA, GSH, TAC and P4 ($P < 0.002$ and $p \leq 0.05$) favoring the β -carotene group.

Key words: Goats, gestation, β -carotene, haemato-biochemical parameters, oxidative stress parameters, Hormone

Introduction

Gestation is one of the important physiological stages in which nutritional needs are enhanced for supporting the growth and development of fetus. Nutrients including β -carotene are transmitted via maternal circulation and placental transfer to the fetus during pregnancy. During pregnancy, females are also more prone to oxidative stress caused by the imbalance between the prooxidant-antioxidant levels (Toescu et al., 2002). Thus, it is most likely that maternal β -carotene deficiency during pregnancy can lead to abnormal physiological function and poor health condition. Supplementation of either vitamin A or its precursor β -carotene promotes an ample range of biological processes such as cellular development, differentiation and morphogenesis through the action of retinoic acid (RA) (Amann et al., 2011). β -carotene is a potent scavenger of free radicals, especially singlet oxygen (Schweigert et al., 2003). Since RA interacts with nuclear receptors, it has the ability to modulate many gene products linked to reproductive performance (Schweigert et al., 2003; Amann et al., 2011).

In herbivorous ungulates, the largest β -carotene accumulation occurs in the liver with cattle and horses reflecting the highest β -carotene liver content, followed by goats, buffalo and sheep. Goats' β -carotene liver concentration is around $3.4 \mu\text{g/g}$

tissue (Darwish et al., 2016). Even though an optimal intake of β -carotene is hypothesized to affect ruminant reproduction, both negative (Folman et al., 1987) and positive effects have been reported (Kawashima et al., 2009).

Blood is an important and reliable medium for indicating the health status of individual animals. The blood parameters of animals can be greatly altered by numerous factors such as nutrition, disease, stress, parturition and climate. Therefore the hematological investigations served as basic information for animal health assistance. Previous studies have suggested that β -carotene supplementation can improve the immune function, reproductive and growth performance in goats (Dominic., 2016). Blood antioxidant status, hematological and biochemical parameters of goats can also be influenced by the β -carotene supplemented in diet (El-Demerdash et al., 2004). However, research work about the influence of dietary β -carotene on the antioxidant status, hormone profile and haemato-biochemical parameters of pregnant animals is rather limited. The objective of the present study was to gain insights regarding a possible relationship between β -carotene supplementation of crossbred goat does (50% Zaraibi x 50% Baladi) and some of their blood biochemical, haematological and oxidative stress parameters as well as their hormonal levels, during gestation stages.

Material and methods

Animals and Feeding

The experiment was carried out in the Experimental Farms Project (Goats Farm), Nuclear Research Center, Atomic Energy Authority, Inshas. The experimental goats were fed basal ration of concentrate feed mixture (CFM) according to the allowances of **NRC (2007)** of goats. The CFM composed of 37.4% wheat bran, 27% yellow corn, 12.5% soybean meal, 10.0% undecorticated cottonseed cake, 5% rice bran, 4% sugarcane molasses, 3% limestone, 1% sodium chloride and 0.1 vitamin and minerals premix. Concentrate feed mixture (3.5% of body weight) was offered once daily at 10 am. Barseem hay was offered *ad libitum*. Fresh drinking water was available at all time.

Experimental Design

Twenty pregnant female goats aged 2-3 years with average initial body weight 26 ± 2 kg were randomly divided into two equal groups. Animals in the 1st group were fed on basal ration without any additives (control), while the 2nd group was fed basal ration and orally supplemented with 50 mg β -carotene /head /daily.

Ambient temperature, relative humidity and temperature humidity index

The ambient temperature and relative humidity were obtained daily from meteorological station of Atomic Energy Authority during the whole experimental period. The temperature humidity index (THI) was calculated during the whole pregnancy period from (May, 2014 to October, 2014) according to **Maraïet al. (2000)** as: $THI = db^{\circ}C - [(0.31 - 0.31RH) \times (db^{\circ}C - 14.4)]$, where, THI= temperature humidity index, $db^{\circ}C$ = dry bulb temperature in Celsius and RH = relative humidity%. Since the averages of ambient temperature (AT), relative humidity (RH %) and temperature humidity index (THI) were 32.79°C, 76.16% and 31.43, respectively.

