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Mini Review

Essential Minerals for Good Heath, but their Overdose is Not

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Abstract

Present review paper focussed on the essential metals Cu and Zn in the marine mussels by oral human consumption based on estimated daily intakes (EDI) and target hazard quotient (THQ) for both metals. The values of EDI and THQ have been re-calculated with the cited data of Cu and Zn from 8 publications with four marine mussel species. It is found that high level mussel consumers have higher values of EDI and THQ, when compared to average level mussel consumers. The uncontrolled intake of contaminated mussels could result in THQ value > 1, indicating negative health implications during a life span in a human population. Therefore, this finding indicated both metals, although are essential minerals for good health, their overdose is not.

Keywords: *Essential Metals; Estimated Daily Intakes; Target Hazard Quotient; Mussels*

A good nutrition for healthy life in human needs a balance diet following a healthy food pyramid with the widest base on the bottom. Sources of essential minerals may come from different food sources such as meats, fish, shellfish, vegetables and fruits besides drinking water. These minerals usually are those needed for the basal metabolisms and catabolisms for the living tissues in human. However, any minerals uptake exceeding the threshold levels or permissible limits could be detrimental or pose a potential threat to the cells of human body.

Let me exemplify with the intake of essential metals Cu and Zn in the marine mussels by oral human consumption based on estimated daily intakes (EDI) for average level mussel (ALM) and high level mussel (HLM) consumers in marine mussels in order to evaluate a once- or long-term potential hazardous exposure to metals through consumption of mussels [1,2] by the population of Malaysia, the EDI (μg/kg/day) values were calculated by using the following formula EDI= (Mc x Consumption rate)/ body weight (Where, Mc: the metal concentration in mussel ST was obtained on ww bases; Consumption rate: 17.86 and 35.7 g/day, for ALM and HLM consumers, respectively [3]; Body weight: 60 kg for adults).

The EDI value of each metal will be compared with the oral reference dose (ORD) in order to obtain the target hazard quotient (THQ) value of Cu and Zn. The ORD values (μg/kg/day) used in this paper were: Cu: 40.0 and Zn: 300, provided by the USEPA's regional screening level [4]. The THQ values, developed by the USEPA [1,2], have been recognized as useful parameters for human health risk assessments of metals associated with the intake of mussels [5]. The THQ is also a non-carcinogenic risk assessment which is a ratio between the estimated dose of metal exposure and the ORD. A THQ > 1 indicates that the exposure level exceeds the recommended ORD value, which assumes that a daily exposure at this metal level could cause negative health implications during a life span in a human population [6].

In this paper, I have reviewed and cited the data of Cu and Zn from 8 publications (7 from Science Direct database and one from Springer Link database), covering four marine mussel species (*Perna viridis; Mytilus galloprovincialis; Mytilus edulis trossulus; Perna perna*) from eight different countries. Recalculation of EDI and THQ, based on the above mentioned consumption rate and body weight had been followed in order to provide a valid comparison. The only difference is the concentrations of Cu and Zn cited from the respective publication.

Results

The results of the calculations are presented in Tables 1 and 2 for EDI and THQ, respectively. As expected, the mussels with higher concentrations of Cu and Zn would produce higher values of EDI and THQ. It is found that HML consumers have higher values of EDI and THQ, when compared to ALM consumers. This strongly indicated that the more amount of marine mussels being consumed, there is a better chance of exceeding the ORD value and thus the THQ value to exceed one.

Table 1: *Comparisons of estimated daily intakes (EDI) of Cu and Zn for average (ALM) and high level mussel (HLM) consumers in marine mussels from in the literature.*

