



## Vanadium Health Research Programme: Recent Published Literature

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October 2017 to December 2017

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# Introduction

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This report presents the bibliographic details of the 32 papers identified as being published during the period October 2017 to December 2017.

The papers were selected because they address research areas that are considered of direct relevance to the health and environmental effects of Vanadium. In order to aid review, the papers are presented under the following categories; it should be noted however, that when considered appropriate, some papers may appear in more than one section.

**Section 1 – HUMAN EXPOSURE MEASUREMENT AND MODELLING:** Papers relating to the measurement or modelling of environmental and occupational Vanadium exposure; the development of human biomarkers of exposure or effect.

**Section 2 - HEALTH EFFECTS:** Papers on the influence of Vanadium on health, disease and dysfunction; assessment of the influence of genetic and epigenetic factors on human susceptibility to the effects of Vanadium; development and implementation of new medical approaches to the treatment of excessive Vanadium exposure.

**Section 3 – BIOLOGICAL MECHANISMS:** Papers on the biochemical and toxicological mechanisms underlying the effects of Vanadium.

**Section 4 – USES OF VANADIUM:** Papers relating to the use of Vanadium in medical and dental devices, dietary supplements and as therapeutic agents.

**Section 5 – ENVIRONMENTAL EFFECTS in PLANTS and SOIL:** Papers relating to the effects following environmental exposure to Vanadium that are specific to plants and soil.

**Section 6 – ENVIRONMENTAL EFFECTS in TERRESTRIAL ORGANISMS:** Papers relating to the effects following environmental exposure to Vanadium that are specific to terrestrial organisms.

**Section 7 – ENVIRONMENTAL EFFECTS in AQUATIC ORGANISMS:** Papers relating to the effects following environmental exposure to Vanadium that are specific to aquatic organisms.

**Section 8 – MISCELLANEOUS:** Other papers considered of general interest or potential relevance to the study of the health effects of Vanadium that do not relate to the above categories.

# 1. HUMAN EXPOSURE MEASUREMENT AND MODELLING

Kafaei, R., Tahmasbi, R., Ravanipour, M., et al. (2017) Urinary arsenic, cadmium, manganese, nickel, and vanadium levels of schoolchildren in the vicinity of the industrialised area of Asaluyeh, Iran. *Environmental Science and Pollution Research*, 24(30): 23498-23507. Available at: <https://doi.org/10.1007/s11356-017-9981-6>

## **Abstract:**

Asaluyeh is one of the most heavily industrialised areas in the world where gas, petrochemical, and many downstream industries are located. This study aims to survey the biomonitoring of four metals and one metalloid in children living in the vicinity of Asaluyeh area. To do this, we analysed the creatinine-adjusted urinary levels of arsenic (As), cadmium (Cd), vanadium (V), manganese (Mn), and nickel (Ni) in 184 elementary schoolchildren (99 boys and 85 girls) living in Asaluyeh and compared them with a reference population. The comparisons were done for two seasons (spring and fall). The results showed that in the case area (Asaluyeh), the levels of As, V, Mn, and Ni were significantly higher and that of Cd was not significantly higher than the reference city for both seasons. The mean concentration of metal(loid)s in Asaluyeh (case) and Sadabad (reference) area as  $\mu\text{g/g} \cdot \text{creatinine}$  was As 2.90 and 2.24, V 0.06 and 0.03, Mn 0.28 and 0.25, Ni 0.54 and 0.29, and Cd 0.31 and 0.28 in spring and As 3.08 and 2.28, V 0.07 and 0.03, Mn 0.30 and 0.26, Ni 0.91 and 0.30, and Cd 0.36 and 0.31 in the fall. Seasonal variations played a key role in determining urinary metal(loid) concentration, as we saw the significant level of As, Cd, V, and Ni in fall than in spring. With regard to the impact of gender on the absorption and accumulation of urinary metal(loid)s, boys showed higher levels of the studied elements, especially for As, than girls as outdoor activities are more popular among boys. Due to the values being lower than those reported in literature, more research is needed on various population groups and other exposure sources in order to judge whether living in the vicinity of the gas and petrochemical industries in Asaluyeh is a threat to nearby residents.

Lubczynska, M.J., Sunyer, J., Tiemeier, H., et al. (2017) Exposure to elemental composition of outdoor PM<sub>2.5</sub> at birth and cognitive and psychomotor function in childhood in four European birth cohorts. *Environment International*, 109: 170-180.

Keywords: Air pollution; Child development; Child health; Neuropsychological tests; Particulate matter

## **Abstract:**

Background: Little is known about developmental neurotoxicity of particulate matter composition. We aimed to investigate associations between exposure to elemental composition of outdoor PM<sub>2.5</sub> at birth and cognitive and psychomotor functions in childhood. Methods: We analyzed data from 4 European population-based birth cohorts in the Netherlands, Germany, Italy and Spain, with recruitment in 2000-2006. Elemental composition of PM<sub>2.5</sub> measurements were performed in each region in 2008-2011 and land use regression models were used to predict concentrations at participants' residential addresses at birth. We selected 8 elements (copper, iron, potassium, nickel, sulfur, silicon, vanadium and zinc) and used principal component analysis to combine elements from the same sources. Cognitive (general, verbal, and non-verbal) and psychomotor (fine and gross) functions were assessed between 1 and 9 years of age. Adjusted cohort-specific effect estimates were combined using random-effects meta-analysis. Results: 7246 children were included in this analysis. Single element analysis resulted in negative association between estimated airborne iron and fine motor function (-1.25 points [95% CI -2.45 to -0.06] per 100ng/m<sup>3</sup> increase of iron). Association between the motorized traffic component, derived from principal component analysis, and fine motor function was not significant (-0.29 points [95% CI -0.64 to 0.06] per unit increase). None of the elements were associated with gross

motor function or cognitive function, although the latter estimates were predominantly negative. Conclusion: Our results suggest that iron, a highly prevalent element in motorized traffic pollution, may be a neurotoxic compound. This raises concern given the ubiquity of motorized traffic air pollution. © 2017 Elsevier Ltd.

**Wilk, A., Wiszniewska, B., Szypulska-Koziarska, D., et al. (2017) The Concentration of Vanadium in Pathologically Altered Human Kidneys. *Biological Trace Element Research*, 180(1): 1-5.** Available at: <https://link.springer.com/content/pdf/10.1007%2Fs12011-017-0986-2.pdf>

Keywords: Kidney; Kidney cortex; Kidney graft; Kidney medulla; Renal cell carcinoma; Vanadium

**Abstract:**

Vanadium has a unique and beneficial effect on both humans and animal organisms; however, excessive amount of the above-mentioned metal can cause many alterations in tissues and organs, including the kidneys. The aim of the study was to determine the concentration of vanadium (V) in the kidneys removed from patients due to lesions of various etiologies, including the rejection of the transplanted kidneys. Additionally, we determined the influence of selected biological and environmental factors on the V concentration. The study material consisted of the kidneys with tumor lesions (n = 27) and extracted kidney grafts (n = 10) obtained from patients from the north-western Poland. The V concentrations were assessed by atomic absorption spectrophotometry emission in inductively coupled argon plasma and expressed in concentrations in dry weight (dw). Statistically significant differences were observed for V concentrations in the renal medulla between the kidneys with tumors and renal grafts, where the lowest concentration of V was observed. The kidneys in more advanced stages of the tumor (T3 + T4) contained more vanadium than the kidneys of T1 + T2 stages and medians were 2.07 and 1.51, respectively. We also compared the V concentration in the kidneys between the renal grafts (K2) and the kidneys with tumor (K1) in two stages of advancement: T1 with T2 (K11 + 2) and T3 with T4 (K13 + 4). Statistically significant differences were noted between the renal medullae of the above-mentioned groups of kidneys. According to the previous studies on the concentrations of other heavy metals, renal grafts accumulate less vanadium than cancerous kidneys, what can be associated with the immunosuppressive drugs taken by patients after the transplantation.

