EFFECT OF SHORT TERM VITAMIN A DEFICIENCY ON ORGAIN WEIGHTS, BLOOD GLUCOSE AND LACTATE LEVELS AND, TISSUE PROTEIN AND GLYCOGEN CONTENTS OF ALBINO RATS : *A PRELIMINARY STUDY*

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Summary : The effect of short term dietary vitamin A deficiency in post-pubertal female rats in terms of weight gain, food consumption, organ weights, haemoglobin content, blood glucose and lactate levels and, tissue protein and glycogen contents has been evaluated to gain insight into the possible interrelationship between vitamin A and general metabolism. Significant elevation in blood glucose level and reduction in blood lactate and haemoglobin alongwith a tendency of reduction in weights of spleen, adrenals and ovaries have been noted. Lowered tissue protein and glycogen contents and reduced body weight gain have also been revealed. Obviously, reduced functional competence of some of the organs and certain alterations in general metabolism especially of carbohydrates are suspected and hence is discussed in relation to supportive evidences available.

Key words : blood glucose blood lactate metabolism Vitamin A

INTRODUCTION

Vitamin A is an essential nutrient for all mammalian species including man as it cannot be synthesized within the body and has to be obtained from daily dietary intake either as vitamin A, as carotenoid vitamin A precursors or as a mixture of the two (3). Ingested excess of the vitamin gets stored in the liver which can sustain animals and man during periods of dietary vitamin A deficiency or insufficiency. However, protracted dietary deficiency of vitamin A by depleting the hepatic store could lead to hypovitaminosis A and ultimately to many deficiency syndromes. Apart from its deleterious effects on photoreceptor mechanisms (8), vitamin A deficiency is known to cause dryness of the eyes, undefined cellular changes in the corneal epithelium leading to ulceration and perforation (13, 15, 26, 16) and also affect

adversely growth (1, 21), reproduction (10, 21) and resistance to infection (18, 6, 28, 4, 5, 12). There are also experimental evidences for vitamin A deficiency induced hyperkeratinization of epthelia (31, 21) depression of DNA and RNA (nuclear and tRNA synthesis), reduction in glycoprotein formation and promotion of carcinogenesis (12).

Despite the fact that multiple structural and biochemical changes associated with vitamin A deficiency disorders have been recognized, the exact mode of action nor its relation to general metabolism have been elucidated. As far as the metabolic aspects are concerned, vitamin A deficiency has been noted to affect protein metabolism both by reducing the synthesis and release of retinol binding protein from liver and by impairing nitrogen utilization and excreting more nitrogen as urea in the urine (12). Epidemiologic data from human nutrition surveys also suggest a correlation between the prevalence of anemia and of vitamin A deficiency (22, 23). Hence in this light it was thought pertinent to carry out a preliminary study to evaluate the effect of a short term dietary vitamin A deficiency (two weeks) in albino rats on organ weights, haemoglobin (Hb) status, blood glucose and lactate levels and tissue contents of glycogen and protein alongwith hepatic retinol and water contents.

MATERIAL AND METHODS

Ten healthy Wistar strain post-pubertal female rats weighing about 125 g were divided nto 2 groups of 5 each and were maintained on vitamin A deficient (experimental) and vitamin A sufficient (control) diets for a period of two weeks. The control diet contained 10% casein protein and the diet contained all vitamins and minerals according to the suggested allowances for adult rats (24). The experimental diet was the same as the control diet except that it was devoid of vitamin A. The casein used for the experimental diet was devitaminised by washing twice with 20% alcohol. The diets were fed *ad libitum*. Food intake and weight changes were recorded daily. Haemoglobin content was estimated by the Cyanomethemoglobin method (11). At the end of the experimental period, the rats were weighed and sacrificed. Blood was obtained from the jugular vein and the levels of glucose and lactate were estimated by the method of Folin and Malmros (14) and Barker and Summerson (2) respectively. Liver, spleen, adrenals, ovaries and skin from abdominal region were removed, blotted free of tissue fluids and weighed, Glycogen content of liver, skin and ovary was estimated by the method of Seifter *et al.* (29). Hepatic and muscle protein contents were estimated by the method of Lowry *et al.* (17). The retinol content of the liver was estimated by the method of Neeld and Parson (25) and the water content of the liver was determined by the difference in weight of fresh and dried tissue. The mean and standard deviation were calculated and student's "t" test and two-sample rank test of Wilcoxon and Whitney (31) were applied for evaluating statistical significance.

RESULTS AND DISCUSSION

The net weight gain, food consumption, g. food consumed/g. weight gain and relative weight of organs are given in Table I. Table II depicts the haemoglobin value and blood glucose and lactate levels while Table III shows the tissue contents of protein, glycogen, retinol and water.

A cursory glance of Table I shows that vitamin A deficient rats were lighter by 7% than the vitamin A sufficient rats but the former tended to eat more (19%); consequently the g. food intake/g. weight gain ratio was higher in the latter group of rats. Similarly the relative weight of various organs studied has revealed a decreasing trend in the rats fed with vitamin A deficient diet. The relative weights of liver, ovary, spleen and adrenals of vitamin A deficient rats were found to be significantly lesser (30-45%) than that of the vitamin A sufficient control rats.

