Mineral content of semen: Novel findings

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Abstract

Introduction
Human seminal plasma contains several elements that play important metabolic role(s). The present report is the first investigation into the mineral content of human semen intended to elucidate differences in mineral content in health and disease, and to establish normal range. However, the cost of analysis by Plasma Mass Spectrometry proved to be prohibitively expensive hence the present effort is confined to a small sample size (n=9).
Methodology
Inductively coupled plasma mass spectrometry (ICP-MS) was employed to determine the mineral content of human semen. Fifteen important elements were investigated in 9 semen samples obtained with informed consent of which 4 were normozoospermic, 3 oligospermic and 2 severe oligozoospermic. The level of Ca, P, K, Cl, Na, Mg, Cu, Fe, Se, Zn, Al, Co, Cr, Mn and Li were determined (n=15 minerals). Student's unpaired T-test was used to determine differences between normal and abnormal specimen.
Results
Mn, Co, Li and Cr were absent in all semen samples which included both normal and abnormal specimen. It was noted Fe, Cu, P was significantly higher in normozoospermic and severe oligospermic compared to oligozoospermic specimen; whereas Na and Cl was significantly lower in normozoospermic and severe oligozoospermic compared oligozoospermic specimen.
Discussion and Conclusion
In this small preliminary investigation although significant differences were seen between groups for specific elements but were at times confounded by conflicting results which occurred due to very small sample size. A more accurate interpretation of the data can be made after the study is completed with a larger sample size. The sample size is too small to conclude at this stage. The study is on-going. The actual levels of minerals will be known after completion of study. Suffice to say, at this stage, we have demonstrated approximate levels of 15 minerals in human semen for the first time.

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Introduction

Human seminal plasma contains several trace elements that may play important metabolic role(s) as well important functional roles on spermatozoa development, and activity. In the human semen except for zinc we have very little information regarding other minerals. The roles of various trace elements and minerals on the spermatozoa development, function, and activity has been extensively reviewed by Mirnamniha and coworkers (Mirnamniha et al.,2019) and role of dietary factors including minerals on the spermatozoa have also been reveiwed or investigated by a number of workers (see Buhling et al., 2019; Garolla et al., 2020; Kerns et al., 2018; Nenkova et al., 2017; Saddogh et al., 2021; Skorackaet al., 2020) and many more.

However there do not appear to be any study that investigated the complete mineral profile of the human semen in health and disease. In the pursuance of providing information on the semen mineral profile, effort has been made to determine the levels of the most physiologically useful micro minerals in 3 categories of

human seminal plasma namely:

- Normozoospermic
- Oligozoospermic and
- Severe Oligozoospermic

Differences between these specimen with regard to their mineral content will enable us understand the impact of minerals on the semen quality and the performance of spermatozoa in health and disease. The findings of this study may allow us to develop techniques for induction and or improvement of spermatozoal activity in some pathological conditions.

The present report is the first investigation into the mineral content of human semen intended to elucidate differences in mineral content in health and disease, and to establish normal range. It is well recognized that trace elements are involved in the regulation of metabolism, tissue respiration, the biosynthesis of hormones and are cofactors that are structural components of several enzymes.

However cost of analysis by inductively coupled plasma mass spectrometry (ICP-MS) proved to be prohibitively expensive hence the present effort is confined to a small sample size.

Materials and methods

Semen samples were obtained with informed consent from patients seeking ART treatment at the University of Malaya Fertility Center (UMFC).

Fifteen important elements were investigated in 9 semen (n=9) semen samples obtained with informed consent, Of these 4 were normozoospermics, 3 oligozoospermics and 2 severe oligozoospermics obtained with informed consent,. Of these 4 were normozoospermics, 3 oligozoospermics and 2 severe oligozoospermics.

The investigations were performed using Inductively Coupled Plasma Mass Spectometry (ICP-MS) in collaboration with the Department of Chemistry, Faculty of Science.

The level of Ca, P, K, Cl, Na, Mg, Cu, Fe, Se, Zn, Al, Co, Cr, Mn and Li were determined (n=15 minerals).

Student's unpaired T-test was used to determine differences between normal and abnormal specimen.