**Wu, W., Jiang, S., Zhao, Q., et al. (2018) Environmental exposure to metals and the risk of hypertension: A cross-sectional study in China. *Environmental Pollution*, 233: 670-678.**

Keywords: Urinary metal; Environmental exposure; Epidemiology; Hypertension; Blood pressure

**Abstract:**

Metal pollution is a severe environmental issue in China, which has been recently linked with the risk of hypertension. However, relevant epidemiological studies are limited. The present exploratory study was conducted to assess the associations of environmental exposure to metals with the odds of hypertension as well as blood pressure (BP) levels using urine samples in a Chinese general population. From May 2016 to April 2017, a total of 823 eligible participants were consecutively enrolled in our study in Wuhan, China. Hypertension was defined as systolic BP (SBP) of  $\geq 140$  mmHg or diastolic BP (DBP) of  $\geq 90$  mmHg, a self-reported physician diagnosis, or current use of antihypertensive medication. We used urine samples as biomarkers to reflect the levels of environmental exposure to 20 metals. Multivariable regression models were applied to assess the potential association. Multi-metal models were conducted to investigate the impacts of co-exposure to various metals. Based on the results from various models, positive trends for increased odds of hypertension with increasing quartiles of vanadium (V), iron (Fe), zinc (Zn) and selenium (Se) were suggested. Compared

with those in the lowest quartiles, participants in the highest quartiles of V, Fe, Zn and Se had a 4.4-fold, 4.9-fold, 4.2-fold and 2.5-fold increased odds of having hypertension, respectively. High urinary Hg level was found to increase the levels of DBP. Individuals in the highest group of Hg were found to have a 4.3 mmHg higher level of DBP. Our findings suggest that environmental exposure to V, Fe, Zn, Se and Hg might increase the risk of hypertension or elevate the levels of BP. These findings warrant further prospective studies in a larger population.

**Wu, W., Jiang, S., Zhao, Q., et al. (2018) Associations of environmental exposure to metals with the risk of hypertension in China. *Science of the Total Environment*, 622–623: 184-191.**

Keywords: Metal; Urine; Exposure; Epidemiology; Hypertension

**Abstract:**

Hypertension contributes largely to the global burden of disease and mortality. Environmental exposure to metals might be a causative factor for hypertension, but the association remains unclear. The present case-control study of 502 hypertension patients and 502 healthy participants aimed to evaluate the potential relationships between the concentrations of 20 metal in urine and the risk of hypertension in a Chinese population. Multivariate logistic analyses adjusted for potential confounders were performed separately considering the effects of single and multi-metal. We found the increasing trends of urinary Fe, Co, Ni, Cu, Zn and Sr quartiles and the decreasing trends of urinary V and Rb quartiles with the ORs for hypertension. These dose-response associations were confirmed in the RCS models and remained robust in the multi-metal model. Urinary Hg quartiles were positively associated with the risk of hypertension in the models of single-metal and multi-metal. Urinary Cd quartiles were inversely associated with the risk of hypertension in the multi-metal model. Besides, modification effects of gender, BMI and smoking status on the associations of the exposure to various metals with the risk of hypertension were also suggested in the subgroup analysis. Our findings suggest that environmental exposure to V, Fe, Co, Ni, Cu, Zn, Rb, Sr, Cd and Hg might be related with the prevalence of hypertension. Further studies with prospective design should be conducted to confirm these findings.

## **2. HEALTH EFFECTS**

**Liu, Y., Liu, G., Yuan, Z., et al. (2017) Presence of arsenic, mercury and vanadium in aquatic organisms of Laizhou Bay and their potential health risk. *Marine Pollution Bulletin*, 125(1-2): 334-340.**

Keywords: Trace elements; Stable isotope ratios; Aquatic organism; Laizhou Bay

**Abstract:**

This study aims at describing and interpreting concentrations of arsenic (As), mercury (Hg) and vanadium (V) in seven species of fish, three species of shellfish, one species of crab and two species of shrimp from the typical estuary-bay ecosystem. Arsenic, Hg and V differed among species, and the highest As, Hg and V were observed in shellfish. The stable nitrogen ( $\delta^{15}\text{N}$ ) and carbon ( $\delta^{13}\text{C}$ ) isotopes were determined to investigate the trophic interactions between fluctuating environment and aquatic species. Arsenic concentrations in samples were found negatively correlated with  $\delta^{15}\text{N}$ , implying biodilution effect of As through the food web, while Hg concentrations in samples were positively correlated with  $\delta^{15}\text{N}$ , indicating their biomagnification effect. The estimated daily intake values of Hg and V in this study were all below the oral reference dose. However, elevated As intakes of some aquatic organisms suggested a potential risk for frequent consumers. "

**Lubczynska, M.J., Sunyer, J., Tiemeier, H., et al. (2017) Exposure to elemental composition of outdoor PM2.5 at birth and cognitive and psychomotor function in childhood in four European birth cohorts. *Environment International*, 109: 170-180.**

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**Wilk, A., Szypulska-Koziarska, D. & Wiszniewska, B. (2017) The toxicity of vanadium on gastrointestinal, urinary and reproductive system, and its influence on fertility and fetuses malformations. *Postępy Higieny i Medycyny Doswiadczalnej (Online)*, 71(0): 850-859.**

Keywords: intestine; kidney; liver; reproductive system; stomach; toxicity; vanadium

**Abstract:**

Vanadium is a transition metal that has a unique and beneficial effect on both humans and animals. For many years, studies have suggested that vanadium is an essential trace element. Its biological properties are of interest due to its therapeutic potential, including in the treatment of diabetes mellitus. Vanadium deficiencies can lead to a range of pathologies. However, excessive concentration of this metal can cause irreversible damage to various tissues and organs. Vanadium toxicity mainly manifests in gastrointestinal symptoms, including diarrhea, vomiting, and weight reduction. Vanadium also exhibits hepatotoxic and nephrotoxic properties, including glomerulonephritis and pyelonephritis. Vanadium compounds may also lead to partial degeneration of the seminiferous epithelium of the seminiferous tubules in the testes and can affect male fertility. This paper describes the harmful effects of vanadium on the morphology and physiology of both animal and human tissues, including the digestive system, the urinary tract, and the reproductive system. What is more, the following study includes data concerning the correlation between the above-mentioned metal and its influence on fertility and fetus malformations. Additionally, this research identifies the doses of vanadium which lead to pathological alterations becoming visible within tissues. Moreover, this study includes information about the protective efficacy of some substances in view of the toxicity of vanadium.

**Wilk, A., Wiszniewska, B., Szypulska-Koziarska, D., et al. (2017) The Concentration of Vanadium in Pathologically Altered Human Kidneys. *Biological Trace Element Research*, 180(1): 1-5.** Available at: <https://link.springer.com/content/pdf/10.1007%2Fs12011-017-0986-2.pdf>

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environmental exposure to V, Fe, Zn, Se and Hg might increase the risk of hypertension or elevate the levels of BP. These findings warrant further prospective studies in a larger population.