Haemato-biochemical parameter analysis

Before the morning feeding two blood samples were collected biweekly from each animal via the jugular vein puncture. The first blood sample (3 ml) was collected into an EDTA tube. In order to determine the hematological parameters, an automated analyzer (Autolysers AL 820, Swiss) was utilized to measure red blood cell (RBC) counts, hemoglobin (Hb) concentration and the total leucocytes count (WBC). The second blood sample was handled to harvest serum samples and preserved at $\sim 20^{\circ}C$. Serum total protein was determined via Biuret method (**Armstrong and Carr, 1964**). Serum cholesterol concentration was calibrated colorimetrically as described by **Watson (1960)**.

Assessment of oxidative stress and hormonal assay

Reduced Glutathione (GSH) expressed as (umol/dl) were detected by High Performance Liquid Chromatography (HPLC) using the method of **Jayatileke and Shaw (1993)**. Total MDA (umol/dl) (**Karatepe, 2004**). Total antioxidant capacity (TAC), and was expressed as (mmol/dl) (**El-Deeb and Younis, 2009**). Hormonal analysis of progesterone (P4), were analyzed by direct radioimmunoassay technique (RIA).

Statistical analysis

Data were expressed as mean \pm SE. The data were analyzed statistically by GLM procedure of the SAS program (**SAS, 1998**). Duncan's Multiple Range test was used to detect the significant differences among means of the experimental groups (**Duncan, 1955**).

Using the following model: $Y_{ijk} = \mu + T_i + S_j + (TS)_{ij} + e_{ijk}$ Where: Y_{ijk} = the dependent variables estimated, μ = Overall mean, T_i = the effect of treatment (1 = control, 2 = beta carotene) S_j = the effect of gestation stages (1 = Early, 2 = Mid and 3 = Late), $(TS)_{ij}$ = the effect of interaction between treatment and gestation stages, e_{ijk} = random error.

Results

Biochemical parameters

Biochemical parameters of pregnant does are presented in Tables 1 and 2. Total protein (8.730 ± 0.075 g/dL), albumin (5.237 ± 0.065 g/dL) and Globulin (3.500 ± 0.052 g/dL), were significantly ($p \leq 0.05$) increased by the β -carotene orally supplementation. While Total cholesterol (139.59 ± 0.351 mg/dL), Triglyceride (122.67 ± 0.301 mg/dL) and the activities of ALT (39.50 ± 0.114 U/L) and AST (53.04 ± 0.095) were significantly ($P < 0.001$) decreased by the β -carotene orally supplementation when compared with the control. Gestation stages showed a significant ($p \leq 0.05$) effect and late gestation showed the highest mean concentration for TP, ALB, GLB, TC, TG concentrations and ALT and AST activities. Interestingly the interaction between β -carotene and gestation stages showed significant differences, except for ALB, GLB and TC the interaction showed no significant differences, such differences favored the β -carotene group.

Table 1. Serum biochemical parameters of does, during gestation, as affected by treatment, gestation stages and their interactions.

Item	TP (g/dL)	ALB (g/dL)	GLB (g/dL)
Treatment (T)			
Control	6.16 ^B ± 0.074	3.70 ^B ± 0.064	2.46 ^B ± 0.051
Beta carotene	8.73 ^A ± 0.075	5.24 ^A ± 0.065	3.50 ^A ± 0.052
P values	0.05	0.05	0.05
Gestation stages (S)			
Early	6.95 ^C ± 0.065	4.17 ^B ± 0.055	2.79 ^B ± 0.044
Mid	7.60 ^B ± 0.064	4.54 ^{AB} ± 0.054	3.05 ^{AB} ± 0.043
Late	7.80 ^A ± 0.066	4.69 ^A ± 0.056	3.11 ^A ± 0.045
P value	0.05	0.05	0.05
(T * S)			
Control			
Early	5.40 ^b ± 0.129	3.24 ^a ± 0.111	2.18 ^b ± 0.089
Mid	6.50 ^a ± 0.128	3.90 ^a ± 0.110	2.57 ^a ± 0.088
Late	6.58 ^a ± 0.127	3.95 ^a ± 0.112	2.63 ^a ± 0.087
Beta carotene			
Early	8.50 ^a ± 0.126	5.10 ^a ± 0.113	3.40 ^b ± 0.086
Mid	8.70 ^b ± 0.125	5.18 ^a ± 0.114	3.52 ^a ± 0.085
Late	9.01 ^b ± 0.124	5.43 ^a ± 0.115	3.58 ^a ± 0.084
P value	0.05	0.157	0.175

Means with different letters (A, B and C or a, b, c,...) in the same column within the same factor are significantly different at (P<0.05).

