Novel vitamin D-Nanoemulsion improves testicular function of vitamin D deficient rats

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Abstract

Background and aim: Vitamin D (VD) deficiency is associated with disturbed reproductive functions in male rats which might be ameliorated by vitamin D (VD) supplementation. In this study, the efficacy of a novel VD carrier, developed by sonication and pH-shifting of pea protein isolate (nanoemulsion), in improving testicular function of VD-deficient rats was investigated.

Methods: Thirty weaned male albino rats (92.6±13.6 g) were divided into two groups. Group I (n=20) was fed a synthetic AIN-93G diet while Group II (n=20) was fed a customized AIN-93G diet containing all nutrients. Group II was further subdivided into two groups (n=10 each): a nanoemulsion without VD deficient control (DC group) and a nanoemulsion with VD treatment (DT group). Animals were treated for 2 weeks with a gavage dose (1 mL of 27 µg/mL; cholecalciferol) plus US (20 kHz) 5 min was prepared.

Results: Consumption of diets deficient in VD resulted in low serum 25OHVD levels in the deficient animals (15.9±5.8 vs. 36.8±9.1 µg/mL, p<0.001). Serum 25OHVD was not correlated with testosterone levels (r=0.408, p=0.18). Histology showed a significant reduction in the total germ cell mass and degenerative changes in all levels of the spermatogenesis (Figure 1a and 1b). After treatment, DT group showed a 6-fold increase in serum T in comparison with that of DC group and double of that in SC (7.30±1.18 vs. 0.83±0.22 and 3.06±0.74 ng/mL respectively, p<0.001 for all 3 groups). Microscopically, selected ROIs showed marked improvement of germinal epithelium and all stages of spermatogenesis, together with an increase in Leydig cell count.

Conclusions: Oral VD supplementation using pea protein nanoemulsion could improve serum T levels and ameliorate VD deficiency-induced histopathological changes in testis. Future research should investigate the underlying mechanisms.

Introduction

Vitamin D found in many dietary sources especially in dairy products and fatty fish in addition to its endogenous biosynthesis in the skin after exposure to the ultraviolet B rays (UVB) from sunlight. Vitamin D metabolites, especially 1,25-dihydroxy-vitamin D, is the hormonal form with many physiological functions [1]. The presence of VD receptors in testicular tissues underscores its role in male reproductive functions [2]. With VD receptor gene knockouts showed hypo¬gondism, low sperm count and motility, and microscopic abnormalities of testicular tissues [3]. Human and animal studies proved that a low VD level is associated with higher risk of hypogondism. Moreover, it was reported that low doses of VD could improve reproductive function based on sperm count and Leydig cell mass, while high doses produced the reverse [4]. Ninety percent of VD requirements can be obtained after skin exposure to UVB making the basis for its fame as the sunshine vitamin. The active form of VD metabolite, 1,25-dihydroxy cholecalciferol (1,25(OH)2VD), is not an exclusive renal product. It is also released from other organs such as the prostate, colon, skin and osteoblasts to act via autocrine or paracrine mechanisms regulating a myriad of cellular functions such as cell growth [5]. However, the effect of VD repletion on testostereone (T) levels is still under investigation especially the potential mechanism, the adverse effects and the outcomes in cases with hypogondism [6]. Beyond sunlight exposure, repletion of VD stores by dietary means using new protein carriers, which could facilitate VD absorption and bioavailability is an active area of research. Our group has developed a novel pea protein isolate nanoemulsion with functional properties to disperse lipid soluble nutrients and bioactives [7] in light of the above evidence, the efficacy of a novel VD carrier, developed by sonication and pH-shifting of pea protein isolate into a functional nanoemulsion, in improving the testicular function of VD-deficient rats was investigated.