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### 3. BIOLOGICAL MECHANISMS

**Hill, T. & Rice, R.H. (2018) DUOX expression in human keratinocytes and bronchial epithelial cells: Influence of vanadate. *Toxicology in Vitro*, 46: 257-264.** Available at: [https://ac.els-cdn.com/S0887233317303077/1-s2.0-S0887233317303077-main.pdf?\\_tid=50ecaa2a-d421-11e7-a49d-00000aacb35d&acdnat=1511862701\\_7d89d65bc9bb9f158282020e70abaed2](https://ac.els-cdn.com/S0887233317303077/1-s2.0-S0887233317303077-main.pdf?_tid=50ecaa2a-d421-11e7-a49d-00000aacb35d&acdnat=1511862701_7d89d65bc9bb9f158282020e70abaed2)

Keywords: DUOX; Human epidermal keratinocytes; Human bronchial cells; Interferon  $\gamma$ ; Interleukin 4; Vanadate

**Abstract:**

Dual oxygenases (DUOX) 1 and 2, expressed in many animal tissues, participate in host defense at mucosal surfaces and may have important signaling roles through generation of reactive oxygen. Present work addresses their expression in cultured human epidermal keratinocytes and effects of cytokines and metal/metalloid compounds. Both DUOX1 and 2 were expressed at much higher levels after confluence than in the preconfluent state. Maximal DUOX1 mRNA levels were 50 fold those of DUOX2. DUOX1 and 2 were induced  $\approx$ 3 fold by interleukin 4, but only DUOX1 was induced by interferon gamma (IFN $\gamma$ ). In human bronchial HBE1 cells, by contrast, interleukin 4 induced only DUOX 1, and IFN $\gamma$  induced only DUOX2. A survey in the keratinocytes of metal/metalloid compounds showed that arsenite, antimonite, chromate, cadmium, copper, lead and vanadate suppressed DUOX1 levels but did not prevent interleukin 4 stimulation. Effects on DUOX2 were less dramatic, except that vanadate potentiated the stimulation by IFN $\gamma$  up to 7 fold. The results indicate that epithelial cell types of different tissue origins can differ in their cytokine regulation and that epidermal cells can exhibit striking alterations in response due to certain metal/metalloid exposures. "

**Jhang, K.A., Park, J., Kim, H., et al. (2017) Resveratrol ameliorates tau hyperphosphorylation at Ser396 site and oxidative damage in rat hippocampal slices exposed to vanadate: Implication of ERK1/2 and GSK-3 $\beta$  signaling cascades. Journal of Agricultural and Food Chemistry, 65(44): 9626-9634.**

**Abstract:**

The objective of this study was to investigate the effect of resveratrol (a natural polyphenolic phytoestrogen) on tau hyperphosphorylation and oxidative damage induced by sodium orthovanadate (Na<sub>3</sub>VO<sub>4</sub>), the prevalent species of vanadium (vanadate), in rat hippocampal slices. Our results showed that resveratrol significantly inhibited Na<sub>3</sub>VO<sub>4</sub>-induced hyperphosphorylation of tau at Ser396 (p-S396-tau) site, which is upregulated in the hippocampus of Alzheimer's disease (AD) brains and principally linked to AD-associated cognitive dysfunction. Subsequent mechanistic studies revealed that reduction of ERK1/2 activation was involved in the inhibitory effect of resveratrol by inhibiting the ERK1/2 pathway with SL327 mimicking the aforementioned effect of resveratrol. Moreover, resveratrol potently induced GSK-3 $\beta$  Ser9 phosphorylation and reduced Na<sub>3</sub>VO<sub>4</sub>-induced p-S396-tau levels, which were markedly replicated by pharmacologic inhibition of GSK-3 $\beta$  with LiCl. These results indicate that resveratrol could suppress Na<sub>3</sub>VO<sub>4</sub>-induced p-S396-tau levels via downregulating ERK1/2 and GSK-3 $\beta$  signaling cascades in rat hippocampal slices. In addition, resveratrol diminished the increased extracellular reactive oxygen species generation and hippocampal toxicity upon long-term exposure to Na<sub>3</sub>VO<sub>4</sub> or FeCl<sub>2</sub>. Our findings strongly support the notion that resveratrol may serve as a potential nutraceutical agent for AD.

**Mukhtiar, M., Jan, S.U., Ullah, I., et al. (2017) The role of Glutathione, Cysteine and D-Penicillamine in exchanging Palladium and Vanadium metals from albumin metal complex. Pakistan Journal of Pharmaceutical Sciences, 30(6(Supplementary)): 2405-2410.**

**Abstract:**

Thiol groups are extensively present across biological systems being found in range of small molecules (e.g. Glutathione, Homo-cysteine) and proteins (e.g. albumin, haemo-globin). Albumin is considered to be a major thiol containing protein present in circulating Plasma. Albumin contains a single thiolate group located at cysteine-34(cys-34) at its active site. Albumin also binds a wide variety of metals and metals complexes at various sites around the protein. Usually heavy metals are preferentially attached with the thiol group of albumin. The binding of heavy metals at cys-34 provides a mechanism by which the residence time of potentially toxic species in the body can be increased. In this research we have assessed the oxidative modification of and metal binding capacity of cys-34 with heavy metals Palladium and Vanadium to investigate the ease with which it is possible to effect disulfide-thiol exchange at this sites/or remove a metal bound at this position. Both the metals were treated with albumin and then the albumin metals (Pd and V) complexes were treated with small thiol molecules like Glutathione, Cysteine and D-Penicillamine. Our finding showed that the albumin thiol group retained the metals with itself by forming some strong bonding with the Thiols group, it is concluded from this finding that if by chance both the metals enter the living system; strongly disturb the chemistry and physiological function of this bio-molecule.

**Soussi, A., Abdennabi, R., Ghorbel, F., et al. (2017) Ameliorated Effects of (-)-Epigallocatechin Gallate Against Toxicity Induced by Vanadium in the Kidneys of Wistar Rats. Biological Trace Element Research, 180(2): 239-245.**

Keywords: Catechin; Green tea; Metavanadate; Oxidative stress; Vitamins E and A

**Abstract:**

The aim of the study was to assess the protective effect of (-)-epigallocatechin gallate (EGCG), a flavonoid abundant in green tea, against ammonium metavanadate (AMV)-induced oxidative stress in male Wistar rats. Four groups of animals have been used, a control group

and three test groups. In the first test group, AMV was intra-peritoneally (i.p) injected daily (5 mg/kg body weight for five consecutive days). The second test group of animals was also injected daily with EGCG (5 mg/kg body weight) during the same period. However, the third test group was i.p. injected with both AMV and EGCG (5 mg/kg body weight for five consecutive days). When given alone, AMV induced an oxidative stress evidenced by an increase of lipid peroxidation levels (expressed as TBARS concentration) in kidney. In these animals, activities of superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPX) were significantly decreased, suggesting significant reduction of the antioxidant defense system at the cell level. Kidney histological sections, showed glomerular hypertrophy and tubular dilatation. In AMV-treated animals receiving EGCG, the oxidative stress was much less pronounced and activities of antioxidant enzymes were kept close to control values. Histopathological changes were less prominent. Our results confirm that green tea and other sources of flavonoids might confer a strong protection against ammonium metavanadate-induced oxidative stress. © 2017 Springer Science+Business Media New York.

## 4. USES OF VANADIUM

**Ahmadi-Eslamloo, H., Moosavi, S.M.S. & Dehghani, G.A. (2017) Cerebral ischemia-reperfusion injuries in vanadyl-treated diabetic rats. Iranian Journal of Medical Sciences, 42(6): 544-552. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5684375/pdf/IJMS-42-544.pdf>**

Keywords: Cerebrum; Diabetes mellitus; Injury; Ischemia/Reperfusion; Rat; Vanadium

### **Abstract:**

#### **BACKGROUND:**

Ischemic stroke recovery is poor in diabetic mellitus (DM). Vanadium compounds (vanadium) relieve DM signs, but their influences on cerebral ischemia/reperfusion injury (I/RI) are inconclusive. Herein, the intensity of I/RI was inspected in vanadium-treated DM rats.

#### **METHODS:**

Rats made diabetic with a single intravenous dose of streptozocin (39 mg/kg). Normal and DM rats used water or vanadylsolution for 45 days. Under isoflurane anesthesia, right middle cerebral artery occlusion was performed for 60 minutes and 12 hours reperfusion. Ischemic rats were divided into untreated-control normal (ICN) and diabetic (ICD), vanadium-treated normal (IVTN) and diabetic (IVTD) groups (n=14 each). After neurological deficit score (NDS) test, the rats were sacrificed and their brain removed and stained with triphenyltetrazolium chloride (TTC) to measure cerebral infarct volume (CIV, mm<sup>3</sup>) or Evans blue extravasation (EBE, µg/g wet-tissue). Data analysis was performed using one-way ANOVA and Tukey's test (SPSS software, version 21.0) and P values <0.05 were considered statistically significant.