TP= Total protein; ALB= Albumin; GLB=Globulin.

Table 2. Serum biochemical parameters of does during gestation as affected by treatment, gestation stages and their interactions.

Item	ALT (U/L)	AST (U/L)	TC (mg/dl)	TG (mg/dl)
Treatment(T)				
Control	40.20 ^A ± 0.115	57.99 ^A ± 0.096	142.00 ^A ± 0.352	125.33 ^A ± 0.300
Beta carotene	39.50 ^B ± 0.114	53.04 ^B ± 0.095	139.59 ^B ± 0.351	122.67 ^B ± 0.301
P values	0.05	0.05	0.05	0.05
Gestation stages (S)				
Early	40.25 ^B ± 0.083	52.00 ^B ± 0.100	134.90 ^C ± 0.305	117.50 ^C ± 0.260
Mid	37.40 ^C ± 0.082	50.35 ^C ± 0.101	139.75 ^B ± 0.306	118.50 ^B ± 0.261
Late	41.90 ^A ± 0.081	61.36 ^A ± 0.081	148.49 ^A ± 0.304	131.50 ^A ± 0.262
P value	0.05	0.05	0.05	0.05
(T * S)				
Control				
Early	40.60 ^a ± 0.169	55.40 ^a ± 0.199	136.00 ^c ± 0.604	119.00 ^a ± 0.526
Mid	37.80 ^b ± 0.168	51.40 ^b ± 0.195	141.50 ^b ± 0.603	125.00 ^b ± 0.521
Late	42.20 ^a ± 0.167	66.18 ^a ± 0.198	150.00 ^a ± 0.607	133.00 ^a ± 0.522
Beta carotene				
Early	39.90 ^a ± 0.166	48.60 ^a ± 0.197	133.80 ^c ± 0.607	116.00 ^b ± 0.523
Mid	37.00 ^b ± 0.165	49.30 ^b ± 0.196	138.00 ^b ± 0.606	112.00 ^a ± 0.524
Late	41.60 ^a ± 0.164	56.49 ^a ± 0.194	146.98 ^a ± 0.605	130.00 ^a ± 0.525
P value	0.05	0.05	0.1	0.007

Means with different letters (A, B and C or a, b, c,...) in the same column within the same factor are significantly different at (P < 0.05).

ALT= Alanine amino transferase; AST= Aspartate amino transferase; TC= Total Cholesterol; TG=Tri glyceride.

Haematological parameters

Haematological parameters of pregnant does are presented in Table 3. Hb (9.367 ± 0.063 g/dl), RBCs (11.30 ± 0.064 10⁶/μl), PCV% (27.10 ± 0.068 %), and WBCs (10.10 ± 0.071 10³/μl) were significantly (p ≤ 0.05) increased by the β -carotene orally supplementation, when compared with the control. Gestation stages showed a significant

(p ≤ 0.05) effect and early gestation showed the highest mean for Hb concentration, RBCs and WBCs counts. Interestingly the interaction between β -carotene and gestation stages showed significant differences, such differences favored the β -carotene group for Hb concentration, RBCs count and PCV%. Except for WBCs count the interaction showed no significant differences.