From Table II it can be seen that the haemoglobin content and the lactate level in the blood of vitamin A deficient rats were lower than the corresponding values of the controls. On the other hand the blood glucose level of vitamin A deficient rats was increased. The protein content of liver and muscle as well as the glycogen content of liver and skin tended to be lesser in the vitamin A deficient animals than in the controls (Table III).

Though recent epidemiological studies have shown a relationship between vitamin A deficiency and anemia (22), carlier studies had failed to bring out this relationship (32). There are very few reports available on vitamin A status in animals and its influence on

TABLE I : Weight gain, food consumption, food consumption weight gain ratio and relative weight of organs in vitamin A deficient and control rats.

	Control	*Vitamin A deficient*
Net weight gain (*g*)	21.09±6.4	19.50±6.5 (—7.1%)
Food consumed (*g*)	92.3±16.9	110.1±3.18 (+19.2%)
Food consumed weight gain ratio	4.3	5.6
Liver (*g*)	3.03±0.26	3.99±0.25 (—31.6%)*
Ovary (*mg*)	40.6±2.0	27.8±7.9 (—31.5%)**
Spleen (*mg*)	205.6±27.0	144.6±32.0 (—29.6%)**
Adrenals (*mg*)	13.3±2.0	7.3±0.2 (—45%)***

*Wilcoxon significance, **P<0 02, ***P<0.001

TABLE II : Haemoglobin content and blood glucose and lactate levels of control and vitamin A deficient rats.

	Control	*Vitamin A deficient*
Haemoglobin *(g/100 ml)*	18.63±1 61	17.22±0.96 (−7.5%)
Blood glucose *(mg/dl)*	79.28±7.34	98.89±5.82 (+24.6%)**
Blood lactate *(mg/dl)*	14.57±1 09	9.86±1.49 (−32.3%)*

*P<0.05, **P<0.01

TABLE III : Tissue protein and glycogen contents and, retinol and water contents of liver in control and vitamin A deficient rats.

	Control	*Vitamin A defcient*
Hepatic protein *(mg/100 mg)*	10.16±0.83	8.46±0.45 (−13.4%)**
Muscle protein *(mg/100 mg)*	8.08±1.49	6.63±0.33 (−12.7%)
Hepatic glycogen *(mg/100 mg)*	8.99±0.90	7.17±1.12 (−20.2%)*
Ovary glycogen *(Ug/100 mg)*	223.5±113.9	233.9±89.5
Skin glycogen *(Ug/100mg)*	185.6±14.7	147.9±28.0 (−9.9%)*
Retinol *(Ug/g)*	34.51±1.95	21.55±1.34 (−37.5%)**
Hepatic water *(mg/100 mg)*	34.30±8.74	23.03±2.98 (−32.8%)*

*P<0.05 **P<0.01

various organs. Most of those available are from the distant past and have been reviewed by Wolbach (32). While serious atrophic effects on the seminiferous tubules of testis of man and laboratory animals have been noted to occur (33, 19, 27, 21), no effect of vitamin A on ovaries has been documented. Except for greater deposition of haemosiderin, no other vitamin A deficiency changes have been reported for spleen (32). Both vitamin A deficiency as well as hypervitaminosis have been reported to induce some changes in the adrenals of rat and guinea pig. Whereas vitamin A deficiency depicted some evidences of atrophy (9, 30), hypervitaminosis induced adrenocortical enlargement and loss of cortical lipids (7). In the present study decrease in the relative weight of adrenals has been noticed which tend to suggest the possible influence of vitamin A either directly or indirectly in maintaining their functional competence. The recent reports of relationship of anaemia with vitamin A

deficiency (22), and the reported deposition of haemosiderin in the spleen (32) are in agreement with the herein observed decrement in haemoglobin content (7.5%) in vitamin A deficient rats. The significant decrease in spleen weight by 30% in vitamin A deficient rats obviously bespeak of a reduced functional competence of the spleen which relates well with the known easy susceptibility of vitamin A deficient rats to infection (12). The tendency for reduction in adrenal weight in the experimental animals by about 45% may have something to do with the involvement of both adrenal hormones and vitamin A in the formation of glycoproteins (12). Though there are no previous reports on vitamin A deficiency on ovarian structure and function, the decrement in relative weight of ovary to the tune of about 31% has been noted in the present study and needs to be evaluated more critically.

An association of vitamin A deficiency with protein metabolism is inferred from the observation of reduced protein synthesis and excessive excretion of urea (12). Apparently a net negative nitrogen balance can be thought to occur and in this light the herein observed decrease in hepatic and muscle protein contents by 13% could be self explanatory. The most significant changes recorded in the present study are for those of blood glucose and lactate levels. Whereas the blood glucose level was elevated by 25%, the lactate level was reduced by 32%. Correspondingly the hepatic glycogen content was depleted by 20% while a marginal deerease of about 10% was shown by the skin glycogen content. To our knowledge there are no reports as yet about vitamin A deficiency status and its influence on carbohydrate metabolism. Hence the present observations seem interesting and the involvement of vitamin A in maintaining carbohydrate homeostasis is a distinct possibility. In this wake, the hyperglycaemic condition exhibited by the rats fed on vitamin A deficient diets along with the depletion of hepatic and skin glycogen stores are complementary changes. However the reduced blood lactate level could indicate diminished peripheral utilization of carbohydrate reserves through glycolysis. These aspects of carbohydrate metabolism in relation to vitamin A deficiency need to be evaluated and as such detailed studies on these lines are in progress.

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