#### **RESULTS:**

Blood glucose (BG, mg/dL) was similar in ICN and IVTN, elevated in IVTD and ICD (245±6 vs. 344±2, P<0.001). The increased CIV in ICN and IVTN was similar (48±2 and 34±5), very high in ICD but lower in IVTD (249±37 vs. 110±16, P<0.001). EBE was absent in non-lesioned hemispheres, similarly increased in lesioned hemispheres of ICN and IVTN (14±1 and 13±1). EBE in IVTD was significantly lower than ICD (21±2 vs. 33±5, P=0.01).

#### **CONCLUSION:**

I/RI was moderate in normoglycemia and did not change with vanadium. Hyperglycemia robustly intensified I/RI. Vanadium ameliorated hyperglycemia and reduced I/RI. Nonetheless, more investigations are required to link the mechanisms of vanadium on DM and stroke injuries.

**Basu, A., Bhattacharjee, A., Hajra, S., et al. (2017) Ameliorative effect of an oxovanadium (IV) complex against oxidative stress and nephrotoxicity induced by cisplatin. Redox Report,**

**Abstract:**

Objective: The present study was designed to investigate the chemoprotective efficacy of an L-cysteine-based oxovanadium (IV) complex, namely, oxovanadium (IV)-L-cysteine methyl ester complex (VC-IV) against cisplatin (CDDP)-induced renal injury in Swiss albino mice. Methods: CDDP was administered intraperitoneally (5 mg/kg body weight) and VC-IV was administered orally (1 mg/kg body weight) in concomitant and 7 days pre-treatment schedule. Results: CDDP-treated mice showed marked kidney damage and renal failure. Administration of VC-IV caused significant attenuation of renal oxidative stress and elevation of antioxidant status. VC-IV also significantly decreased serum levels of creatinine and blood urea nitrogen, and improved histopathological lesions. Western blot analysis of the kidneys showed that VC-IV treatment resulted in nuclear translocation of nuclear factor E2-related factor 2 (Nrf2) through modulation of cytosolic Kelch-like ECH-associated protein 1. Thus, VC-IV stimulated Nrf2-mediated activation of antioxidant response element (ARE) pathway and promoted expression of ARE-driven cytoprotective proteins, heme oxygenase 1 and NAD(P)H:quinone oxidoreductase 1, and enhanced activity of antioxidant enzymes. Interestingly, VC-IV did not alter the bioavailability and renal accumulation of CDDP in mice. Discussion: In this study, VC-IV exhibited strong nephroprotective efficacy by restoring antioxidant defense mechanisms and hence may serve as a promising chemoprotectant in cancer chemotherapy

**Chen, Y., Cheng, L., Dong, Z., et al. (2017) Degradable Vanadium Disulfide Nanostructures with Unique Optical and Magnetic Functions for Cancer Theranostics. *Angewandte Chemie (International Ed.in English)*, 56(42): 12991-12996.**

Keywords: VS<sub>2</sub> nanostructures, multimodal imaging, photothermal therapy, toxicity, clearance

**Abstract:**

Multifunctional biodegradable inorganic theranostic nano-agents are of great interests to the field of nanomedicine. Herein, VS<sub>2</sub> nanosheets upon lipid modification could be converted into ultra-small VS<sub>2</sub> nanodots encapsulated inside polyethylene glycol (PEG) modified lipid micelles. Owing to the paramagnetic property, high near-infrared (NIR) absorbance, and chelator-free <sup>99m</sup>Tc<sup>4+</sup> labeling of VS<sub>2</sub>, such VS<sub>2</sub>@lipid-PEG nanoparticles could be used for T<sub>1</sub>-weighted magnetic resonance (MR), photoacoustic (PA), and single photon emission computed tomography (SPECT) tri-modal imaging guided photothermal ablation of tumors. Importantly, along with the gradual degradation of VS<sub>2</sub>, our VS<sub>2</sub>@lipid-PEG nanoparticles exhibit effective body excretion without appreciable toxicity. Our work presents the unique advantages of VS<sub>2</sub> nanostructures with highly integrated functionalities and biodegradable behaviors, promising for applications in cancer theranostics.

**Jakusch, T. & Kiss, T. (2017) In vitro study of the antidiabetic behavior of vanadium compounds. *Coordination Chemistry Reviews*, 351: 118-126.**

Keywords: Biospeciation; Diabetes; HMM-binders; Insulin mimetics; LMM-binders; Serum; Vanadium complexes; Whole blood speciation

**Abstract:**

The paper deals with the so far most efficient antidiabetic transition metal compound family. It focuses on the species distribution of the most frequently studied vanadium(IV,V) compounds in biology: in the gastro-intestinal tract (being important in absorption of the compounds), the blood serum (very likely the main route of their transport), the whole blood (recently the role of the red blood cells are also assumed in their transport) and in the cells (where glutathione and ATP may be the most important redox and complex formation partners of the original vanadium-"insulinomimetics").The discussed details fit into the

general view, but far from a complete and clear understanding of the pharmacodynamics of these antidiabetics. A lot more in vitro and mostly in vivo studies are necessary to justify their real clinical use. © 2017 Elsevier B.V.

**Niu, X., Yang, J. & Yang, X. (2017) Synthesis and anti-diabetic activity of new N,N-dimethylphenylenediamine-derivatized nitrilotriacetic acid vanadyl complexes. Journal of Inorganic Biochemistry, 177: 291-299.**

Keywords: Vanadium; Diabetes; DMPD; Alzheimer's disease

**Abstract:**

Vanadium compounds are promising anti-diabetic agents. However, reducing the metal toxicity while keeping/improving the hypoglycemic effect is still a big challenge towards the success of anti-diabetic vanadium drugs. To improve the therapeutic potency using the anti-oxidative strategy, we synthesized new N,N-dimethylphenylenediamine (DMPD)-derivatized nitrilotriacetic acid vanadyl complexes ([VO(dmada)]). The in vitro biological evaluations revealed that the DMPD-derivatized complexes showed improved antioxidant capacity and lowered cytotoxicity on HK-2 cells than bis(maltolato)oxidovanadium (IV) (BMOV). In type II diabetic mice, [VO(p-dmada)] (0.15 mmol kg<sup>-1</sup>/day) exhibited better hypoglycemic effects than BMOV especially on improving glucose tolerance and alleviating the hyperglycemia-induced liver damage. These insulin enhancement effects were associated with increased expression of peroxisome proliferator-activated receptor  $\alpha$  and  $\gamma$  (PPAR $\alpha/\gamma$ ) in fat, activation of Akt (v-Akt murine thymoma viral oncogene)/PKB (protein kinase-B) in fat and liver, and inactivation of c-Jun NH2-terminal protein kinases (JNK) in liver. Moreover, [VO(p-dmada)] showed no tissue toxicity at the therapeutic dose in diabetic mice and the oral acute toxicity (LD50) was determined to be 1640 mg kg<sup>-1</sup>. Overall, the experimental results indicated that [VO(p-dmada)] can be a potent insulin enhancement agent with improved efficacy-over-toxicity index for further drug development. In addition, the results on brain Tau phosphorylation suggested necessary investigation on the effects of vanadyl complexes on the pathology of the Alzheimer's disease in the future.