Oxidative stress status parameters and hormonal level

Oxidative stress status parameters of pregnant does are presented in Table 4. MDA ($1.09 \pm 0.022 \mu\text{mol/dL}$), GSH ($7.09 \pm 0.069 \mu\text{mol/dL}$), TAC ($7.70 \pm 0.074 \text{mmol/dl}$), and P4 ($24.893 \pm 0.074 \text{ng/mL}$) were significantly ($p \leq 0.05$) increased by the β -carotene orally supplementation. when compared with the control. Gestation stages showed a significant ($p \leq 0.05$) effect and mid gestation showed the highest mean for MDA, GSH, TAC and P4 concentrations while the lowest ones were in early gestation for MDA, GSH and P4 and late gestation for TAC. Interestingly the interaction between β -carotene and gestation stages showed significant differences, such differences favored the β -carotene group for MDA, GSH, TAC and P4 concentration.

Discussion

Current results support our working hypothesis in that β -carotene supplementation improved haemato-biochemical, oxidative stress status and hormonal levels during gestation stages. β -carotene supplementation promotes the increasing, across

gestation period, in blood metabolites specifically TP, ALB, GLB. The main increases were observed towards the late pregnancy. Despite our fragmentary knowledge regarding the mechanisms modulating the intermediate metabolism (Meza-Herrera and Tena-Sempere, 2012), results of our study suggest that such neurophysiologic scenario observed in the β -carotene supplemented gestational goats may potentially involve BC as an acting molecule involved in the intermediate metabolism, specially upon protein, carbohydrate, and lipid metabolism. However, TC and TG were decreased by supplementation of β -carotene this result is in agreement with results obtained by Bianca, et al (1997) who demonstrated that β -carotene, and its precursor lycopene, suppress cellular cholesterol synthesis from acetate, but not from mevalonate in a concentration-dependent manner. This inhibition was concomitant with a stimulation of the LDL receptor in macrophages which could lead to enhanced of LDL from the plasma. Lavy et al (1993) and Levy et al (1995) previously have shown that carotenoids can bind to lipoproteins and to macrophages (Levy et al, 1996) and to affect their oxidative state.

Table 3. Haematological parameters of does during gestation as affected by treatment, gestation stages and their interactions.

Item	Hb (g/dl)	RBCs ($10^6/\mu\text{l}$)	PCV (%)	WBCs ($10^3/\mu\text{l}$)
Treatments(T)				
Control	$8.729^B \pm 0.064$	$10.91^B \pm 0.053$	$26.47^B \pm 0.069$	$9.70^A \pm 0.074$
Beta carotene	$9.367^A \pm 0.063$	$11.30^A \pm 0.052$	$27.10^A \pm 0.068$	$10.10^A \pm 0.071$
P values	0.05	0.05	0.05	0.05
Gestation stages (S)				
Early	$9.35^A \pm 0.055$	$11.68^A \pm 0.059$	$26.75^B \pm 0.060$	$10.23^A \pm 0.064$
Mid	$8.90^A \pm 0.054$	$10.48^C \pm 0.058$	$25.62^C \pm 0.061$	$9.55^B \pm 0.063$
Late	$8.89^A \pm 0.053$	$11.15^B \pm 0.057$	$27.99^A \pm 0.062$	$9.96^{AB} \pm 0.062$
P value	0.002	0.05	0.05	0.05
(T * S)				
Control				
Early	$8.90^b \pm 0.106$	$10.56^b \pm 0.114$	$26.50^b \pm 0.119$	$9.90^a \pm 0.129$
Mid	$8.41^c \pm 0.107$	$10.16^b \pm 0.113$	$25.03^c \pm 0.118$	$9.30^a \pm 0.128$
Late	$8.88^a \pm 0.108$	$11.00^a \pm 0.112$	$27.89^a \pm 0.117$	$9.90^a \pm 0.127$
Beta carotene				
Early	$9.80^a \pm 0.101$	$11.80^a \pm 0.117$	$27.00^a \pm 0.116$	$10.50^a \pm 0.126$
Mid	$9.40^a \pm 0.102$	$10.80^b \pm 0.116$	$26.20^b \pm 0.115$	$9.80^b \pm 0.125$
Late	$8.90^a \pm 0.103$	$11.30^a \pm 0.115$	$28.10^a \pm 0.114$	$10.01^b \pm 0.124$
P value	0.05	0.05	0.05	0.02

Means with different letters (A, B and C or a, b, c,...) in the same column within the same factor are significantly different at ($P < 0.05$).