No.	Locations (Species; number of sites; sampling year)	EDI	Cu	Zn	Reference
1.	Gulf of Gdansk, Poland	ALM	0.37	6.98	Szefer., *et al.* (2002) [7]
	(MET; 1 site; 1997)	HLM	0.73	13.9	
2.	Mason Bay (M3), Korea	ALM	0.40	6.02	Szefer., *et al.* (2004) [8]
	(MG; 1 site; 1998-1999)	HLM	0.81	12.0	
3.	Hong Kong coastal waters	ALM	6.58	8.60	Liu and Kueh (2005) [9]
	(PV; 5 sites, 1998-2003)	HLM	13.2	17.2	
4	Port Mudanya, Turkey	ALM	0.28	9.92	Unlu., *et al.* (2008) [10]
	(MG; 1 site; 2004)	HLM	0.56	19.8	
5.	Gulf of Annaba (Sidi Salem Beach, Algeria	ALM	1.35	18.2	Belabed., *et al.* (2013) [11]
	(PP; 1 site; 2006-2007)	HLM	2.70	36.3	
6.	Diane pond, east Corsica, France	ALM	0.24	3.67	Richir and Gobert (2014) [12]
	(MG; 1 site; 2011)	HLM	0.49	7.34	
7.	Boka Kotorska Bay, Montenegro	ALM	0.27	5.63	Jovic and Stankovic (2014) [13]
	(MG; 7 sites; 2009)	HLM	0.54	11.2	
8.	The Straits of Malacca, Malaysia	ALM	0.87	4.63	Yap., *et al.* (2016) [14]
	(PV; 10 sites; 2002-2009)	HLM	1.73	9.24	
	Oral Reference Dose (RfDo, µg/kg/day)		40.0	300	USEPA (2015) [4]

Note: *All calculations of EDI were based on adult body weight of 60kg with average (ALM) and high level mussel (HLM) consumption rate as 17.86 g/day and 35.7 g/day, respectively.*

Original metal data were all reported in mg/kg dry weight; PV: Perna viridis; MG: Mytilus galloprovinciallis; MET: Mytilus edulis trossulus; PP: Perna perna.

Of course, the establishment of EDI and THQ is more reflective to the potential harm effects to human if compared to direct comparison of maximum permissible limit (MPL) of individual metal. This is because of the consideration of amount of mussels consumed (consumption rate), the body weight of the consumers (a child has a smaller size than an adult), besides the metal concentrations (mg/kg) of the seafood. However, these important parameters are not taken in account if direct comparison of MPL of a metal is conducted.

Table 2: *Comparisons of target hazard quotient (THQ) of Cu and Zn for average (ALM) and high level mussel (HLM) consumers in the marine mussels reported in the literature.*

No.	Locations (Species; number of sites; sampling year)		Cu	Zn	Reference
1.	Gulf of Gdansk, Poland	ALM	0.009	0.023	Szefer., *et al.* (2002) [7]
	(MET; 1 site; 1997)	HLM	0.018	0.047	
2.	Mason Bay (M3), Korea	ALM	0.010	0.020	Szefer., *et al.* (2004) [8]
	(MG; 1 site; 1998-1999)	HLM	0.020	0.040	
3.	Hong Kong coastal waters	ALM	0.164	0.029	Liu and Kueh (2005) [9]
	(PV; 5 sites, 1998-2003)	HLM	0.329	0.057	
4	Port Mudanya, Turkey	ALM	0.007	0.033	Unlu., *et al.* (2008) [10]
	(MG; 1 site; 2004)	HLM	0.014	0.066	
5.	Gulf of Annaba (Sidi Salem Beach, Algeria	ALM	0.034	0.061	Belabed., *et al.* (2013) [11]
	(PP; 1 site; 2006-2007)	HLM	0.068	0.121	
6.	Diane pond, east Corsica, France	ALM	0.006	0.012	Richir and Gobert (2014) [12]
	(MG; 1 site; 2011)	HLM	0.012	0.024	
7.	Boka Kotorska Bay, Montenegro	ALM	0.007	0.019	Jovic and Stankovic (2014) [13]
	(MG; 7 sites; 2009)	HLM	0.013	0.037	
8.	The Straits of Malacca, Malaysia	ALM	0.022	0.016	Yap., *et al.* (2016) [14]
	(PV; 10 sites; 2002-2009)	HLM	0.043	0.031	

Note: *PV: Perna viridis; MG: Mytilus galloprovinciallis; MET: Mytilus edulis trossulus; PP: Perna perna.*

Conclusion

In conclusion, although Cu and Zn are essential minerals for living cells in human, the amount of these two metals should still be controlled and limited. The establishment of ORD values for Cu and Zn should be followed and the EDI of metals of marine mussels should not exceed the ORD values established for the metals. A THQ value > 1 gives us an assumption that a daily exposure at this level is potentially a negative health signal to us. As a proverb goes 'Prevention of better than cure'. So, essential minerals are important for good heath, but their overdose is not.

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