**Wang, J., Zhou, H., Guo, G., et al. (2017) A functionalized surface modification with vanadium nanoparticles of various valences against implant-associated bloodstream infection. International Journal of Nanomedicine, 12: 3121-3136.** Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5402895/pdf/ijn-12-3121.pdf>

Keywords: Anti-Bacterial Agents/chemistry/pharmacology; Bacteremia/drug therapy; Cell Line; Erythrocytes/drug effects; Glass/chemistry; Humans; Methicillin-Resistant Staphylococcus aureus/drug effects; Nanoparticles/administration & dosage/chemistry; Prosthesis-Related Infections/drug therapy; Pseudomonas Infections/drug therapy; Pseudomonas aeruginosa/drug effects; Staphylococcal Infections/drug therapy; Staphylococcus aureus/drug effects; Surface Properties; Vanadium/chemistry/pharmacology; Vanadium Compounds/chemistry/pharmacology; antibacterial activities; nanomaterials; red blood cell; surface modification; vanadium

**Abstract:**

Bloodstream infection, especially with implants involved, is an often life-threatening condition with high mortality rates, imposing a heavy burden on patients and medical systems. Herein, we firstly deposited homogeneous vanadium metal, V<sub>2</sub>O<sub>3</sub>, VO<sub>2</sub>, and V<sub>2</sub>O<sub>5</sub> nanofilms on quartz glass by magnetron sputtering. Using these platforms, we further investigated the potential antimicrobial efficiency of these nano-VO<sub>x</sub> films and the interactions of human erythrocytes and bacteria (methicillin-resistant Staphylococcus aureus and Pseudomonas aeruginosa) with our samples in a novel cell-bacteria coculture model. It was demonstrated that these nano-VO<sub>x</sub> precipitated favorable antibacterial activity on both bacteria, especially on S. aureus, and this effect increased with higher vanadium valence. A possible mechanism

accountable for these results might be elevated levels of vanadium-induced intracellular reactive oxygen species. More importantly, based on hemolysis assays, our nano-VOx films were found to be able to kill prokaryotic cells but were not toxic to mammalian cells, holding the potential for the prevention of implant-related hematogenous infections. As far as we know, this is the first report wherein such nano-VOx films have assisted human erythrocytes to combat bacteria in a valence-dependent manner. Additionally, vanadium ions were released from these nano-VOx films in a sustained manner, and low-valence films possessed better biocompatibility with human fibroblasts. This work may provide new insights for biomedical applications of inorganic vanadium compounds and attract growing attention in this field. From the perspective of surface modification and functionalization, this study holds promise to avail the prophylaxis of bloodstream infections involving implantable biomedical devices.

## 5. ENVIRONMENTAL EFFECTS in PLANTS and SOIL

**Aihemaiti, A., Jiang, J., Li, D., et al. (2017) Toxic metal tolerance in native plant species grown in a vanadium mining area. *Environmental Science and Pollution Research*, 24(34): 26839-26850.**

### **Abstract:**

Vanadium (V) has been extensively mined in China and caused soil pollution in mining area. It has toxic effects on plants, animals and humans, posing potential health risks to communities that farm and graze cattle adjacent to the mining area. To evaluate in situ phytoremediation potentials of native plants, V, chromium, copper and zinc concentrations in roots and shoots were measured and the bioaccumulation (BAF) and translocation (TF) efficiencies were calculated. The results showed that *Setaria viridis* accumulated greater than 1000 mg kg<sup>-1</sup> V in its shoots and exhibited TF > 1 for V, Cr, Zn and BAF > 1 for Cu. The V accumulation amount in the roots of *Kochia scoparia* also surpassed 1000 mg kg<sup>-1</sup> and showed TF > 1 for Zn. *Chenopodium album* had BAF > 1 for V and Zn and *Daucus carota* showed TF > 1 for Cu. *Eleusine indica* presented strong tolerance and high metal accumulations. *S. viridis* is practical for in situ phytoextractions of V, Cr and Zn and phytostabilisation of Cu in V mining area. Other species had low potential use as phytoremediation plant at multi-metal polluted sites, but showed relatively strong resistance to V, Cr, Cu and Zn toxicity, can be used to vegetate the contaminated soils and stabilise toxic metals in V mining area.

**Banana, A.A., Al-Gheethi, A.A., Noman, E.A., et al. (2017) Assessment of soil pollution by toxic metals and petrochemical compounds in western Libya. *Desalination and Water Treatment*, 83: 272-276.**

Keywords: Abu-Kammash; GC-MS; ICP-mass; Petrochemical compounds; Soil; Toxic elements

### **Abstract:**

The current study aims to assess soil contamination by toxic metals including titanium (Ti), beryllium (Be), tungsten (W), phosphorus (P) and vanadium (V) as well as other heavy metals. The soil samples were collected from Abu-Kammash in Libya which were exposed to petrochemical wastewater generated from the General Company of Chemical Industries (GCCl). The presence of hazardous materials was determined using inductively coupled plasma (ICP-Mass) spectrometry and gas chromatography– mass spectrometry (GC-MS). The results revealed that the soil samples obtained from 100 m of west and east Abu-Kammash were polluted with Ti (39 vs. 175 µg kg<sup>-1</sup>), Be (219 vs. 421 µg kg<sup>-1</sup>), W (0.015 vs. 0.041 µg kg<sup>-1</sup>) and V (18.5 vs. 21.3 µg kg<sup>-1</sup>). The concentration of heavy metal ions ranged from 18.5 µg kg<sup>-1</sup> of vanadium (V) to 1120 µg kg<sup>-1</sup> of zinc (Zn). Among the petrochemical compounds determined in this study, tetratriacontane (C<sub>31</sub>H<sub>64</sub>), 3-methyl-2-oxopropylfuran (C<sub>8</sub>H<sub>10</sub>O<sub>2</sub>) and tetratriacontane (C<sub>54</sub>H<sub>108</sub>Br<sub>2</sub>) were the most frequently detected elements in the soil

samples. The presence of these toxic elements in the environment could pose adverse effects on human health since they might be accumulated in plant tissue and later transmitted to humans via the food chain. © 2017 Desalination Publications. All rights reserved.

**Guagliardi, I., Cicchella, D., De Rosa, R., et al. (2018) Geochemical sources of vanadium in soils: Evidences in a southern Italy area. Journal of Geochemical Exploration, 184(B): 358-364.**

Keywords: Anthropogenic activities; Geochemistry; Geostatistics; Parent rocks; Soils; Vanadium; Fuels; Pollution; Rural areas; Anthropogenic activity; Anthropogenic pollution; Critical threshold value; Geo-statistics; Geochemical composition; Geostatistical method; Soil forming process; Vanadium concentration; Soil pollution

**Abstract:**

Identifying differences of vanadium concentrations in soils is essential to individuate pollution sources and potential risks to humans and the environment. Marked differences in the geochemical composition of the rocks, which form the parent materials of soils, and variations in the intensity of soil-forming processes can result in wide ranges of concentrations of vanadium in soils, even in those unaffected by contamination. Conversely, the anthropogenic input can give rise to contamination in urban soil. The main aim of this study was to analyse the concentrations of vanadium in a southern Italy area, in both rural and urban soils, in order to determine different geochemical sources. In the study area, 149 topsoil samples were collected (0.10. m) and analysed for vanadium and other elements by ICP-MS. Statistical and geostatistical methods were used to identify the main factors influencing the different sources of vanadium in urban and peri-urban soils and to map the concentrations of vanadium. The concentrations of V were higher in the rural soils where were related to the ophiolite-bearing units outcroppings, which influenced importantly the distribution of vanadium, rather than in the urban soil, where were lowly affected by anthropogenic pollution due, predominantly, to circulating vehicle fuels. In urban area the mean concentration of vanadium amounted below the critical threshold value imposed by Italian Decree 152/2006. © 2016.