Hb= Haemoglobin; RBCs= Red blood cells count; PCV= Packed cell volume; WBCs= White blood cells count.

Table 4.Antioxidant status parameters in blood and p4 of does during gestation, as affected by treatment, gestation stages and their interactions.

Item	MDA($\mu\text{mol/dl}$)	GSH ($\mu\text{mol /dl}$)	TAC (mmol /dl)	P4(ng/ml)
Treatment(T)				
Control	1.35 ^A \pm 0.023	6.42 ^B \pm 0.072	6.60 ^D \pm 0.073	23.17 ^C \pm 0.075
Beta carotene	1.09 ^{BC} \pm 0.022	7.09 ^A \pm 0.069	7.70 ^B \pm 0.074	24.90 ^B \pm 0.074
P values	0.05	0.05	0.001	0.001
Gestation stages (S)				
Early	0.91 ^C \pm 0.026	5.09 ^C \pm 0.062	7.25 ^B \pm 0.063	19.26 ^C \pm 0.065
Mid	1.65 ^A \pm 0.024	9.22 ^A \pm 0.061	7.65 ^A \pm 0.064	26.80 ^A \pm 0.064
Late	1.09 ^B \pm 0.027	5.75 ^B \pm 0.063	6.55 ^C \pm 0.065	24.98 ^B \pm 0.063
P value	0.05	0.05	0.05	0.05
(T * S)				
Control				
Early	1.00 ^a \pm 0.040	4.98 ^c \pm 0.120	6.50 ^d \pm 0.127	16.50 ^d \pm 0.130
Mid	1.90 ^a \pm 0.042	8.78 ^d \pm 0.121	7.00 ^d \pm 0.126	27.00 ^e \pm 0.131
Late	1.14 ^a \pm 0.041	5.50 ^d \pm 0.122	6.30 ^d \pm 0.125	26.00 ^e \pm 0.132
Beta carotene				
Early	0.82 ^b \pm 0.043	5.20 ^b \pm 0.123	8.00 ^b \pm 0.124	20.00 ^b \pm 0.133
Mid	1.40 ^c \pm 0.044	9.65 ^a \pm 0.124	8.30 ^b \pm 0.123	28.00 ^b \pm 0.134
Late	1.04 ^{ab} \pm 0.045	5.99 ^a \pm 0.131	6.80 ^b \pm 0.122	26.68 ^b \pm 0.135
P value	0.05	0.002	0.05	0.05

Means with different letters (A, B and C or a, b, c,...) in the same column within the same factor are significantly different at (P<0.05).

MDA= Malondialdehyde; GSH= Reduced glutathione; TAC= Total anti-oxidant capacity; P4= Progesterone.

Shokrzadehet et al. (2012) and Draeger et al. (2014) stated that vitamin A supplementation was significantly decreased serum levels of the liver function biomarkers, AST and ALT. This may possibly explained by the antioxidant activity of vitamin A which can protect the liver from free radicals generated by metabolic reactions.

β -carotene orally supplementation enhanced blood haematological values and these findings were similar to those of **Bendich (1991)**, **AMAR et al. 2000** and **El-Demerdash et al. (2004)** whom illustrated that carotenoids have been implicated in enhancing the immune response such as proliferation, induction of specific effector cells as well as the secretion of cytokines. β -carotene levels up to 200 mg kg⁻¹ diet enhanced some immune parameters like serum complement and total plasma immunoglobulin in the experimental rainbow trout. Moreover, immunoenhancement of β -carotene involves the quenching of free radicals or the lowering of lipid peroxide levels and alterations in membrane fluidity, which account on increasing the levels of RBCs, Hb, and PCV upon its supplementation in diet. These results may partly due to the antioxidant activity of vitamin A. It has been regarded that improving antioxidant status enhanced immune function of animals (**Grimble, 2001**). **Bendich and Shapiro (1986)** reported that supplementation rat with the vitamin A or β -carotene protected its immune responses to certain environmental sources of free radicals. Vitamin A can function as natural antioxidants to remove harmful free radicals produced through normal cellular activity and from environmental stressors, thereby

maintaining the structural integrity of immune cells (**Chew, 1996**).