Results

There does not appear to be major differences between the mineral content of normozoospermic, oligozoospermic and severe oligozoospermic semen samples but the sample size is too small to conclude. Suffice to say we are able to see approximate levels of these minerals in semen for the first time.

Mn, Co, Li and Cr were absent in all semen samples which included both normal and abnormal specimen. Fe, Cu, P was significantly higher in normozoospermic and severe oligospermic semen compared to oligozoospermic specimen; whereas Na and Cl was significantly lower in normozoospermic and severe oligozoospermic compared oligozoospermic specimen.

Of interest is that in 1 sample with the lowest sperm count the concentration of Sodium (Na) was the lowest compared to the others.

The results shows that there is a significant ($p<0.001$) difference between all the I5 mineral when compared between (i) normozoospermic with oligozoospermic, (ii) normospermic with severe oligozoospermic and (iii) oligozoospermic with severe oligozoospermic semen. We did not have any azoospermic specimen amongst the 15 patients investigated

Discussion

This study, to the best of our knowledge, was the first attempt at determining the mineral content of human semen in both normal and pathological states. A number of factors are well recognized to affect male fertility (Skorracka et al., 2020).

Trace elements are necessary for all aspects of human physiology, including reproduction. Metal ions, among many other things, play critical roles in approximately one-third of enzymes (Silva et al., 1991).

Table 1: The mineral content of 15 elements found in human semen

Element	Nor Mean ppb	Oli Mean ppb	Sev Mean ppb	Nor vs Oli p-value	Nor vs Sev p value	Oli vs Sev p-value	Nor vs Oli+Sev p-value
Mn	0	0	0	N/A	N/A	N/A	N/A
Fe	8.07	0.3282	5.483	0.0023	0.4347	0.0017	0.4692
Co	0	0	0	N/A	N/A	N/A	N/A
Cu	2.4328	0.3105	0.855	0.0177	0.0635	0.2312	0.0374
Zn	10021	3627.3	5721	0.4664	0.1164	0.1318	0.1244
Se	1.6302	0.5555	1.12	0.2985	0.3479	0.183	0.3818
Li	0	0	0	N/A	N/A	N/A	N/A
Na	16550	37428	0	0.356	0	0	0.356
Mg	9657	5319.3	3766.3	0.1629	0.2125	0.4216	0.0699
Al	3.09	0.345	2.145	0.3117	0.2152	0.3791	0.3636
P	52496	9190	40083	0.0122	0.2969	0.0046	0.2498
Cl	698.75	1444.3	0	0.2926	0	0	0.2936
K	40145	31640	15488	0.1651	0.3206	0.2988	0.0702
Ca	1999.3	1613.5	728	0.2005	0.4771	0.216	0.1128
Cr	0	0	0	N/A	N/A	N/A	N/A

There do not appear to be significant differences in the mineral composition of normozoospermic, oligozoospermic, and severe oligozoospermic semen samples, however significant differences were noted in the levels of individual elements between normal and pathological states. However the sample size is too small to draw any conclusions. At this stage; suffice to say, for the first time, we have provided approximate levels of a number of trace minerals in semen.

Four elements were absent in both normal and abnormal semen namely Mn, Co, Li and Cr. Whereas Fe, Cu, P was significantly higher in normozoospermic and severe oligospermic compared to oligozoospermic specimen; whereas Na and Cl was significantly lower in normozoospermic and severe oligozoospermic compared oligozoospermic specimen. However due to the limitation of the samll sample size these observations cannot be accepted as factual because of confounding by conflicting results.

A more accurate interpretation of the data can be made after if a study can be completed with a larger sample size. The actual levels of minerals can be determined with a greater level of confidence if a larger study involving many patients. Suffice to say, at this stage, we have demonstrated approximate levels of 15 minerals in human semen for the first time.

Conclusion

This small preliminary investigation revealed the levels of 15 trace elements and minerals in the human semen, some of them for the first time. Four elements namely, Mn, Co, Li and Cr were absent in both normal and abnormal

semen.This is a novel finding. Although significant differences in semen with regard to levels of t hese trace elements and minerals were seen between normal and pathological conditions for specific elements but the information accrued may not be factual due to the small sample size. A more accurate interpretation of the data can be made after a larger study can be performed.

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