**Jiménez-Ballesta, R., García-Navarro, F.J., Bravo, S., et al. (2017) Environmental assessment of potential toxic trace element contents in the inundated floodplain area of Tablas de Daimiel wetland (Spain). Environmental Geochemistry and Health, 39(5): 1159-1177.**

Keywords: Fertilization; Potentially toxic trace elements; Spatial variability; Tablas de Daimiel National Park; Wastewater; Wetland

**Abstract:**

Contamination of aquatic systems with potentially toxic trace elements (PTEs) is a major problem throughout the world. The National Park Tablas de Daimiel (NPTD) is considered to make up one of the two most important wetlands in the Biosphere Reserve called “Wet Spot.” Since PTEs are good indicator of the prevailing environmental conditions and possible contamination, soil samples collected from 43 sites were analyzed in order to investigate the levels and its distribution of these elements, in the inundated floodplain area of the NPTD wetland. In addition, some physicochemical parameters such as pH, electrical conductivity and organic matter were measured. The total concentrations of 32 trace elements were determined by X-ray fluorescence. The results show that there was accumulation of lead (Pb), tin (Sn), selenium (Se), antimony (Sb), copper (Cu), vanadium (V), nickel (Ni), zinc (Zn), arsenic (As), strontium (Sr) and zirconium (Zr)—in some cases at high concentrations. The interpolated maps showed that the distributions of some of these elements and in some cases the trend in spatial variability are pronounced and decrease from the inlet to the outlet. The values for some elements are higher than the reference values, which is consistent with contamination (some values are higher by a factor of more than 10 compared to the reference). In the case of iodine (I), the levels at some sample points are significantly more

than ten times the reference; Se appears in the range from 1.0 to 9.8 mg/kg, with an average value of 3.1 mg/kg, and these can be considered as seleniferous soils. The concentrations found are consistent with the introduction in the wetland of pollution by human activities, such as agricultural non-point sources, uncontrolled fertilization over many years, treatment with urban wastewater and other possible sources. © 2016 Springer Science+Business Media Dordrecht.

**Kashin, V.K. (2017) Vanadium in Landscape Components of Western Transbaikalia. Eurasian Soil Science, 50(10): 1154-1165.**

Keywords: soil-forming rocks; soils; plants; coefficient of biological uptake; accumulation; Luvisols; Chernozems; Kastanozems; Fluvisols; BACKGROUND CONCENTRATIONS; CHEMICAL-ELEMENTS; HEAVY-METALS; METALLOIDS; REGION; Agriculture

**Abstract:**

Vanadium in soil-forming rocks, soils, and vegetation of forest-steppe, steppe, and dry-steppe landscapes of Transbaikalia has been studied. The mean element contents in rocks and soils are equal to its mean natural abundances (Clarke values). The content of vanadium in soils is strictly determined by its content in parent materials; its dependence on the vanadium concentration in plants and on the soil pH and humus is less pronounced. With respect to the coefficient of biological uptake by plants, vanadium is assigned to the group of elements of slight accumulation (0.10-0.33) on mineral soils and of moderate accumulation (1.1-1.5) on peat bog soils. The mean vanadium concentration in steppe, meadow, and cultivated vegetation exceeds the norm for animals by 1.7-2.6 times but does not reach toxic levels. Vanadium uptake by plants is most intensive in meadow cenoses and is less intensive in dry-steppe cenoses.

**Xiao, X.Y., Wang, M.W., Zhu, H.W., et al. (2017) Response of soil microbial activities and microbial community structure to vanadium stress. Ecotoxicology and Environmental Safety, 142: 200-206.**

Keywords: Biomass; Cluster Analysis; Denaturing Gradient Gel Electrophoresis; Ecosystem; Microbial Consortia/drug effects/genetics/physiology; Models, Theoretical; RNA, Ribosomal, 16S/genetics; Soil/chemistry; Soil Microbiology; Soil Pollutants/analysis/toxicity; Vanadium/analysis/toxicity; Community structure; PCR-DGGE analysis; Response; Soil microbial activity; Vanadium

**Abstract:**

High levels of vanadium (V) have long-term, hazardous impacts on soil ecosystems and biological processes. In the present study, the effects of V on soil enzymatic activities, basal respiration (BR), microbial biomass carbon (MBC), and the microbial community structure were investigated through 12-week greenhouse incubation experiments. The results showed that V content affected soil dehydrogenase activity (DHA), BR, and MBC, while urease activity (UA) was less sensitive to V stress. The average median effective concentration (EC<sub>50</sub>) thresholds of V were predicted using a log-logistic dose-response model, and they were 362mgV/kg soil for BR and 417mgV/kg soil for DHA. BR and DHA were more sensitive to V addition and could be used as biological indicators for soil V pollution. According to a polymerase chain reaction-denaturing gradient gel electrophoresis (PCR-DGGE) analysis, the structural diversity of the microbial community decreased for soil V contents ranged between 254 and 1104mg/kg after 1 week of incubation. As the incubation time increased, the diversity of the soil microbial community structure increased for V contents ranged between 354 and 1104mg/kg, indicating that some new V-tolerant bacterial species might have replicated under these conditions.

## 6. ENVIRONMENTAL EFFECTS in TERRESTRIAL ORGANISMS

**Usende, I.L., Emikpe, B.O. & Olopade, J.O. (2017) Heavy metal pollutants in selected organs of African giant rats from three agro-ecological zones of Nigeria: evidence for their role as an environmental specimen bank. *Environmental Science and Pollution Research International*, 24(28): 22570-22578.**

Keywords: African giant rats; Agro-ecological zones; Ecotoxicological research; Environmental pollution; Environmental specimen banks; Heavy metals; Nigeria

### **Abstract:**

An assessment of the concentration of heavy metals in the liver, brain, kidney, bone, and lungs of African giant rats (AGRs) from three agro-ecological zones of Nigeria having different industrial activities was carried out using atomic absorption spectrophotometer. Twenty adult AGRs from cities in mangrove/freshwater swamp, rainforest, and woodland/tall grass savanna agro-ecological zones of Nigeria were used for this study. AGRs were euthanized, carefully dissected, and the brains, liver, lungs, bone, and kidneys were harvested, digested, and analyzed for concentrations of vanadium (V), lead (Pb), cadmium (Cd), zinc (Zn), selenium (Se), copper (Cu), and iron (Fe). All data generated were evaluated for statistical significance using one-way ANOVA with Tukey's multiple post-test comparison. Results showed the major environmental heavy metal pollutants of the mangrove/freshwater swamp to be vanadium and selenium while those of woodland/tall grass savanna agro-ecological zones were lead, selenium, and zinc. The vanadium concentration was more than twofold higher in the observed tissues of AGR from the mangrove/freshwater swamp, and this may be related to increased exploitation of minerals and the activities of militants in pipeline vandalization in this zone. Interestingly, the highest concentration of this metal was seen in the lungs suggestive of a respiratory route of exposure. Among the potential adverse effects derived from exposure to metals, developmental toxicity is a serious risk. This type of investigation can assist in knowing the level of animal and human exposure to environmental pollutants both in highly industrialized and non-industrialized areas and is more ideal in environmental monitoring. This study therefore suggests AGR as model for ecotoxicological research and environmental specimen banks (ESBs) in this part of Africa.