Malondialdehyde is a good indicator of lipid peroxidation which can generally be used as a biomarker for radical induced damage and endogenous lipid peroxidation (**Wang et al., 2008**). In the present study, MDA concentration in the serum was reduced by inclusion of β -carotene supplementation. This may be due to what stated by **Tsuchihashi et al. (1995)** that beta-carotene and other carotenoids are widely regarded as biological antioxidants. Carotenoids can inhibit the propagation of radical initiated lipid peroxidation. Modulation of lipid peroxidation by alpha-tocopherol or betacarotene may be an important mechanism for reducing oxidative stress. And what had demonstrated by **Salem (2015)** that the supplementation of lycopene, β -carotene or their mixture in rats resulted in a significant reduction of liver MDA, and as significant elevation of liver and blood glutathione (GSH), in comparison with the levels of high fat diet group. The supplementation of lycopene, β -carotene or their mixture resulted in a significant reduction of liver MDA, and as significant elevation of liver and blood glutathione (GSH), in comparison with the levels of high fat diet group.

The present results elucidated that β -carotene elevated progesterone (P4) concentration during gestation periods. A number of studies have reported either positive effect or no effect of supplemental β -carotene on concentration of reproductive hormones in various animal species. However, limited studies have been conducted in goats, therefore studies from other species were discussed. Concerning P4

concentrations, contradicting results have been reported. It was found that the P4 concentration was increased through supplemental β -carotene in cattle (Greenberg *et al.*, 1986) and goats (Arellano-Rodriguez *et al.*, 2009).

Conclusion

The current study reported that β -carotene supplementation (50mg/day/does) generates serum biochemical, haematological, oxidative stress parameters as well as progesterone concentrations across gestation stages in does goats.

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التأثير المحسن للبيتا كاروتين على المؤشرات الدموية والبيوكيميائية ومؤشرات الإجهاد التأكسدي خلال فترات الحمل في الماعز

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1. قسم التطبيقات البيولوجية - شعبة تطبيقات النظائر المشعة - مركز البحث النووية - هيئة الطاقة الذرية

2. قسم الإنتاج الحيواني - كلية الزراعة - جامعة بنها

يهدف هذا البحث دراسة التأثيرات المحتملة لإضافة البيتاكاروتين عن طريق الفم على التغيرات الدموية والبيوكيميائية ومؤشرات الإجهاد التأكسدي بالإضافة إلى التغيرات في مستوى هرمون البروجسترون خلال فترات الحمل المختلفة. أجريت الدراسات خلال الفترة من شهر مايو وحتى شهر أكتوبر على عدد 20 عنزة خليطة (50% بلدى × 50% زرايبي) عن عمر 2-3 سنوات وتم تقسيمهم عشوائيا إلى مجموعتين متساويتين بمتوسط وزن 26±2 كجم. تم تجميع عينات الدم والحصول على سيرم الدم لاجراء تحليلات البروتين الكلي ، الألبومين ، الجلوبيولين ، الكوليسترول الكلى ، الدهون الثلاثية ، ALT ، AST ، TAC ، GSH ، MDA بالإضافة إلى هرمون البروجسترونالذي تم تقديره بطريقة المناعه الإشعاعية - خلال فترات الحمل المختلفة . تم تقدير الهيموجلوبين و عدد كرات الدم الحمراء والبيضاء وأخيراً حجم خلايا الدم المكثفة فى بلازما الدم. أوضحت النتائج أن استخدام البيتاكاروتين أدى الى زيادة معنوية فى كل من البروتين الكلى ، الألبومين ، الجلوبيولين ، الجلوتاثيون المختزل والسعة التأكسدية الكلية بالإضافة إلى مستويات البروجسترون. كما أدت المعاملة بالبيتاكاروتين الى انخفاض معنوى فى الكوليسترول الكلى والدهون الثلاثية وكذلك إنزيمات الكبد بالإضافة إلى التأثير المشترك بين المعاملة وفترات الحمل على البروتين الكلى و إنزيمات الكبد والهيموجلوبين وعدد كرات الدم الحمراء وحجم كرات الدم فى بلازما الدم الى تفضيل استخدام البيتاكاروتين بمعدل 50مجم/عزّه/اليوم خلال فترة الحمل.