## 7. ENVIRONMENTAL EFFECTS in AQUATIC ORGANISMS

**Celis-Hernandez, O., Rosales-Hoz, L., Cundy, A.B., et al. (2018) Historical trace element accumulation in marine sediments from the Tamaulipas shelf, Gulf of Mexico: An assessment of natural vs anthropogenic inputs. *Science of the Total Environment*, 622–623: 325-336.**

Keywords: Trace element; Sediment cores; Oil industry; Barium; Gulf of Mexico; 210Pb dating

### **Abstract:**

The Gulf of Mexico is considered one of the world's major marine ecosystems, supporting important fisheries and habitats such as barrier islands, mangrove forests, seagrass beds, coral reefs etc. It also hosts a range of complex offshore petroleum exploration, extraction, and refining industries, which may have chronic or acute impacts on ecosystem functioning. Previous work on the marine effects of this activity is geographically incomplete, and has tended to focus on direct hydrocarbon impacts, while impacts from other related contaminants (e.g. heavy metals, salt-rich drilling muds) which may be discharged from oil facilities have not been widely assessed. Here, we examine historical trace element accumulation in marine sediments collected from four sites in the Tamaulipas shelf, Gulf of

Mexico, in the area of the Arenque oil field. Dated sediment cores were used to examine the sources, and historical and contemporary inputs, of trace metals (including those typically present in oil industry discharges) and their potential biological impact in the Tamaulipas aquatic environment over the last 100 years. CaO (i.e. biogenic component) normalized data showed increasing V, Cr, Zn, Cu, Pb, Zr and Ba towards the sediment surface in three of the four cores, with Ba and V (based on an adverse effect index) possibly associated with adverse effects on organisms. Dated Ba/CaO profiles show an increase of 30–137% after opening of oil installations in the study area, and can be broadly correlated with increasing oil industry activities across the wider Gulf of Mexico. Data do not record however a clear enhancement of Ba concentration in sediment cores collected near to oil platforms over more distal cores, indicating that any Ba released from drilling platforms is incorporated quickly into the sediments around the drilling sites, and once this element has been deposited its rate of resuspension and mobility is low. Capsule abstract Sediment core data from the Tamaulipas shelf show the influence of oil industry activities on selected trace element concentrations, with Ba/CaO broadly correlating with increasing oil industry activities across the wider Gulf of Mexico.

**Liu, Y., Liu, G., Yuan, Z., et al. (2018) Heavy metals (As, Hg and V) and stable isotope ratios (d13C and d15N) in fish from Yellow River Estuary, China. Science of the Total Environment, 613-614: 462-471. Available at: [https://www.researchgate.net/profile/Yuan\\_Liu102/publication/319879809\\_Heavy\\_metals\\_As\\_Hg\\_and\\_V\\_and\\_stable\\_isotope\\_ratios\\_d13C\\_and\\_d15N\\_in\\_fish\\_from\\_Yellow\\_River\\_Estuary\\_China/links/59cb9a47aca272bb050c3998/Heavy-metals-As-Hg-and-V-and-stable-isotope-ratios-d13C-and-d15N-in-fish-from-Yellow-River-Estuary-China.pdf](https://www.researchgate.net/profile/Yuan_Liu102/publication/319879809_Heavy_metals_As_Hg_and_V_and_stable_isotope_ratios_d13C_and_d15N_in_fish_from_Yellow_River_Estuary_China/links/59cb9a47aca272bb050c3998/Heavy-metals-As-Hg-and-V-and-stable-isotope-ratios-d13C-and-d15N-in-fish-from-Yellow-River-Estuary-China.pdf)**

Keywords: Fish; Heavy metals; Stable isotope ratios; Yellow River Estuary

**Abstract:**

The Yellow River Estuary is a significant fishery, but at present there are few studies about the concentrations of arsenic (As), mercury (Hg) and vanadium (V) in fish from this area, which might cause potential health risk to fish consumers. The aim of this study was to research on the accumulation and potential sources of heavy metals in the fish of the Yellow River Estuary. Arsenic, Hg, V and stable isotope ratios (d15N and d13C) in 11 species of 129 fish were analyzed. Results showed that the concentrations of As and Hg were all lower than the guideline levels established by international organizations and legal limits by several countries. The mean concentrations of V in samples in this study were significantly higher than the results of previous studies on other regions. Arsenic, Hg and V significantly differed across species ( $P < 0.05$ ), which might be due to the different foraging habitats and dietary habits of the studied fish. Values of d15N and d13C in fish from the study area ranged from 5.1‰ to 14.6‰ and from - 27.6‰ to - 14.5‰, indicating a wide range of trophic positions and energy sources. There was evidence of bioaccumulation of Hg, which could be explained by the positive correlation between Hg concentrations and d15N in fish. Through estimation of daily intake of inorganic As (iAs), Hg and V via fish consumption, the heavy metal contamination level of fish samples fell in an acceptable range, indicating no potentially hazardous for human health. © 2017 Elsevier B.V.

**Liu, Y., Liu, G., Yuan, Z., et al. (2017) Presence of arsenic, mercury and vanadium in aquatic organisms of Laizhou Bay and their potential health risk. Marine Pollution Bulletin, 125(1-2): 334-340.**

Keywords: Trace elements; Stable isotope ratios; Aquatic organism; Laizhou Bay

**Abstract:**

This study aims at describing and interpreting concentrations of arsenic (As), mercury (Hg) and vanadium (V) in seven species of fish, three species of shellfish, one species of crab and

two species of shrimp from the typical estuary-bay ecosystem. Arsenic, Hg and V differed among species, and the highest As, Hg and V were observed in shellfish. The stable nitrogen ( $\delta^{15}\text{N}$ ) and carbon ( $\delta^{13}\text{C}$ ) isotopes were determined to investigate the trophic interactions between fluctuating environment and aquatic species. Arsenic concentrations in samples were found negatively correlated with  $\delta^{15}\text{N}$ , implying biodilution effect of As through the food web, while Hg concentrations in samples were positively correlated with  $\delta^{15}\text{N}$ , indicating their biomagnification effect. The estimated daily intake values of Hg and V in this study were all below the oral reference dose. However, elevated As intakes of some aquatic organisms suggested a potential risk for frequent consumers. "

**Schiffer, S. & Liber, K. (2017) Estimation of Vanadium Water Quality Benchmarks for the Protection of Aquatic Life with Relevance to the Athabasca Oil Sands Region using Species Sensitivity Distributions. *Environmental Toxicology and Chemistry*, 36(11): 3034-3044.**

Keywords: Oil sands coke; Species sensitivity distribution (SSD); Vanadium; Water quality guidelines

**Abstract:**

Elevated vanadium (V) concentrations in oil sands coke, which is produced and stored on the site of some major Athabasca Oil Sands companies, could pose a risk to aquatic ecosystems in northern Alberta, Canada, depending on its future storage and utilization. In the present study, V toxicity was determined in reconstituted Athabasca River water to various freshwater organisms, including 2 midge species (*Chironomus dilutus* and *Chironomus riparius*; 4-d and 30- to 40-d exposures) and 2 freshwater fish species (*Oncorhynchus mykiss* and *Pimephales promelas*; 4-d and 28-d exposures) to facilitate estimation of water quality benchmarks. The acute toxicity of V was 52.0 and 63.2 mg/L for *C. dilutus* and *C. riparius*, respectively, and 4.0 and 14.8 mg V/L for *P. promelas* and *O. mykiss*, respectively. Vanadium significantly impaired adult emergence of *C. dilutus* and *C. riparius* at concentrations  $\geq 16.7$  (31.6% reduction) and 8.3 (18.0% reduction) mg/L, respectively. Chronic toxicity in fish presented as lethality, with chronic 28-d estimates of 0.5 and 4.3 mg/L for *P. promelas* and *O. mykiss*, respectively. These data were combined with data from the peer-reviewed literature, and separate acute and chronic species sensitivity distributions (SSDs) were constructed. The acute and chronic hazardous concentrations endangering only 5% of species (HC5) were estimated as 0.64 and 0.05 mg V/L, respectively. These new data for V toxicity to aquatic organisms ensure that there are now adequate data available for regulatory agencies to develop appropriate water quality guidelines for use in the Athabasca Oil Sands region and elsewhere. Until then, the HC5 values presented in the present study could serve as interim benchmarks for the protection of aquatic life from exposure to hazardous levels of V in local aquatic environments. This article is protected by copyright. All rights reserved.

## 8. MISCELLANEOUS

**Barbieri, M., Mencio, F., Papi, P., et al. (2017) Corrosion behavior of dental implants immersed into human saliva: preliminary results of an in vitro study. *European Review for Medical and Pharmacological Sciences*, 21(16): 3543-3548.** Available at: <http://www.europeanreview.org/wp/wp-content/uploads/3543-3548-Corrosion-behavior-of-dental-implants-immersed-into-human-saliva.pdf>

**Abstract:**

OBJECTIVE: Over the years, different implant surfaces have been used to try to maximize bone to implant contact. The aim of this study was to compare levels of metallic ions and particles dissolution collected from two different dental implants surfaces immersed into human saliva. PATIENTS AND METHODS: A total of 60 dental implants were tested. Group A: sanded with aluminium oxide medium grade particles and acid-etched; Group B: micro-sanded with calcium phosphate powders and acid-etched. Forty implants were immersed in 20 ml of

human saliva, twenty, as a control, in sterile saline solution. ICP-MS was performed to detect any metallic ions released from dental implants at T0, on day 1 (T1), on day 3 (T2), after one week (T3), on day 14 (T4), after 3 months (T5) and after 6 months (T6). RESULTS: Dissolution of metallic particles of titanium and nickel, absent in human saliva (T0), were found after one week (T3) for Group B and after 3 months (T5) for Group A. Vanadium was already detected in small concentrations in either group after 1 day, with an exponential growth for Group B. CONCLUSIONS: Preliminary results reported significant values of Ti, Ni and V released by Group B, showing for the first time statistically significant values of vanadium.

**Liu, H., Zhang, B., Yuan, H., et al. (2017) Microbial reduction of vanadium (V) in groundwater: Interactions with coexisting common electron acceptors and analysis of microbial community. Environmental Pollution (Barking, Essex : 1987), 231(Pt 2): 1362-1369.**

Keywords: Electron acceptors; Groundwater; Microbial community; Microbial reduction; Vanadium (V)

**Abstract:**

Vanadium (V) pollution in groundwater has posed serious risks to the environment and public health. Anaerobic microbial reduction can achieve efficient and cost-effective remediation of V(V) pollution, but its interactions with coexisting common electron acceptors such as NO<sub>3</sub>(-), Fe(3+), SO<sub>4</sub>(2-) and CO<sub>2</sub> in groundwater remain unknown. In this study, the interactions between V(V) reduction and reduction of common electron acceptors were examined with revealing relevant microbial community and identifying dominant species. The results showed that the presence of NO<sub>3</sub>(-) slowed down the removal of V(V) in the early stage of the reaction but eventually led to a similar reduction efficiency (90.0% +/- 0.4% in 72-h operation) to that in the reactor without NO<sub>3</sub>(-). The addition of Fe(3+), SO<sub>4</sub>(2-), or CO<sub>2</sub> decreased the efficiency of V(V) reduction. Furthermore, the microbial reduction of these coexisting electron acceptors was also adversely affected by the presence of V(V). The addition of V(V) as well as the extra dose of Fe(3+), SO<sub>4</sub>(2-) and CO<sub>2</sub> decreased microbial diversity and evenness, whereas the reactor supplied with NO<sub>3</sub>(-) showed the increased diversity. High-throughput 16S rRNA gene pyrosequencing analysis indicated the accumulation of *Geobacter*, *Longilinea*, *Syntrophobacter*, *Spirochaeta* and *Anaerolinea*, which might be responsible for the reduction of multiple electron acceptors. The findings of this study have demonstrated the feasibility of anaerobic bioremediation of V(V) and the possible influence of coexisting electron acceptors commonly found in groundwater.

**Liu, Y., Liu, G., Qu, Q., et al. (2017) Geochemistry of vanadium (V) in Chinese coals. Environmental Geochemistry and Health, 39(5): 967-986.**

Keywords: Chinese coals; Distribution; Geochemistry; Modes of occurrence; Vanadium

**Abstract:**

Vanadium in coals may have potential environmental and economic impacts. However, comprehensive knowledge of the geochemistry of V in coals is lacking. In this study, abundances, distribution and modes of occurrence of V are reviewed by compiling >2900 reported Chinese coal samples. With coal reserves in individual provinces as the weighting factors, V in Chinese coals is estimated to have an average abundance of 35.81 µg/g. Large variation of V concentration is observed in Chinese coals of different regions, coal-forming periods, and maturation ranks. According to the concentration coefficient of V in coals from individual provinces, three regions are divided across Chinese coal deposits. Vanadium in Chinese coals is probably influenced by sediment source and sedimentary environment, supplemented by late-stage hydrothermal fluids. Specifically, hydrothermal fluids have relatively more significant effect on the enrichment of V in local coal seams. Vanadium in coals is commonly associated with aluminosilicate minerals and organic matter, and the modes of V occurrence in coal depend on coal-forming environment and coal rank. The Chinese V

emission inventory during coal combustion is estimated to be 4906 mt in 2014, accounting for 50.55 % of global emission. Vanadium emissions by electric power plants are the largest contributor.

**Makhotkina, E.S. & Shubina, M.V. (2017) Industrial, ecological and resource-efficient aspects of vanadium production and use of technogenic vanadium sources. *Solid State Phenomena*, 265: 994-998.**

Keywords: Leaching; Resource-efficient; Roasting; Technogenic waste; Titanomagnetites; Vanadium; Vanadium extraction degree; Vanadium slag; Vanadium sources

**Abstract:**

The causes of the global vanadium consumption increase are described and new applications of this metal are given in the article. The main natural sources of vanadium are titanomagnetite, which is a strategic mineral raw material. The current volumes of vanadium extraction from natural raw materials do not match the demand of the market. Therefore there is an urgent need for recycling of secondary and technogenic sources. Partially the basic existing technologies processing vanadium-containing waste are reviewed. The effect of these wastes on the environment and human health is analyzed. The importance of vanadium steel slag recycling for the ecological state of industrial regions, resource-efficiency in expanding the raw material sources of vanadium and reducing the cost of steel production in general is shown. The results of studies on the extraction of vanadium in the form of soluble vanadate of metallurgical vanadium slag using hydrometallurgical processing are demonstrated. The analysis of the received values of the vanadium extraction degree was conducted. The influence of various factors on the completeness of extraction was examined. A significant influence on the vanadium extraction degree of slag chemical composition, the ratio of slag and alkaline additives in the charge, conditions of roasting and leaching was revealed. © 2017 Trans Tech Publications, Switzerland.

**Visalli, G., Facciola, A., Bertuccio, M.P., et al. (2017) In vitro assessment of the indirect antioxidant activity of Sulforaphane in redox imbalance vanadium-induced. *Natural Product Research*, 31(22): 2612-2620.**

Keywords: Caco-2; HepG2; mitochondrial function; oxidative stress; Sulforaphane; vanadium V(IV); Vero cells

**Abstract:**

Owing to sulforaphane presence, a dietary consumption of Brassicaceae prevents chronic diseases. This hormetic compound induces adaptive stress response at subtoxic doses, while doses that exceed the cellular defence are toxic. In HepG2, Caco-2 and Vero cells, we investigated the sulforaphane (SFN) (5  $\mu$ M) role in counteracting redox imbalance induced by VOSO<sub>4</sub> [V(IV)]. 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) test showed a dose-dependent viability reduction ( $r < -0.95$ ;  $p < 0.01$ ) (range 5–80  $\mu$ M). At 5  $\mu$ M, SFN enhancement of mitochondrial activity was confirmed by  $\Delta\psi_m$  ( $p < 0.05$ ) both in basal condition and in redox-stressed cells. Intracellular ROS, DNA and lysosomal oxidative damages underlined the indirect antioxidant SFN activity, confirmed by the increase of GSH. The SFN empowering effects on mitochondrial function were imputable to the presence of mitochondrial proteins among the Nrf2-responsive phase II proteins. Considering the link between oxidative stress and chronic diseases, a long-term dietary intake of Brassicaceae could be strongly advisable. © 2017 Informa UK Limited, trading as Taylor & Francis Group.